

**AFFILIATED INSTITUTIONS  
ANNA UNIVERSITY, CHENNAI**

**R-2013**

**B. TECH. FOOD TECHNOLOGY**

**I - VIII SEMESTERS CURRICULUM AND SYLLABUS**

**SEMESTER - I**

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

**SEMESTER II**

<b>CODE NO</b>	<b>COURSE TITLE</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>THEORY</b>					
HS6251	Technical English – II*	3	1	0	4
MA6251	Mathematics – II*	3	1	0	4
PH6251	Engineering Physics – II*	3	0	0	3
CY6251	Engineering Chemistry – II*	3	0	0	3
GE6253	Engineering Mechanics	3	1	0	4
GE6252	Basic Electrical & Electronics Engineering	4	0	0	4
<b>PRACTICAL</b>					
GE6262	Physics & Chemistry Laboratory - II*	0	0	3	2
GE6261	Computer Aided Drafting and Modeling Laboratory	0	1	2	2
	<b>TOTAL</b>	<b>19</b>	<b>4</b>	<b>5</b>	<b>26</b>

### SEMESTER III

CODE NO	COURSE TITLE	L	T	P	C
<b>THEORY</b>					
MA6351	Transforms and Partial Differential Equation	3	1	0	4
FD6301	Principles of Chemical Engineering	3	0	0	3
FD6302	Food Process Calculations	3	1	0	4
FD6303	Food Microbiology	3	0	0	3
FD6304	Fluid Mechanics	3	1	0	4
FD6305	Food Chemistry	3	0	0	3
<b>PRACTICALS</b>					
FD6311	Food Microbiology Lab	0	0	4	2
FD6312	Food Chemistry Lab	0	0	4	2
<b>TOTAL</b>		<b>18</b>	<b>2</b>	<b>8</b>	<b>25</b>

### SEMESTER IV

CODE NO	COURSE TITLE	L	T	P	C
<b>THEORY</b>					
MA6468	Probability And Statistics	3	1	0	4
FD6401	Food Analysis	3	0	0	3
FD6402	Fundamentals of Heat and Mass Transfer	3	1	0	4
FD6403	Introduction to food Processing	3	0	0	3
FD6404	Thermodynamics	3	0	0	3
FD6405	Unit Operations for food Industries	3	0	0	3
<b>PRACTICALS</b>					
FD6411	Food Analysis lab	0	0	4	2
FD6412	Chemical Engineering Lab	0	0	4	2
<b>TOTAL</b>		<b>18</b>	<b>3</b>	<b>8</b>	<b>24</b>

### SEMESTER V

CODE NO	COURSE TITLE	L	T	P	C
<b>THEORY</b>					
FD6501	Milling Technology for Food Materials	3	0	0	3
BT6604	Chemical Reaction Engineering	4	0	0	4
FD6502	Refrigeration and Cold chain Management	3	0	0	3
FD6503	Food Additives	3	0	0	3
FD6504	Food Processing and Preservation	3	0	0	3
	Electives I	3	0	0	3
<b>PRACTICALS</b>					
FD6511	Food Processing and Preservation Lab	0	0	4	2
FD6512	Food Production Analysis Lab	0	0	4	2
FD6513	Technical Seminar	0	0	2	1
<b>TOTAL</b>		<b>18</b>	<b>0</b>	<b>10</b>	<b>24</b>

### SEMESTER VI

CODE NO	COURSE TITLE	L	T	P	C
<b>THEORY</b>					
FD6601	Biochemical Engineering	3	0	0	3
FD6602	Baking and Confectionary Technology	3	0	0	3
GE6351	Environmental Science and Engineering	3	0	0	3
FD6603	Fruits and Vegetable Processing Technology	3	0	0	3
GE6757	Total Quality Management	3	0	0	3
E2	Electives II	3	0	0	3
<b>PRACTICALS</b>					
GE6563	Communication skills Laboratory	0	0	4	2
FD6612	Bio Process Lab	0	0	4	2
FD6613	Baking and Confectionary Technology Lab	0	0	4	2
<b>TOTAL</b>		<b>18</b>	<b>0</b>	<b>12</b>	<b>24</b>

### SEMESTER VII

CODE NO	COURSE TITLE	L	T	P	C
<b>THEORY</b>					
FD6701	Genetic Engineering & Genetically Modified Food	3	0	0	3
FD6702	Meat, Fish and Poultry Process Technology	3	0	0	3
FD6703	Dairy process Technology	3	0	0	3
FD6704	Creativity, Innovation and New Food product development	3	0	0	3
GE6075	Professional Ethics in Engineering	3	0	0	3
	Elective III	3	0	0	3
<b>PRACTICALS</b>					
FD6711	Skills for Food Product Design and Development	0	0	4	2
FD6712	Dairy process Technology Lab	0	0	6	3
<b>TOTAL</b>		<b>18</b>	<b>0</b>	<b>10</b>	<b>23</b>

### SEMESTER VIII

CODE NO	COURSE TITLE	L	T	P	C
<b>THEORY</b>					
FD6801	Food Laws & Safety	3	0	0	3
	Elective IV	3	0	0	3
<b>PRACTICAL</b>					
FD6811	Project Work	0	0	12	6
<b>TOTAL</b>		<b>6</b>	<b>0</b>	<b>12</b>	<b>12</b>

**TOTAL NO OF CREDITS : 184**

## LIST OF ELECTIVES FOR B.TECH. FOOD TECHNOLOGY PROGRAMME

### ELECTIVE I

CODE NO	COURSE TITLE	L	T	P	C
FD6001	Biology and Chemistry of Food Flavours	3	0	0	3
FD6002	Biologically Active Phytochemicals in Food	3	0	0	3
FD6003	Human Nutrition	3	0	0	3

### ELECTIVE II

CODE NO	COURSE TITLE	L	T	P	C
FD6004	Process Economics and Industrial Management	3	0	0	3
FD6005	Functional Foods and Nutraceuticals	3	0	0	3
FD6006	Food Toxicology and Allergy	3	0	0	3

### ELECTIVE III

CODE NO	COURSE TITLE	L	T	P	C
FD6007	Entrepreneurship	3	0	0	3
FD6008	Traditional Foods	3	0	0	3
FD6009	Cereal, Pulse and Oil seed Technology	3	0	0	3
GE6083	Disaster Management	3	0	0	3

### ELECTIVE IV

CODE NO	COURSE TITLE	L	T	P	C
FD6010	Food Process Equipment Design	3	0	0	3
FD6011	Food Packaging	3	0	0	3
FD6012	Food safety Management systems	3	0	0	3
GE6084	Human Rights	3	0	0	3

**OBJECTIVES:**

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

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

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

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

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

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

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

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

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

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

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

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

Learners should be able to

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

**TEXTBOOKS:**

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

**REFERENCES:**

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

**EXTENSIVE Reading (Not for Examination)**

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

**WEBSITES:**

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

**TEACHING METHODS:**

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

## EVALUATION PATTERN:

### Internal assessment: 20%

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

- Project
- Assignment
- Reviews
- Creative writing
- Poster making, etc.

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

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

### End Semester Examination: 80%

**MA6151**

**MATHEMATICS – I**

**LT P C**  
**3 1 0 4**

#### OBJECTIVES:

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

#### UNIT I      **MATRICES**

**9+3**

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

#### UNIT II      **SEQUENCES AND SERIES**

**9+3**

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

#### UNIT III      **APPLICATIONS OF DIFFERENTIAL CALCULUS**

**9+3**

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

**UNIT IV DIFFERENTIAL CALCULUS OF SEVERAL VARIABLES 9+3**

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

**UNIT V MULTIPLE INTEGRALS 9+3**

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

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

**OUTCOME:**

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

**TEXT BOOKS:**

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

**REFERENCES:**

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

**PH6151**

**ENGINEERING PHYSICS – I**

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

**OBJECTIVES:**

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

**UNIT I CRYSTAL PHYSICS 9**

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

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

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



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

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

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

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

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

**UNIT V PHOTONICS AND FIBRE OPTICS****9**

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

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

**TOTAL: 45 PERIODS****OUTCOME:**

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

**TEXT BOOKS:**

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

**REFERENCES:**

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

**CY6151****ENGINEERING CHEMISTRY - I****LT P C  
3 0 0 3****OBJECTIVES:**

- To make the students conversant with basics of polymer chemistry.
- To make the student acquire sound knowledge of second law of thermodynamics and second law based derivations of importance in engineering applications in all disciplines.
- To acquaint the student with concepts of important photophysical and photochemical processes and spectroscopy.

- To develop an understanding of the basic concepts of phase rule and its applications to single and two component systems and appreciate the purpose and significance of alloys.
- To acquaint the students with the basics of nano materials, their properties and applications.

**UNIT I POLYMER CHEMISTRY 9**

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

**UNIT II CHEMICAL THERMODYNAMICS 9**

Terminology of thermodynamics - Second law: Entropy - entropy change for an ideal gas, reversible and irreversible processes; entropy of phase transitions; Clausius inequality. Free energy and work function: Helmholtz and Gibbs free energy functions (problems); Criteria of spontaneity; Gibbs-Helmholtz equation (problems); Clausius-Clapeyron equation; Maxwell relations – Van't Hoff isotherm and isochore(problems).

**UNIT III PHOTOCHEMISTRY AND SPECTROSCOPY 9**

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

**UNIT IV PHASE RULE AND ALLOYS 9**

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

**UNIT V 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, electrode position, chemical vapour deposition, laser ablation; Properties and applications

**TOTAL :45 PERIODS**

**OUTCOME:**

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

**TEXT BOOKS:**

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

**REFERENCES:**

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

**GE6151****COMPUTER PROGRAMMING****LT PC  
3 0 0 3****OBJECTIVES:****The students should be made to:**

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

**UNIT I INTRODUCTION 8**

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

**UNIT II C PROGRAMMING BASICS 10**

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

**UNIT III ARRAYS AND STRINGS 9**

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

**UNIT IV FUNCTIONS AND POINTERS 9**

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

**UNIT V STRUCTURES AND UNIONS 9**

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

**TOTAL: 45 PERIODS**

**OUTCOMES:**

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

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

**TEXTBOOKS:**

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

**REFERENCES:**

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

**GE6152****ENGINEERING GRAPHICS****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.

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

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

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

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

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

Introduction to drafting packages and demonstration of their use.

**TOTAL: 75 PERIODS**

**OUTCOMES:**

On Completion of the course the student will be able to

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

**TEXT BOOK:**

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

**REFERENCES:**

1. Gopalakrishna K.R., “Engineering Drawing” (Vol. I&II combined), Subhas Stores, Bangalore, 2007.
2. Luzzader, Warren.J. and Duff,John M., “Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
3. Shah M.B., and Rana B.C., “Engineering Drawing”, Pearson, 2<sup>nd</sup> Edition, 2009.
4. Venugopal K. and Prabhu Raja V., “Engineering Graphics”, New Age International (P) Limited, 2008.
5. Natrajan K.V., “A text book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 2009.
6. Basant Agarwal and Agarwal C.M., “Engineering Drawing”, Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.

**Publication of Bureau of Indian Standards:**

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

5. IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods.

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

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

**GE6161**

**COMPUTER PRACTICES LABORATORY**

**LT P C  
0 0 3 2**

**OBJECTIVES:**

**The student should be made to:**

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

**LIST OF EXPERIMENTS:**

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

**TOTAL : 45 PERIODS**

**OUTCOMES:**

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

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

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

Standalone desktops with C compiler      30 Nos.

(or)

Server with C compiler supporting 30 terminals or more.

**GE6162**

**ENGINEERING PRACTICES LABORATORY**

**LT P C**

**OBJECTIVES:**

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

**GROUP A (CIVIL & MECHANICAL)****I CIVIL ENGINEERING PRACTICE****9****Buildings:**

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

**Plumbing Works:**

- (a) Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, elbows in household fittings.
- (b) Study of pipe connections requirements for pumps and turbines.
- (c) Preparation of plumbing line sketches for water supply and sewage works.
- (d) Hands-on-exercise:

Basic pipe connections – Mixed pipe material connection – Pipe connections with different joining components.

- (e) Demonstration of plumbing requirements of high-rise buildings.

**Carpentry using Power Tools only:**

- (a) Study of the joints in roofs, doors, windows and furniture.
- (b) Hands-on-exercise:

Wood work, joints by sawing, planing and cutting.

**II MECHANICAL ENGINEERING PRACTICE****13****Welding:**

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

**Basic Machining:**

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

**Sheet Metal Work:**

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

**Machine assembly practice:**

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

**Demonstration on:**

- (a) Smithy operations, upsetting, swaging, setting down and bending. Example –  
Exercise – Production of hexagonal headed bolt.
- (b) Foundry operations like mould preparation for gear and step cone pulley.
- (c) Fitting – Exercises – Preparation of square fitting and vee – fitting models.

## **GROUP B (ELECTRICAL & ELECTRONICS)**

### **III ELECTRICAL ENGINEERING PRACTICE**

**10**

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

### **IV ELECTRONICS ENGINEERING PRACTICE**

**13**

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

**TOTAL: 45 PERIODS**

#### **OUTCOMES:**

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

#### **REFERENCES:**

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

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

##### **CIVIL**

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



(c) Circular Saw	2 Nos
(d) Planer	2 Nos
(e) Hand Drilling Machine	2 Nos
(f) Jigsaw	2 Nos

### MECHANICAL

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

### ELECTRICAL

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

### ELECTRONICS

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

**GE6163**

**PHYSICS AND CHEMISTRY LABORATORY – I**

**LT P C  
0 0 2 1**

### PHYSICS LABORATORY – I

#### OBJECTIVES:

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

#### LIST OF EXPERIMENTS

(Any FIVE Experiments)

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

Bridge

**OUTCOME:**

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

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

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

**CHEMISTRY LABORATORY- I****OBJECTIVES:**

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

**LIST OF EXPERIMENTS**

(Any FIVE Experiments)

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

**TOTAL: 30 PERIODS**

**OUTCOME:**

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

**REFERENCES:**

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

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

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

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

**HS6251**

**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 'emojicons' as symbols in email messages; Grammar - Regular and irregular verbs - Active and passive voice; Vocabulary - Homonyms (e.g. 'can') - Homophones (e.g. 'some', 'sum'); E-materials - Interactive exercise on Grammar and vocabulary – blogging; Language Lab - Listening to different types of conversation and answering questions.

**UNIT II**

**9+3**

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

**UNIT III**

**9+3**

Listening - Listening to the conversation - Understanding the structure of conversations; Speaking - Conversation skills with a sense of stress, intonation, pronunciation and meaning - Seeking information – expressing feelings (affection, anger, regret, etc.); Reading - Speed reading – reading passages with time limit - Skimming; Writing - Minutes of meeting – format and practice in the preparation of minutes - Writing summary after reading articles from journals - Format for journal

articles – elements of technical articles (abstract, introduction, methodology, results, discussion, conclusion, appendices, references) - Writing strategies; Grammar - Conditional clauses - Cause and effect expressions; Vocabulary - Words used as nouns and verbs without any change in the spelling (e.g. 'rock', 'train', 'ring'); E-materials - Interactive exercise on Grammar and vocabulary - Speed Reading practice exercises; Language Lab - Intonation practice using EFLU and RIE materials – Attending a meeting and writing minutes.

#### **UNIT IV**

**9+3**

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

#### **UNIT V**

**9+3**

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

**TOTAL (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.

#### **TEXTBOOKS:**

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

#### **REFERENCES:**

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

**EXTENSIVE Reading (Not for Examination)**

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

**Websites**

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

**TEACHING METHODS:**

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

**EVALUATION PATTERN:**

**Internal assessment: 20%**

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

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

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

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

**End Semester Examination: 80%**

**OBJECTIVES:**

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

**UNIT I VECTOR CALCULUS****9+3**

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

**UNIT II ORDINARY DIFFERENTIAL EQUATIONS****9+3**

Higher order linear differential equations with constant coefficients – Method of variation of parameters – Cauchy's and Legendre's linear equations – Simultaneous first order linear equations with constant coefficients.

**UNIT III LAPLACE TRANSFORM****9+3**

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

**UNIT IV ANALYTIC FUNCTIONS****9+3**

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

**UNIT V COMPLEX INTEGRATION****9+3**

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

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

- The subject helps the students to develop the fundamentals and basic concepts in vector calculus, ODE, Laplace transform and complex functions. Students will be able to solve problems related to engineering applications by using these techniques.

**TEXT BOOKS:**

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

**REFERENCES:**

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

**PH6251****ENGINEERING PHYSICS – II****L T P C  
3 0 0 3****OBJECTIVES:**

- To enrich the understanding of various types of materials and their applications in engineering and technology.

**UNIT I CONDUCTING MATERIALS 9**

Conductors – classical free electron theory of metals – Electrical and thermal conductivity – Wiedemann – Franz law – Lorentz number – Draw backs of classical theory – Quantum theory – Fermi distribution function – Effect of temperature on Fermi Function – Density of energy states – carrier concentration in metals.

**UNIT II SEMICONDUCTING MATERIALS 9**

Intrinsic semiconductor – carrier concentration derivation – Fermi level – Variation of Fermi level with temperature – electrical conductivity – band gap determination – compound semiconductors -direct and indirect band gap- derivation of carrier concentration in n-type and p-type semiconductor – variation of Fermi level with temperature and impurity concentration — Hall effect –Determination of Hall coefficient – Applications.

**UNIT III MAGNETIC AND SUPERCONDUCTING MATERIALS 9**

Origin of magnetic moment – Bohr magneton – comparison of Dia, Para and Ferro magnetism – Domain theory – Hysteresis – soft and hard magnetic materials – antiferromagnetic materials – Ferrites and its applications  
Superconductivity: properties – Type I and Type II superconductors – BCS theory of superconductivity(Qualitative) - High  $T_c$  superconductors – Applications of superconductors – SQUID, cryotron, magnetic levitation.

**UNIT IV DIELECTRIC MATERIALS 9**

Electrical susceptibility – dielectric constant – electronic, ionic, orientational and space charge polarization – frequency and temperature dependence of polarisation – internal field – Claussius – Mosotti relation (derivation) – dielectric loss – dielectric breakdown – uses of dielectric materials (capacitor and transformer) – ferroelectricity and applications.

**UNIT V                    ADVANCED ENGINEERING MATERIALS                    9**

Metallic glasses: preparation, properties and applications. Shape memory alloys (SMA): Characteristics, properties of NiTi alloy, application, Nanomaterials–Preparation -pulsed laser deposition – chemical vapour deposition – Applications – NLO materials –Birefringence- optical Kerr effect – Classification of Biomaterials and its applications

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- The students will have the knowledge on physics of materials and that knowledge will be used by them in different engineering and technology applications.

**TEXT BOOKS:**

1. Arumugam M., Materials Science. Anuradha publishers, 2010
2. Pillai S.O., Solid State Physics. New Age International(P) Ltd., publishers, 2009

**REFERENCES:**

1. Palanisamy P.K. Materials Science. SCITECH Publishers, 2011
2. Senthilkumar G. Engineering Physics II. VRB Publishers, 2011
3. Mani P. Engineering Physics II. Dhanam Publications, 2011
4. Marikani A. Engineering Physics. PHI Learning Pvt., India, 2009

**CY6251**

**ENGINEERING CHEMISTRY - II**

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

**OBJECTIVES:**

- To make the students conversant with boiler feed water requirements, related problems and water treatment techniques.
- Principles of electrochemical reactions, redox reactions in corrosion of materials and methods for corrosion prevention and protection of materials.
- Principles and generation of energy in batteries, nuclear reactors, solar cells, wind mills and fuel cells.
- Preparation, properties and applications of engineering materials.
- Types of fuels, calorific value calculations, manufacture of solid, liquid and gaseous fuels.

**UNIT I                    WATER TECHNOLOGY                    9**

Introduction to boiler feed water-requirements-formation of deposits in steam boilers and heat exchangers- disadvantages (wastage of fuels, decrease in efficiency, boiler explosion) prevention of scale formation -softening of hard water -external treatment zeolite and demineralization - internal treatment- boiler compounds (phosphate, calgon, carbonate, colloidal) - caustic embrittlement -boiler corrosion-priming and foaming-desalination of brackish water –reverse osmosis.

**UNIT II                    ELECTROCHEMISTRY AND CORROSION                    9**

Electrochemical cell - redox reaction, electrode potential- origin of electrode potential-oxidation potential- reduction potential, measurement and applications - electrochemical series and its significance - Nernst equation (derivation and problems). Corrosion- causes- factors- types-chemical, electrochemical corrosion (galvanic, differential aeration), corrosion control - material selection and design aspects - electrochemical protection – sacrificial anode method and impressed current cathodic method. Paints- constituents and function. Electroplating of Copper and electroless plating of nickel.

**UNIT III                    ENERGY SOURCES                    9**

Introduction- nuclear energy- nuclear fission- controlled nuclear fission- nuclear fusion-



differences between nuclear fission and fusion- nuclear chain reactions- nuclear reactor power generator- classification of nuclear reactor- light water reactor- breeder reactor- solar energy conversion- solar cells- wind energy. Batteries and fuel cells: Types of batteries- alkaline battery- lead storage battery- nickel-cadmium battery- lithium battery- fuel cell  $H_2$  - $O_2$  fuel cell- applications.

**UNIT IV ENGINEERING MATERIALS 9**

Abrasives: definition, classification or types, grinding wheel, abrasive paper and cloth. Refractories: definition, characteristics, classification, properties – refractoriness and RUL, dimensional stability, thermal spalling, thermal expansion, porosity; Manufacture of alumina, magnesite and silicon carbide, Portland cement- manufacture and properties - setting and hardening of cement, special cement- waterproof and white cement-properties and uses. Glass - manufacture, types, properties and uses.

**UNIT V FUELS AND COMBUSTION 9**

Fuel: Introduction- classification of fuels- calorific value- higher and lower calorific values- coal- analysis of coal (proximate and ultimate)- carbonization- manufacture of metallurgical coke (Otto Hoffmann method) - petroleum- manufacture of synthetic petrol (Bergius process)- knocking- octane number - diesel oil- cetane number - natural gas- compressed natural gas(CNG)- liquefied petroleum gases(LPG)- producer gas- water gas. Power alcohol and bio diesel. Combustion of fuels: introduction- theoretical calculation of calorific value- calculation of stoichiometry of fuel and air ratio- ignition temperature- explosive range - flue gas analysis (ORSAT Method).

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- The knowledge gained on engineering materials, fuels, energy sources and water treatment techniques will facilitate better understanding of engineering processes and applications for further learning.

**TEXT BOOKS:**

1. Vairam S, Kalyani P and SubaRamesh., "Engineering Chemistry"., Wiley India PvtLtd., New Delhi., 2011
2. DaraS.S, UmareS.S. "Engineering Chemistry", S. Chand & Company Ltd., New Delhi , 2010

**REFERENCES:**

- 1 Kannan P. and Ravikrishnan A., "Engineering Chemistry", Sri Krishna Hi-tech Publishing Company Pvt. Ltd. Chennai, 2009
2. AshimaSrivastava and Janhavi N N., "Concepts of Engineering Chemistry", ACME Learning Private Limited., New Delhi., 2010.
3. RenuBapna and Renu Gupta., "Engineering Chemistry", Macmillan India Publisher Ltd., 2010.
4. Pahari A and Chauhan B., "Engineering Chemistry"., Firewall Media., New Delhi., 2010

**GE6253**

**ENGINEERING MECHANICS**

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

**OBJECTIVES:**

- To develop capacity to predict the effect of force and motion in the course of carrying out the design functions of engineering.

**UNIT I BASICS AND STATICS OF PARTICLES**

**12**

Introduction – Units and Dimensions – Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces — Vectorial representation of forces – Vector operations of forces -additions, subtraction, dot product, cross product – Coplanar Forces – rectangular components – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility .

**UNIT II EQUILIBRIUM OF RIGID BODIES 12**

Free body diagram – Types of supports –Action and reaction forces –stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon's theorem – Single equivalent force -Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions

**UNIT III PROPERTIES OF SURFACES AND SOLIDS 12**

Centroids and centre of mass– Centroids of lines and areas - Rectangular, circular, triangular areas by integration – T section, I section, - Angle section, Hollow section by using standard formula –Theorems of Pappus - Area moments of inertia of plane areas – Rectangular, circular, triangular areas by integration – T section, I section, Angle section, Hollow section by using standard formula – Parallel axis theorem and perpendicular axis theorem –Principal moments of inertia of plane areas – Principal axes of inertia-Mass moment of inertia –mass moment of inertia for prismatic, cylindrical and spherical solids from first principle – Relation to area moments of inertia.

**UNIT IV DYNAMICS OF PARTICLES 12**

Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion - Newton's laws of motion – Work Energy Equation– Impulse and Momentum – Impact of elastic bodies.

**UNIT V FRICTION AND ELEMENTS OF RIGID BODY DYNAMICS 12**

Friction force – Laws of sliding friction – equilibrium analysis of simple systems with sliding friction –wedge friction-. Rolling resistance -Translation and Rotation of Rigid Bodies – Velocity and acceleration – General Plane motion of simple rigid bodies such as cylinder, disc/wheel and sphere.

**TOTAL : 60 PERIODS**

**OUTCOMES:**

- ability to explain the differential principles applies to solve engineering problems dealing with force, displacement, velocity and acceleration.
- ability to analyse the forces in any structures.
- ability to solve rigid body subjected to dynamic forces.

**TEXT BOOKS:**

1. Beer, F.P and Johnston Jr. E.R., “Vector Mechanics for Engineers (In SI Units): Statics and Dynamics”, 8<sup>th</sup> Edition, Tata McGraw-Hill Publishing company, New Delhi (2004).
2. Vela Murali, “Engineering Mechanics”, Oxford University Press (2010)

**REFERENCES:**

1. Hibbeler, R.C and Ashok Gupta, “Engineering Mechanics: Statics and Dynamics”, 11<sup>th</sup> Edition, Pearson Education 2010.
2. Irving H. Shames and Krishna Mohana Rao. G., “Engineering Mechanics – Statics and Dynamics”, 4<sup>th</sup> Edition, Pearson Education 2006.
3. Meriam J.L. and Kraige L.G., “ Engineering Mechanics- Statics - Volume 1, Dynamics- Volume 2”, Third Edition, John Wiley & Sons,1993.
4. Rajasekaran S and Sankarasubramanian G., “Engineering Mechanics Statics and Dynamics”, 3<sup>rd</sup> Edition, Vikas Publishing House Pvt. Ltd., 2005.
5. Bhavikatti, S.S and Rajashekarappa, K.G., “Engineering Mechanics”, New Age

- International (P) Limited Publishers, 1998.
6. Kumar, K.L., "Engineering Mechanics", 3<sup>rd</sup> Revised Edition, Tata McGraw-Hill Publishing company, New Delhi 2008.

**GE6252      BASIC ELECTRICAL AND ELECTRONICS ENGINEERING      L T P C**  
**4 0 0 4**

**OBJECTIVES:**

- To explain the basic theorems used in Electrical circuits and the different components and function of electrical machines.
- To explain the fundamentals of semiconductor and applications.
- To explain the principles of digital electronics
- To impart knowledge of communication.

**UNIT I              ELECTRICAL CIRCUITS & MEASUREMENTS              12**

Ohm's Law – Kirchoff's Laws – Steady State Solution of DC Circuits – Introduction to AC Circuits – Waveforms and RMS Value – Power and Power factor – Single Phase and Three Phase Balanced Circuits.

Operating Principles of Moving Coil and Moving Iron Instruments (Ammeters and Voltmeters), Dynamometer type Watt meters and Energy meters.

**UNIT II              ELECTRICAL MECHANICS              12**

Construction, Principle of Operation, Basic Equations and Applications of DC Generators, DC Motors, Single Phase Transformer, single phase induction Motor.

**UNIT III              SEMICONDUCTOR DEVICES AND APPLICATIONS              12**

Characteristics of PN Junction Diode – Zener Effect – Zener Diode and its Characteristics – Half wave and Full wave Rectifiers – Voltage Regulation.

Bipolar Junction Transistor – CB, CE, CC Configurations and Characteristics – Elementary Treatment of Small Signal Amplifier.

**UNIT IV              DIGITAL ELECTRONICS              12**

Binary Number System – Logic Gates – Boolean Algebra – Half and Full Adders – Flip-Flops – Registers and Counters – A/D and D/A Conversion (single concepts)

**UNIT V              FUNDAMENTALS OF COMMUNICATION ENGINEERING              12**

Types of Signals: Analog and Digital Signals – Modulation and Demodulation: Principles of Amplitude and Frequency Modulations.

Communication Systems: Radio, TV, Fax, Microwave, Satellite and Optical Fibre (Block Diagram Approach only).

**TOTAL: 60 PERIODS**

**OUTCOMES:**

- ability to identify the electrical components explain the characteristics of electrical machines.
- ability to identify electronics components and use of them to design circuits.

**TEXT BOOKS:**

1. Mittle N., "Basic Electrical Engineering", Tata McGraw Hill Edition, New Delhi, 1990.
2. Sedha R.S., "Applied Electronics", S. Chand & Co., 2006.

**REFERENCES:**

1. Muthusubramanian R, Salivahanan S and Muraleedharan K A, "Basic Electrical, Electronics and Computer Engineering", Tata McGraw Hill, Second Edition, 2006.

2. Nagsarkar T K and Sukhija M S, "Basics of Electrical Engineering", Oxford press 2005.
3. Mehta V K, "Principles of Electronics", S.Chand & Company Ltd, 1994.
4. Mahmood Nahvi and Joseph A. Edminister, "Electric Circuits", Schaum' Outline Series, McGraw Hill, 2002.
5. Premkumar N, "Basic Electrical Engineering", Anuradha Publishers, 2003.

**GE6262      PHYSICS AND CHEMISTRY LABORATORY – II**

**L T P C**  
**0 0 2 1**

**PHYSICS LABORATORY – II**

**OBJECTIVES:**

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

**LIST OF EXPERIMENTS**

**(Any FIVE Experiments)**

1. Determination of Young's modulus by uniform bending method
2. Determination of band gap of a semiconductor
3. Determination of Coefficient of viscosity of a liquid –Poiseuille's method
4. Determination of Dispersive power of a prism - Spectrometer
5. Determination of thickness of a thin wire – Air wedge method
6. Determination of Rigidity modulus – Torsion pendulum

**OUTCOMES:**

- The students will have the ability to test materials by using their knowledge of applied physics principles in optics and properties of matter.

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

1. Traveling microscope, meter scale, Knife edge, weights
2. Band gap experimental set up
3. Burette, Capillary tube, rubber tube, stop clock, beaker and weighing balance
4. spectrometer, prism, sodium vapour lamp.
5. Air-wedge experimental set up.
6. Torsion pendulum set up.
  - a. (vernier Caliper, Screw gauge, reading lens are required for most of the experiments)

**CHEMISTRY LABORATORY - II**

**OBJECTIVES:**

- To make the student acquire practical skills in the wet chemical and instrumental methods for quantitative estimation of hardness, alkalinity, metal ion content, corrosion in metals and cement analysis.

**LIST OF EXPERIMENTS**

**(Any FIVE Experiments)**

- 1 Determination of alkalinity in water sample
- 2 Determination of total, temporary & permanent hardness of water by EDTA method
- 3 Estimation of copper content of the given solution by EDTA method
- 4 Estimation of iron content of the given solution using potentiometer
- 5 Estimation of sodium present in water using flame photometer
- 6 Corrosion experiment – weight loss method
- 7 Conductometric precipitation titration using BaCl<sub>2</sub> and Na<sub>2</sub>SO<sub>4</sub>

**OUTCOMES:**

- The students will be conversant with hands-on knowledge in the quantitative chemical analysis of water quality related parameters, corrosion measurement and cement analysis.

**REFERENCES:**

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

- **Laboratory classes on alternate weeks for Physics and Chemistry.**

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

1. Potentiometer	-	5 Nos
2. Flame photo meter	-	5 Nos
3. Weighing Balance	-	5 Nos
4. Conductivity meter	-	5 Nos

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

**GE6261 COMPUTER AIDED DRAFTING AND MODELING LABORATORY**

**L T P C  
0 1 2 2**

**LIST OF EXERCISES USING SOFTWARE CAPABLE OF DRAFTING AND MODELING**

1. Study of capabilities of software for Drafting and Modeling – Coordinate systems (absolute, relative, polar, etc.) – Creation of simple figures like polygon and general multi-line figures.
2. Drawing of a Title Block with necessary text and projection symbol.
3. Drawing of curves like parabola, spiral, involute using Bspline or cubic spline.
4. Drawing of front view and top view of simple solids like prism, pyramid, cylinder, cone, etc, and dimensioning.
5. Drawing front view, top view and side view of objects from the given pictorial views (eg. V-block, Base of a mixie, Simple stool, Objects with hole and curves).
6. Drawing of a plan of residential building ( Two bed rooms, kitchen, hall, etc.)
7. Drawing of a simple steel truss.
8. Drawing sectional views of prism, pyramid, cylinder, cone, etc,
9. Drawing isometric projection of simple objects.

10. Creation of 3-D models of simple objects and obtaining 2-D multi-view drawings from 3-D model.

**NOTE: PLOTTING OF DRAWINGS MUST BE MADE FOR EACH EXERCISE AND ATTACHED TO THE RECORDS WRITTEN BY STUDENTS.**

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

1. Pentium IV computer or better hardware, with suitable graphics facility - 30 No.
2. Licensed software for Drafting and Modeling. – 30 Licenses
3. Laser Printer or Plotter to print / plot drawings – 2 No.

**MA6351**

**TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS**

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

**OBJECTIVES**

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

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

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

**UNIT II FOURIER SERIES 9 + 3**

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

**UNIT III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 9 + 3**

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

**UNIT IV FOURIER TRANSFORMS 9 + 3**

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

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

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

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

**OUTCOMES:**

- To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
- To acquaint the student with Fourier transform techniques used in wide variety of situations.

- To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Ztransform techniques for discrete time systems.

#### **TEXT BOOKS:**

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

#### **REFERENCES:**

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

**FD6301**

**PRINCIPLES OF CHEMICAL ENGINEERING**

**L T P C**

**3 0 0 3**

#### **AIM**

To understand the principles of Process calculations.

To understand principles of fluid mechanics and its application.

#### **OBJECTIVES**

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

#### **UNIT I BASIC PRINCIPLES OF STOICHIOMETRY**

**9**

Importance of material balance and energy balance in a process Industry-Dimensions, Units, conversion factors and their use –Data sources, Humidity and applications.

#### **UNIT II UNIT OPERATIONS**

**9**

Introduction to size reduction - Size Separation – Drying - Evaporation, Distillation – Basic concept and equipment used in the operations.

#### **UNIT III UNIT PROCESS**

**9**

Overview of Food Processing Principles – Processing of Agro Products – Fundamentals of Biosynthesis – Introduction to Bioreactors, Freezing – Drying – Salting process.

#### **UNIT IV FLUID MECHANICS**

**9**

Fluid – properties – compressible, incompressible fluids, Newtonian and Non Newtonian Fluids, Fluid statics for compressible & incompressible fluids-Static pressure-application to pressure measurement, gravity settling, Fluid Flow phenomena – through pipes and other devices – pressure drop calculations. Pressure measuring devices.

**UNIT V      AGITATION FLOW THROUGH PACKINGS, FLUIDIZATION, FLUID TRANSPORT      9**

Agitation – power requirement, Flow in packed columns, flow in fluidization columns, settling phenomena, Flow measurement, pumping of liquids and gases – equipments.

**TOTAL: 45 PERIODS**

**TEXT BOOKS**

1. McCabe, W.L., J.C. Smith and P.Harriot “Unit Operations of Chemical Engineering”, 6<sup>th</sup> Edition, Mc Graw Hill, 2001.
2. Bhatt, B.I. and S.M. Vora “Stoichiometry (SI Units)”, 3<sup>rd</sup> Edition, Tata McGraw- Hill, 1996.

**REFERENCES**

1. Himmelblau, D.M. “Basic Principles and Calculations in Chemical Engineering”, 6<sup>th</sup> Edition, PHI, 2006.
2. Geankoplis, C.J. “Transport Processes and Separation Process Principles”, 4<sup>th</sup> Edition, PHI, 2006.
3. Foust, A.S. et al., “ Principles of Unit Operations”, 2<sup>nd</sup> Edition, John Wiley & Sons, 1999.
4. Narayanan, K.V. and Lakshmi Kutty “Stoichiometry and Process Calculations”, PHI, 2006.
5. Coulson, J.M. and et al. “Coulson & Richardson’s Chemical Engineering”, 6<sup>th</sup> Edition, Vol. I & II, Butterworth – Heinman / Elsevier, 2004.

**FD6302**

**FOOD PROCESS CALCULATIONS**

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

**OBJECTIVE**

To make them understand different types of laws of chemistry of materials and also prepare the students to accurately calculate the stoichiometric relations between the materials involved in the unit operation process

**UNIT – I      9+3**

**Units and Dimensions:** Basic and derived units, use of model units in calculations, Methods of expression, compositions of mixture and solutions. Ideal and real gas laws – Gas constant - calculations of pressure, volume and temperature using ideal gas law.

**UNIT – II      9+3**

**Fundamental Calculations and Humidity:** Use of partial pressure and pure component volume in gas calculations, applications of real gas relationship in gas calculation. Calculation of absolute humidity, molal humidity, relative humidity and percentage humidity - Use of humidity in condensation and drying - Humidity chart, dew point.

**UNIT – III      9+3**



**Material Balance:** Stoichiometric principles, Application of material balance to unit operations like distillation, evaporation, crystallization, drying, extraction, Leaching.

**Combustion:** Determination of Composition by Orsat analysis of products of combustion of solid, liquid and gas fuels - Calculation of excess air.

#### UNIT – IV

9+3

**Energy Balance:** Heat capacity of solids, liquids, gases and solutions, use of mean heat capacity in heat calculations, problems involving sensible heat and latent heats, evaluation of enthalpy.

#### UNIT – V

9+3

**Enthalpy Changes:** Standard heat of reaction, heats of formation, combustion, solution, mixing etc., calculation of standard heat of reaction - Effect of pressure and temperature on heat of reaction - Energy balance for systems without chemical reaction.

**TOTAL : 60 PERIODS**

(Use of Psychometric chart is permitted in the examination)

#### TEXT BOOKS

1. Bhatt, B.L and Vora, S.M., —Stoichiometry □, Third Edition, McGraw-Hill, New York, 1996.
2. Gavhane, K.A —Introduction to Process Calculations (Stoichiometry) □ Nirali Prakashan Publications, Pune, 2006.

#### REFERENCES

1. Venkataramani, V. and Anantharaman, N., —Process Calculations □, Prentice Hall of India, New Delhi, 2003.
2. Himmelblau, D.M., —Basic Principles and Calculations in Chemical Engineering □, Sixth Edition, Prentice Hall India, New Delhi, 2003.

**FD6303**

**FOOD MICROBIOLOGY**

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

#### AIM

The course aims to develop the knowledge of students in the basic area of Food Microbiology. This is necessary for effective understanding of food processing and technology subjects as well as food safety. This course will enable students to appreciate the role of microbes in food spoilage, preservation of foods and food borne infections.

#### OBJECTIVES

On completion of the course the students are expected to

- Be able to understand and identify the various microbes associated with foods and food groups.
- Be able to understand and identify the role of these microbes in food spoilage, food preservation. Understand the role of pathogens in food borne infections.
- Understand the methods used to detect pathogens in foods.

**UNIT I**

**MICROBES - STRUCTURE AND MULTIPLICATION**

**9**

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.

Structural organization and multiplication of bacteria, viruses, algae and fungi; 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 II           ROLE OF MICROBES IN SPOILAGE OF FOODS AND FOOD BORNE ILLNESS** **9**

Factors affecting spoilage of foods, Microbial flora associated with various food groupstheir spoilage potential. Microbiological spoilage problems associated with typical food products.

Food borne infections and food poisoning, Microbial toxins - types, Gram Negative and Gram positive food borne pathogens – Salmonella, Coliforms, E. coli, Shigella, Vibrio cholerae, Staphylococcus aureus; Clostridium botulinum; Lysteria monocytogenes Toxigenic algae and fungi; Food borne viruses; helminths, nematodes and protozoa.

## **UNIT III           MICROBES IN FOOD FERMENTATIONS** **9**

Microbes of importance in food fermentations, – Homo & hetero-fermentative bacteria, yeasts & fungi; Biochemistry of fermentations – pathways involved, Lactic acid bacteria fermentation and starter cultures, Alcoholic fermentations -Yeast fermentations - characteristics and strain selection, Fungal fermentations. Microbes associated with typical food fermentations- yoghurt, cheese, fermented milks, breads, idli, soy products, fermented vegetables and meats.

## **UNIT IV           MICROBIAL AGENTS OF FOOD BORNE ILLNESS** **9**

Food borne infections and food poisoning, Microbial toxins - types, Gram Negative and Gram positive food borne pathogens – Salmonella, Coliforms, E. coli, Shigella, Vibrio cholerae, Staphylococcus aureus; Clostridium botulinum; Lysteria monocytogenes Toxigenic algae and fungi; Food borne viruses; helminths, nematodes and protozoa.

## **UNIT V           MICROBIAL EXAMINATION OF FOODS** **9**

Detection & Enumeration of microbes in foods; Indicator organisms and microbiological criteria; Rapid and automated microbial methods - development and impact on the detection of food borne pathogens; Detection methods for E. coli, Staphylococci, Yersinia, Campylobacter, B. cereus, Cl. botulinum & Salmonella, Listeria monocytogenes Norwalk virus, Rotavirus, Hepatitis A virus from food samples.

**TOTAL : 45 PERIODS**

### **TEXT BOOKS**

1. Vijaya Ramesh "Food Microbiology". MJP Publishers, 2007
2. Jay, J.M. "Modern Food Microbiology". 4th Edition. CBS Publishers, 2003
3. Adams, M.R and M.O. Moss. "Food Microbiology". New Age International, 2002

### **REFERENCES**

1. Pawsey, R.K. "Case Studies in Food Microbiology for Food Safety and Quality". The Royal Society of Chemistry, 2001.
2. Forsythe, S.J. "The Microbiology of Safe Food". Blackwell Science, 2000.
3. Harrigan, W.F. "Laboratory Methods in Food Microbiology" 3rd Edition, Academic Press.

**UNIT I INTRODUCTION****9**

Fluid – definition, distinction between solid and fluid - Units and dimensions - Properties of fluids - density, specific weight, specific volume, specific gravity, temperature, viscosity, compressibility, vapour pressure, capillary and surface. Properties of velocity field - thermodynamic properties of a fluid - viscosity and other secondary properties - basic flow analysis techniques flow patterns.

**UNIT II PRESSURE DISTRIBUTION IN A FLUID****9**

Pressure and pressure gradient - equilibrium of fluid element - hydrostatic pressure distributions - applications to manometry - Hydrostatic forces on planed and curved submerged surfaces - laws of buoyancy and stability; Considerations for bodies in floatation.

**UNIT III INTEGRAL RELATIONS FOR A CONTROL VOLUME****9**

Basic laws of fluid mechanics, concept of system and control volume concept - The Reynold's transport theorem - continuity equation - the linear momentum equation - the angular momentum theorem - steady flow energy equation - friction less flow - Bernoulli equation - relation between the Bernoulli and steady flow energy equation.

**UNIT IV DIMENSIONAL ANALYSIS AND SIMILITUDE****9**

The principle of dimensional homogeneity - the Pi-theorem - non-dimensional action of the basic equations - similitude - relationship between dimensional analysis and similitude - use of dimensional analysis for scale up studies.

**UNIT V FLOW MEASUREMENT AND COMPRESSIBLE FLOW****9**

Constant and variable head meters - classification of pumps - performance curves, compressors and its efficiency; Adiabatic and isentropic flow with the area changes, shock waves, operation of convergence and divergence nozzles, compressible duct flow with friction.

**TOTAL : 45 PERIODS****TEXT BOOKS**

1. Streeter, V.L., and Wylie, E.B., "Fluid Mechanics", McGraw-Hill, 1983.
2. Kumar, K.L., "Engineering Fluid Mechanics", 7<sup>th</sup> Edition. Eurasia Publishing, 1995.
3. Bansal, R.K., "Fluid Mechanics and Hydraulics Machines". 5<sup>th</sup> Edition. Laxmi Publications, 1995.
4. Vasandani, V.P., "Hydraulic Machines - Theory and Design", Khanna Publishers, 1992.

**AIM**

The course aims to develop the knowledge of students in the basic area of Food Chemistry. This is necessary for effective understanding of food processing and technology subjects. This course will enable students to appreciate the similarities and complexities of the chemical components in foods.

**OBJECTIVES**

On completion of the course the students are expected to

- Be able to understand and identify the various food groups; the nutrient components (macro and micro), proximate composition.
- Be able to understand and identify the non-nutritive components in food,

naturally present.

- Understand and use effectively, food composition tables and databases.
- Grasp the functional role of food components and their interaction in food products in terms of colour, flavour, texture and nutrient composition

## **UNIT I CARBOHYDRATES 9**

Simple Sugars: mono and disaccharides, Hygroscopicity & solubility, optical rotation, mutarotation; sensory properties-sweetness index, caramelization, Maillard reaction; Glucose syrup, high fructose corn syrup, Dextrose Equivalent, Degree of polymerisation; Sugar alcohols; Oligosaccharides: structure, nomenclature, occurrence, uses in foods. Polysaccharides: Starch- amylose and amylopectin- properties, thickening & gelatinization, modified starches, resistant starch, Dextrins and dextrans, Starch hydrosates – Malto dextrins and dextrans; Pectins, gums & seaweeds- gel formation & viscosity. Fiber- Cellulose & hemicellulose; Food sources, functional role and uses in foods.

## **UNIT II PROTEINS 9**

Review of protein structure & conformation; Properties & reactions of proteins in food systems: Dissociation, optical activity, solubility, hydration, swelling, foam formation & stabilization, gel formation, emulsifying effect, thickening & binding, amino acids in Maillard reaction, denaturation; Food enzymes ; Texturized proteins; Food sources, functional role and uses in foods.

## **UNIT III LIPIDS 9**

Review of structure, composition & nomenclature of fats. Non-glyceride components in fats & oils; Properties of fats & oils: crystal formation, polymorphism, melting points, plasticity, isomerisation, unsaturation; Modification of fats: hydrogenation- cis and trans isomers, interesterification, acetylation, winterization; Hydrolytic rancidity & oxidative rancidity; radiolysis Shortening power of fats, tenderization, emulsification, frying-smoke point, auto oxidation, polymerization; Fat replacements; Food sources, functional role and uses in foods

## **UNIT IV WATER**

### **A. WATER 2**

Chemistry, physical properties, free bound & entrapped water, water activity. Drinking water, mineral water, water hardness, water quality for food processing

### **B. MINERALS & VITAMINS 1**

Mineral & vitamin content of foods- Food and Pharmaceutical grades; stability & degradation in foods.

### **C.COLOUR, FLAVOUR & AROMA COMPONENTS 6**

Naturally occurring colours, acids, other flavour & aroma components present in herbs, spices, coffee, tea, cocoa, fruits, vegetables & fermented products; Synthetic Colours and Naturally similar /artificial flavours, Threshold values, off flavours & food taints.

### **D. OTHER COMPONENTS 4**

Naturally occurring toxic substances, protease inhibitors, bioactive components: phytates, polyphenols, saponins, phytoestrogens etc.

## **UNIT V FOOD GROUPS & COMPOSITION 5**

Food groups, proximate composition, food composition tables- uses, food composition data bases.

**TOTAL : 45 PERIODS**

## **TEXT BOOKS**

1. Chopra, H.K. and P.S. Panesar. "Food Chemistry". Narosa, 2010.
2. Meyer, Lillian Hoagland. "Food Chemistry". CBS Publishers, 1987.
3. Deman, John M. "Principles of Food Chemistry". 3<sup>rd</sup> Edition. Springer, 1999.
4. Vaclavik, V. A. and Christian E. W. "Essentials of Food Science". 2<sup>nd</sup> Edition, Kluwer-Academic, Springer, 2003.

## REFERENCES

1. Gopalan C., B.V. Rama Sastri, and S.C. Balasubramanian S. C. "Nutritive Value of Indian Foods". NIN, ICMR, 2004.
2. Damodaran, S., K.L. Parkin and O.R. Fennema. "Fennema's Food Chemistry". 4<sup>th</sup> Edition, CRC Press, 2008
3. Belitz, H.-D, Grosch W and Schieberle P. "Food Chemistry", 3<sup>rd</sup> Rev. Edition, Springer-Verlag, 2004.
4. Walstra, P. "Physical Chemistry of Foods". Marcel Dekker Inc. 2003.
5. Owusu-Apenten, Richard. "Introduction to Food Chemistry". CRC Press, 2005.

**FD6311**

**FOOD MICROBIOLOGY LAB**

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

## OBJECTIVES

- Enable students to understand the methods of isolating and characterizing various microbes associated with foods and food groups.
- Enable students to understand and use various microbiological techniques for the study of foods.
- Understand the methods used to detect pathogens in foods.

## LAB EXPERIMENTS:

1. Introduction, Laboratory Safety, Use of Equipment; Sterilization Techniques; Culture Media-Types and Use; Preparation of Nutrient broth and agar
2. Culture Techniques, Isolation and Preservation of Cultures- Broth: flask, test tubes; Solid: Pour plates, streak plates, slants, stabs
3. Microscopy – Working and care of Microscope; Microscopic Methods in the Study of Microorganisms; Staining Techniques- Simple, Differential- Gram's Staining
4. Quantification of Microbes: Sampling and Serial Dilution; Bacterial count in food products  
TVC
5. Microbiological quality of water (MPN)
6. Microbiological quality of milk
7. Enumeration of Lactic acid bacteria from fermented foods
8. Yeast & Mould count from fruits
9. Enumeration of spores from pepper
10. Inhibitory effect of spices on microbial load in fish & flesh foods
11. Enumeration & Isolation of E. coli from processed meat/chicken
12. Thermal destruction of microbes: TDT & TDP
13. Enumeration & Isolation of Staphylococci from ready to eat street foods
14. Effect of cleaning and disinfection on microbial load

## EQUIPMENT

Autoclave	1
Hot Air Oven	1
Incubators	2
Light Microscopes	4
Incubator Shaker	1

Colorimeter 2  
Lamina Flow Chamber 2  
Glassware, Chemicals, Media as required

**TOTAL : 60 PERIODS**

### REFERENCE

1. Harrigan, W.F. "Laboratory Methods in Food Microbiology" Academic Press, 2011

**FD6312**

**FOOD CHEMISTRY LAB**

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

### AIM

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.

### EXPERIMENTS

1. Preparation and measurement of pH of standard buffers (phosphate, carbonate, borate, TRIS etc.)
2. Qualitative analysis of carbohydrates
3. Quantitative analysis of carbohydrates (Benedict, DNS method)
4. Enzymatic hydrolysis of glycogen by  $\alpha$  and  $\beta$  amylase
5. Quantitative analysis of proteins (Lowry, Bradford, UV method)
6. Qualitative analysis of lipids (triglycerides, cholesterol, phospholipids etc.)
7. Estimation of Viscosity and refractive index of foods
8. Specific gravity and Oxidative rancidity of fat and oils
9. Enzymatic Browning in foods
10. Iso-electric precipitation of casein, Effect of rennin on milk proteins
11. Gelling properties of starch
12. Acid hydrolysis and action of salivary amylase on starch
13. Enzymatic hydrolysis of sucrose and measurement of optical rotation.

**TOTAL: 60 PERIODS**

### REFERENCES

1. Plummer, D.T. "Introduction of Practical Biochemistry" 3<sup>rd</sup> Edition. Tata McGraw-Hill, 1987.
2. Wilson, Keith and John Walker "Principles and Techniques of Biochemistry and Molecular Biology ". 6<sup>th</sup> Edition. Cambridge University Press, 2006.
3. Segel, Irwin H. "Biochemical Calculations : How to solve Mathematical Problem in General Biochemistry" . 2<sup>nd</sup> Edition. John wiley, 2006.
4. Weaver, C.M, and J.R. Daniel. "The Food Chemistry Laboratory – A Manual for Experimental Foods, Dietetics & Food Scientists." 2<sup>nd</sup> Edition, CRC Press, 2005.

**MA6468**

**PROBABILITY AND STATISTICS**

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

### AIM

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

## OBJECTIVES

The students will have a fundamental knowledge of the concepts of probability.

Have knowledge of standard distributions which can describe real life phenomenon. Have the notion of sampling distributions and statistical techniques used in management problems.

### UNIT I      RANDOM VARIABLES      9 + 3

Discrete and Continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma, Weibull and Normal distributions - Functions of a random variable.

### UNIT II      TWO-DIMENSIONAL RANDOM VARIABLES      9 + 3

Joint distributions – Marginal and Conditional distributions – Covariance – correlation and Linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

### UNIT III      TESTING OF HYPOTHESIS      9 + 3

Sampling distributions - Tests for single mean, proportion, Difference of means (large and small samples) – Tests for single variance and equality of variances –  $\chi^2$ -test for goodness of fit – Independence of attributes – Non-parametric tests: Test for Randomness and Rank-sum test (Wilcoxon test).

### UNIT IV      DESIGN OF EXPERIMENTS      9 + 3

Completely randomized design – Randomized block design – Latin square design -  $2^2$  - factorial design.

### UNIT V      STATISTICAL QUALITY CONTROL      9 + 3

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

**TOTAL : 60 PERIODS**

## TEXT BOOKS

1. Milton, J. S. and Arnold, J.C., "Introduction to Probability and Statistics", Tata 4<sup>th</sup> Edition, McGraw Hill, 2007.
2. Johnson, R.A. and Gupta, C.B., "Miller and Freund's Probability and Statistics for Engineers", 7th Edition, Pearson Education, Asia, 2007.

## REFERENCES

1. Devore, J.L., "Probability and Statistics for Engineering and the Sciences", 7<sup>th</sup> Edition Thomson Brooks/Cole, 2008.
2. Walpole, R.E., Myers, R.H., Myers, S.L. and Ye, K., "Probability and Statistics for Engineers and Scientists", 8<sup>th</sup> Edition. Pearson Education, Asia, 2007.
3. Ross, S.M., "Introduction to Probability and Statistics for Engineers and Scientists," 3<sup>rd</sup> Edition, Elsevier, 2004.
4. Spiegel, M.R., Schiller, J. and Srinivasan, R.A., "Schaum's Outline of Theory and Problems of Probability and Statistics", Tata McGraw- Hill, 2004.

**FD6401**

**FOOD ANALYSIS**

**L T P C**

**3 0 0 3**

## AIM

To expose the students to the principles, methods and techniques of chemical and instrumental methods of food analysis.

## OBJECTIVE

- To understand the principles behind analytical techniques in food analysis.
- To know the methods of selecting appropriate techniques in the analysis of food products.
- Appreciate the role of food analysis in food standards and regulations for the manufacture and the sale of food products and food quality control in food industries.
- To familiarize with the current state of knowledge in food analysis.

## PREREQUISITE

Basic knowledge in chemistry, physics and food chemistry.

### UNIT I INTRODUCTION 10

Introduction, food regulations and standards; sampling methods, and sample preparation for analysis; statistical evaluation of analytical data. General methods of food analysis- Moisture determination by different methods; ash analysis-different methods; titrable acidity in foods; determination of crude fiber and dietary fibre.

### UNIT II LIPIDS, PROTEINS AND CARBOHYDRATE ANALYSIS 10

Analysis of oils and fats for physical and chemical parameters and quality standards, protein analysis by different techniques; analysis of carbohydrates by different techniques.

### UNIT III SPECTROSCOPIC TECHNIQUES 10

Basic principles; application of UV-Visible spectrophotometer in the analysis of food additives; IR Spectroscopy in online determination of components of food- FT-IR tintometer in color intensity determination; application of Atomic Absorption Spectrophotometer and ICP-AES in analysis of mineral elements and fluorimeter in vitamin analysis.

### UNIT IV CHROMATOGRAPHIC TECHNIQUES 10

Basic principles; application of paper chromatography and TLC in food analysis; detection of adulterants in foods; Column chromatography for purification analysis- Ion exchange and affinity chromatography; HPLC and GC in food analysis; Significance of MS detectors in HPLC and GC; FAME analysis in oils and fats.

### UNIT V ELECTROPHORESIS, REFRACTOMETRY AND POLARIMETRY 5

Basic principles; application of the electrophoresis in food analysis; Brix value of fruit juices; total soluble solids in fruit products; Refractive indices of oils and fats; specific rotations of sugars; Estimation of simple sugars and disaccharides by polarimeter.

**TOTAL: 45 PERIODS**

## TEXT BOOKS

1. Pomeranz, Yeshajahu. "Food Analysis : Theory and Practice". 3<sup>rd</sup> Edition. Aspen Publishers / Springer, 2000.
2. Kirk, R.S. and R. Sawyer "Pearson's Composition and Analysis of Food". 9<sup>th</sup> Edition. Longman,
3. Nielsen, S. Suzanne. "Food Analysis". 3<sup>rd</sup> Edition. Springer, 2003.

## REFERENCES

1. Otles, Semih. "Methods of Analysis of Food Components and Additives". CRC Press, 2005.
2. Nollet, Leo M.L. "Hand Book of Food Analysis" 2<sup>nd</sup> Rev. Edition. Vol. I, II & III, Marcel & Dekker, 2004.
3. Nollet, Leo M.L. " Food Analysis by HPLC". 2<sup>nd</sup> Rev. Edition, Marcel & Dekker, 2000
4. Otles, Semih. "Handbook of Food Analysis Instruments". CRC Press, 2009.



**AIM**

To understand the principles and applications of heat and mass transfer operations.

**OBJECTIVES**

To understand and apply the principles in heat transfer phenomena To understand and apply the principles in mass transfer phenomena To design heat and mass transfer equipments.

**UNIT I                      HEAT TRANSFER                      11**

Phenomena of heat transfer by conduction-concept of heat conduction resistances – application of heat conduction in series – heat transfer coefficient –heat convection phenomena- application for different situations –combined conduction and convection-overall heat transfer coefficient –application to design of heat exchangers- Principles of radiation heat transfer – Laws in radiation- View factor concepts – application.

**UNIT II                      DIFFUSION & MASS TRANSFER COEFFICIENTS                      8**

Diffusion in Mass Transfer –gas, liq, solid diffusion and mass transfer-Diffusion in biological solutions-measurement of diffusion Coefficients – concept of mass transfer Coefficients-application for different situations.

**UNIT III                      ABSORPTION                      9**

Interphase mass transfer and overall mass transfer Coefficients – Absorption equipments-Hydraulics of Packed Absorbers-Process Design of Packed Absorbers-Concept of height of transfer units and number of transfer units in design.

**UNIT IV                      DISTILLATION                      9**

Vapour Liquid equilibrium and distillation-simple Distillation, Steam distillation, Flash distillation-Staged distillation Column-Design by Mc Cabe-Thiele method-Enthalpy-Concentration diagrams and use in Distillation Column design.

**UNIT V                      LIQUID EXTRACTION & LEACHING                      8**

Principles of liq-extraction-Equilibrium –staged extraction calculation – continuous extraction equipments. Principles of Leaching –equilibrium-staged leaching – Leaching equipments. Principles of adsorption -Design of packed adsorber.

**TOTAL: 45 PERIODS**

**TEXT BOOKS**

1. Treybal, R.E. "Mass-Transfer Operations" 3<sup>rd</sup> Edition, McGraw-Hill, 1981.
2. Dutta, Binay, K. "Principles of Mass Transfer and Separation Process", PHI, 2007.
3. Nag, P.M. "Heat and Mass Transfer", 2<sup>nd</sup> Edition, Tata McGraw-Hill, 2007.
4. Geankoplis, C.J. "Transport Processes and Separation Process Principles (Includes unit Operations) 4<sup>th</sup> Edition, PHI, 2003.

**REFERENCES**

1. Coulson, J.M. and etal. "Coulson & Richardson's Chemical Engineering", 6<sup>th</sup> Edition, Vol. I & II, Butterworth – Heinman (an imprint of Elsevier), 2004
2. McCabe, W.L., J.C. Smith and P.Harriot "Unit Operations of Chemical Engineering", 6<sup>th</sup> Edition, Mc Graw Hill, 2003.

**AIM**

The course aims to introduce the students to the area of Food Processing. This is necessary for effective understanding of a detailed study of food processing and technology subjects. This course will enable students to appreciate the importance of food processing with respect to the producer, manufacturer and consumer.

**OBJECTIVES**

On completion of the course the students are expected to

- Be aware of the different methods applied to processing foods.
- Be able to understand the significance of food processing and the role of food and beverage industries in the supply of foods.

**UNIT I PROCESSING OF FOOD AND ITS IMPORTANCE 9**

Source of food - food of plant, animal and microbial origin; different foods and groups of foods as raw materials for processing – cereals, pulses, grains, vegetables and fruits, milk and animal foods, sea weeds, algae, oil seeds & fats, sugars, tea, coffee, cocoa, spices and condiments, additives; need and significance of processing these foods

**UNIT II METHODS OF FOOD HANDLING AND STORAGE 9**

Nature of harvested crop, plant and animal; storage of raw materials and products using low temperature, refrigerated gas storage of foods, gas packed refrigerated foods, sub atmospheric storage, Gas atmospheric storage of meat, grains, seeds and flour, roots and tubers; freezing of raw and processed foods.

**UNIT III LARGE-SCALE FOOD PROCESSING 12**

Milling of grains and pulses; edible oil extraction; Pasteurisation of milk and yoghurt; canning and bottling of foods; drying – Traditional and modern methods of drying, Dehydration of fruits, vegetables, milk, animal products etc.; preservation by use of acid, sugar and salt; Pickling and curing with microorganisms, use of salt, and microbial fermentation; frying, baking, extrusion cooking, snack foods.

**UNIT IV FOOD WASTES IN VARIOUS PROCESSES 6**

Waste disposal-solid and liquid waste; rodent and insect control; use of pesticides; ETP; selecting and installing necessary equipment.

**UNIT V FOOD HYGIENE 9**

Food related hazards – Biological hazards – physical hazards – microbiological considerations in foods. Food adulteration – definition, common food adulterants, contamination with toxic metals, pesticides and insecticides; Safety in food procurement, storage handling and preparation; Relationship of microbes to sanitation, Public health hazards due to contaminated water and food; Personnel hygiene; Training & Education for safe methods of handling and processing food; sterilization and disinfection of manufacturing plant; use of sanitizers, detergents, heat, chemicals, Cleaning of equipment and premises.

**TOTAL : 45 PERIODS**

**TEXT BOOKS**

1. Karnal, Marcus and D.B. Lund “Physical Principles of Food Preservation”. Rutledge, 2003.
2. VanGarde, S.J. and Woodburn. M “Food Preservation and Safety Principles and Practice”. Surbhi Publications, 2001.
3. Sivasankar, B. “Food Processing & Preservation”, Prentice Hall of India, 2002.
4. Khetarpaul, Neelam, “Food Processing and Preservation”, Daya Publications, 2005.

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

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

**UNIT II SOLUTION THERMODYNAMICS 9**

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

**UNIT III PHASE EQUILIBRIA 9**

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

**UNIT IV CHEMICAL REACTION EQUILIBRIA 9**

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

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

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

**TOTAL : 45 PERIODS****TEXT BOOKS**

1. Smith J.M., Van Ness H.C., and Abbot M.M. "Introduction to Chemical Engineering Thermodynamics", 6th Edition. Tata McGraw-Hill, 2003.
2. Narayanan K.V. "A Text Book of Chemical Engineering Thermodynamics", PHI, 2003.
3. Christiana D. Smolke, " The Metabolic Pathway Engineering Handbook Fundamentals", CRC Press Taylor & Francis Group, 2010.

**REFERENCE**

1. Sandler S.I. "Chemical and Engineering Thermodynamics", John Wiley, 1989.

**AIM**

To understand the principles involved in separation methods.

**OBJECTIVES**

To understand Principles of separation methods used in the process industry.  
To appreciate different equipments developed for separation.

**UNIT I SIZE REDUCTION 9**

Characterisation of solid particles – Mixing of solids – equipments – storage of solids – size reduction of solids – Crushing, grinding Cutting-Power requirements-equipments-

size enlargement.

**UNIT II FLUID – SOLID SEPARATION 9**  
Separation of solids & suspension from gas medium-screening- settling- Principles and equipments-classification-clarification.

**UNIT III FILTRATION 9**  
Filtration – Principles –Equipments-Centrifugal filtration-Principles- equipments – Centrifugal separation of immiscible liquids.

**UNIT IV MEMBRANE SEPARATION 9**  
Cross flow filtration- Membranes –Ultrafiltration-Microfiltration-Concentration Polarisation - operation and equipments.

**UNIT V DRYING & CRYSTALLISATION 9**  
Principles of Drying – Drying equipments Principles of Crystallisation- crystallization equipments.

**TOTAL : 45 PERIODS**

**TEXT BOOKS**

1. Geankoplis, C.J. "Transport Processes and Separation Process Principles", 4<sup>th</sup> Edition, Prentice Hall, 2003.
2. McCabe W.L., Smith J.C. "Unit Operations in Chemical Engineering", 7<sup>th</sup> Edition, McGraw – Hill Int., 2001,

**REFERENCE**

1. Richardson, J.E. et al., "Coulson & Richardson's Chemical Engineering" Vol.2 (Praticle Technology & Separation Processes") 5<sup>th</sup> Edition, Butterworth – Heinemann / Elsevier, 2003.

**FD6411 FOOD ANALYSIS LAB L T P C**  
**0 0 4 2**

**AIM**

Analysis of foods and food products for chemical components, compliance to standards; detection of adulterants in foods.

Examination of typical food products including

- a) Tea, coffee and cocoa,
- b) Milk and milk products,
- c) Edible oils and fats
- d) Cereal and cereal products
- e) Non alcoholic beverages and drinks
- f) Spices and condiments
- g) Bakery, confectionery products,
- h) Sugars and sweetening agents.

**TOTAL : 60 PERIODS**

**LAB EXPERIMENTS**

1. Precision and validity in an experiment using absorption spectroscopy.
2. Validating Lambert-Beer's law using  $KMnO_4$
3. UV spectra of nucleic acids.
4. Determination of moisture in spices powder by distillation method and Hot air oven method.
5. pH, conductivity, TDS and hardness of water

6. Determination of Peroxide Value, Acid value and free fatty acid in edible oils.
7. Isolation and identification of synthetic food colors in sweets, confectionery, beverages by Chromatography and Spectrophotometry..
8. Determination of total fat in liquid milk.
9. Determination of soluble and insoluble fibre in foods.
10. Determination of protein content in ice cream
11. Detection of adulterants in edible oil and ghee.
12. Detection of oil soluble color in spices powder by TLC.
13. Chromatography analysis using column chromatography.

### TEXTBOOKS

1. Skoog, D.A. et al. "Principles of Instrumental Analysis", 5<sup>th</sup> Edition, Thomson / Brooks – Cole, 1998.
2. Braun, R.D. "Introduction to Instrumental Analysis", Pharma Book Syndicate, 1987.
3. Willard, H.H. et al. "Instrumental Methods of Analysis", 7<sup>th</sup> Edition, CBS, 1986.
4. Ewing, G.W. "Instrumental Methods of Chemical Analysis", 5<sup>th</sup> Edition, McGraw-Hill, 1985.

**FD6412**

**CHEMICAL ENGINEERING LAB**  
(Common for IBT, Food and Pharmaceutical Technology)

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

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 : 60 PERIODS**

### TEXT BOOKS

1. McCabe, W.L., J.C. Smith and P. Harriot "Unit Operations of Chemical Engineering", 6<sup>th</sup> Edition, Mc Graw Hill, 2001.
2. Geankoplis, C.J. "Transport Processes and Separation process Principles", 4<sup>th</sup> Edition, PHI, 2006.

**FD6501**

**MILLING TECHNOLOGY FOR FOOD MATERIALS**

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

#### **UNIT I**

#### **GRAIN PROPERTIES**

**9**

Importance of grains and cereals - definitions, Grain structure, Physico-chemical properties of grains and its nutritional value. Storage of cereal grains in relation to maintaining grain quality – types of storage structures.

#### **UNIT II**

#### **MILLING OF RICE**

**9**

Rice milling flow sheet. Explanation of steps in milling operations - Cleaning, Parboiling- Physio –chemical changes during Parboiling and effects of qualities of rice. Methods of Parboiling, Milling, Shellers, Paddy Separator, Whitener, Polisher, Grader, and modern rice mill. Byproducts from rice milling and waste utilization.

**UNIT III MILLING PROCESS OF WHEAT 9**

Wheat milling flow sheet. Explanation of steps in milling, Cleaning Principles of Parboiling of wheat- Methods of Parboiling, Sifters, De-stoners, Roller milling - Break rolls, and reduction rolls, Sifting and purifying, plan sifters. Bran separation. Efficiency of milling process. By products from wheat milling and waste utilization.

**Milling of Corn:** Corn–types. Dry and wet milling of corn–flow sheet and explanation, Byproducts from corn milling, corn starch, corn syrup, corn flakes. Waste utilization.

**UNIT IV MILLING OF PULSES 9**

Importance of legumes. Milling and processing of Legumes- Methods of milling of pulses. Processing methods- dehulling losses and effect of dehulling on nutritive value. Grading methods, Cooking quality.

**UNIT V MILLING OF OIL SEEDS 9**

Oil seed processing- natural sources of oil. Physio-chemical properties, mechanical extraction - Oil processing machinery, solvent extraction, factors influencing extraction, types of solvents. Refining of oil, hydrogenation, winterization, changes during storage. Oil seed flour concentrates and isolate.

**TOTAL : 45 PERIODS**

**TEXT BOOKS**

1. Chakraverty, A. —Post Harvest Technology of Cereals, Pulses and Oil Seeds□, Third Edition,
2. Oxford & IBH publishing & Co., New Delhi, 2000. Sahay, K.M. and Singh. K.K. —Unit operations of Agricultural Processing□, Vikas Publishing House, New Delhi, 1996.

**REFERENCES**

1. Kulp K and Pont J G, —Handbook of Cereal Science and Technology□, Second Edition, Chips Ltd. USA, 2000.
2. Khader, Vijaya and Vimala, V., —Grain Quality and Processing□, Agrotech Publishing, Udaipur, 2007.
3. Harry Lawson. —Food Oils and Fats, Technology, Utilization and Nutrition□, CBS Publishers and Distributors, New Delhi, 1997.

**BT6604 CHEMICAL REACTION ENGINEERING L T P C  
4 0 0 4**

**OBJECTIVES:**

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

**UNIT I SCOPE OF CHEMICAL KINETICS & CHEMICAL REACTION ENGINEERING 12**

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 12**

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

<b>UNIT III</b>	<b>IDEAL FLOW AND NON IDEAL FLOW</b>	<b>12</b>
RTD in non-ideal flow; non-ideal flow models; reactor performance with non-ideal flow.		
<b>UNIT IV</b>	<b>GAS-SOLID, GAS-LIQUID REACTIONS</b>	<b>12</b>
Resistances and rate equations; heterogeneous catalysis; reactions steps; resistances and rate equations.		
<b>UNIT V</b>	<b>FIXED BED AND FLUID BED REACTORS</b>	<b>12</b>
G/L reactions on solid catalysis; trickle bed, slurry reactors; three phase-fluidized beds; reactors for fluid-fluid reactions; tank reactors.		

**TOTAL : 60 PERIODS**

**OUTCOMES:**

Upon completion of this course, the student would be able

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

**TEXT BOOKS:**

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

**REFERENCE:**

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

**FD6502**                      **REFRIGERATION AND COLD CHAIN**                      **L T P C**  
**3 0 0 3**

**UNIT I**                      **MEANING AND IMPORTANCE OF COLD CHAIN, CHART**                      **9**

What is cold chain? Need for the chain for chilled / frozen food item, various links of the chain; importance of shelf- life; just – in-time deliveries; Temperature limits;-in various countries- Europe, US, Australia etc; Chilling and freezing;- Chilling injury, cook-chilling systems; cold –shortening; PPP and TTT concepts; Temperature monitoring; -Critical temperatures; Temperature –time indicators(TTI); Time –temperature –correlation-the kinetic approach, effective temperature; Transportation regulations; Role of packaging in cold chain

– MAS, MAP, CAS, CAP etc; Thaw indicators.

**UNIT II**                      **MICRO ORGANISMS AND THE COLD CHAIN**                      **9**

Micro organisms and their growth phases; response of micro organisms; Inactivation mechanism during Chilling and freezing; Rapid freezing and slow thawing;Categories (groups) of Organisms in respect of their ability to survive under Cold / Chilling environment; Cold shock proteins and cold shock response. Thawing techniques, microbial quality of thawed foods.

**UNIT III**                      **PRINCIPLES AND METHODS OF REFRIGERATION**                      **9**

Concepts of systems and surrounding; meaning of refrigeration; Types of refrigeration; vapour compression-the refrigerating cycle, capacity, COPetc; Power consumption , efficiency factors; Refrigeration cycle as a series of thermodynamics processes

refrigeration cycle; COP, capacity – in vapour absorption refrigeration; comparative study between the above types of refrigeration; Types of refrigerants – their advantages / disadvantages; Refrigeration load demands and their calculation; closed cycle air refrigeration (CCAR); Cryogenic refrigeration; Freezing time – their prediction models, etc. Types freezer; - Blast freezer, Cryogenic tunnel freezer, spiral freezer, fluidized – bed freezer, Tumbling & rotary tunnel freezer, etc; Choosing the right freezer.

#### **UNIT IV SHELF – LIFE OF FOOD PRODUCTS 9**

Defining overall Shelf-life, remaining shelf life in the context of Chilled & Frozen foods; - Deterioration modes of food items; Models of quality deterioration- Kinetic model; shelf-life model; Q10/q10 model; TTT model for the remaining shelf – life; General procedure for shelf –life testing – the 11 steps procedure.

Storage of frozen foods; - Basic design requirements of storage to uphold the shelf –life – size , insulation, entry –exit position, palletization, proper aisle-space for air-circulation, automatic door –closing, proper lighting, temperature monitoring and recording facility; stacking systems, emergency exits, material handling devices like fork-lifts, pallet trucks, etc floor heaters, vapour barriers, etc.

#### **UNIT V HAZARD ANALYSIS CRITICAL CONTROL POINTS (HACCP) 9**

Definition; Purpose; origins of HACCP; Developing the HACCP plan; Preliminary steps- the five –step process-HACCP team assembly, Defining the product and its usage; Constructing the flow diagrams; On-Site confirmation of flow diagram, etc. The 7-point HACCP system: - conducting a hazard analysis; Identifying CCPs; Establishing limits for each CCP; Establishing monitoring procedure for critical limits; Corrective actions to be established; Procedures-setting for verification; Establish documentation and record maintaining.

Top-Management Commitment & involvement; Training of personnel; Implementation and integrating HACCP system with ISO, TQM, etc.

**TOTAL : 45 PERIODS**

#### **TEXT BOOKS**

1. Anand, M.L. “ Refrigeration & Air-Conditioning”. Asian Books Pvt., Ltd., 2002.
2. Sun, Da-Wen. “ Advances in Food Refrigeration”. Leatherhead Publishing, 2001.
3. Kennedy, Christopher J. “Managing Frozen Foods”. CRC / Woodhead Publishing, 2000.
4. James, S.J. and C. James. “ Meat Refrigeration”. CRC / Woodhead Publishing, 2002.
5. Stringer, Mike and C. Dennis. “Chilled Foods : A Comprehensive Guide”. 2<sup>nd</sup> Edition, CRC / Woodhead Publishing, 2002.

#### **REFERENCES**

1. Evans, Judith. “Frozen Food Science and Technology”. Wiley-Blackwell , 2008.
2. Hui, Y.H. et al., “ Handbook of Frozen Foods”. Marcel Dekker, 2004.

**FD6503**

**FOOD ADDITIVES**

**L T P C**

**3 0 0 3**

#### **AIM**

To expose the students to the use of different chemical additives in foods during food processing and preservation.

#### **OBJECTIVES**

- To understand the principles of chemical preservation of foods.
- To understand the role of different food additives in the processing of different



foods and their specific functions in improving the shelf life, quality, texture and other physical and sensory characteristics of foods.

- To know the regulations and the monitoring agencies involved in controlling the safer use of additives in foods

**UNIT I FOOD ADDITIVES 9**

Definition; their function in food processing and preservation. Preservatives – definition; natural preservatives; chemical preservatives; acidulants and low pH – organic acids and esters; sulphur dioxide and its salts; nitrites; antibiotics; surface preservation. Permitted preservatives in foods – Antioxidants; natural and chemical antioxidants; mechanism of antioxidant function; primary and secondary antioxidants; sequestrants; selection and application of antioxidants in foods; evaluation of antioxidant effectiveness – permitted antioxidants in foods.

**UNIT II FOOD COLORS 9**

Natural and synthetic colors; fake colors; inorganic pigments; application of colors in food industry; restriction on the use of colors in foods. Flavoring agents – concept of flavors in foods; natural flavors; nature identical flavors; artificial flavoring substances; restrictions on the use of flavoring agents in foods.

**UNIT III EMULSIFIERS AND STABILIZERS 9**

Definition; properties; HLB value; function of emulsifiers and stabilizers in foods; permitted emulsifiers and stabilizers used in foods; polyols – physical and chemical properties of polyols, application in food industry, permitted polyols in foods.

**UNIT IV SWEETENERS 9**

Natural and chemical sweeteners; nutritive and non-nutritive sweeteners; chemical structure & sweetness; saccharine, acesulfame K, aspartame, sucralose; restriction on the use of sweeteners in foods; Food acids – their function and application in foods; permitted food acids; nutritive additives; enrichment of foods.

**UNIT V FOOD SAFETY 9**

Food – Safety in the use of food additives in foods; regulations and monitoring agencies; toxicological evaluation of additives; interaction of additives with food ingredients.

**TOTAL : 45 PERIODS**

**TEXT BOOK**

1. Mahindru, S.N. "Food Additives: Characteristics, Detection and Estimation". Tata McGraw-Hill, 2000.

**REFERENCES**

1. Brennen, Alfred Larry. "Food Additives". 2<sup>nd</sup> Edition, CRC Press,
2. Clydesdale, Fergus M. "Food Additives- Toxicology Regulation and Properties". CRC Press,
3. Emerton, Victoria, "Food Colours". Blackwell Publishing, 2008.
4. Wilson, Rachel. "Sweeteners" Blackwell Publising, 2007.
5. Hutchings, John B. "Food Color and Appearance". Aspen Publication, 1999.

**AIM**

To expose the students to the principles and different methods of food processing and preservation.

**OBJECTIVES**

- To understand the principles of food processing and preservation.
- To understand the role of different methods the processing of different foods and their impact on the shelf life, quality, and other physical and sensory characteristics of foods.
- To familiarize with the recent methods of minimal processing of foods To understand the materials and types of packaging for foods

**UNIT I PRINCIPLES OF MASS AND ENERGY BALANCE 9**

Transport phenomena with respect to foods; Factors affecting heat and mass transfer; Study of heat transfer and its application in the design of thermal processes and freezing. Thermal processing; calculation of process time temperature-schedules.

**UNIT II CANNING OF FOOD PRODUCTS 9**

Newer methods of thermal processing; batch and continuous; application of infra-red microwaves; ohmic heating; control of water activity; preservation by concentration and dehydration; osmotic methods.

**UNIT III DRYING PROCESS FOR TYPICAL FOODS 9**

Rate of drying for food products; design parameters of different type of dryers; properties of air-water mixtures. Psychrometric chart, freezing and cold storage. freeze concentration, dehydro-freezing, freeze drying, IQF; calculation of refrigeration load, design of freezers and cold storages.

**UNIT IV NON-THERMAL METHODS 9**

(SUPER CRITICAL)Chemical preservatives, preservation by ionizing radiations, ultrasonics, high pressure, fermentation, curing, pickling, smoking, membrane technology. Hurdle technology,

**UNIT V FOOD PACKAGING 9**

Basic packaging materials, types of packaging, packaging design, packaging for different types of foods, retort pouch packing, costs of packaging and recycling of materials.

**TOTAL : 45 PERIODS**

**TEXT BOOKS**

1. Sivasankar, B. "Food Processing and Preservation". Prentice Hall of India, 2002.
2. Desrosier, N.W. and Desrosier, J.N. "The Technology of Food Preservation", 4<sup>th</sup> Edition, CBS, 1987.
3. Khetarpaul, Neelam. "Food Processing and Preservation." Daya Publications, 2005
4. Singh, M.K. "Food Preservation" Discovery Publishing, 2007.
5. Fellows, P.J. "Food Processing Technology : Principles and Practice". 2<sup>nd</sup> Edition, CRC Wood Head Publishing, 2000.
6. Gopala Rao, Chandra. "Essentials of Food Process Engineering". B.S. Publications, 2006.

## REFERENCES

1. Rahman, M. Shafiur. "Handbook of Food Preservation". Marcel & Dekker, 2006.
2. Zeuthen, Peter and Bogh-Sarensen, Leif. "Food Preservation Techniques". CRC / Wood Head Publishing, 2003.
3. Ranganna, S. "Handbook of Canning and Aseptic Packaging". Tata McGraw-Hill, 2000.

**FD6511**

**FOOD PROCESSING AND PRESERVATION LAB**

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

## OBJECTIVES

To develop skills related to

- Preservation of foods
- Use of various techniques and additives for food processing and Preservation

## EXPERIMENTS

1. Refrigeration and Freezing of vegetables and fruits
2. Drying of vegetables and fruits with and without additives - Drying rate studies including, constant rate and falling rate periods and the effects of various factors on them.
3. Osmotic drying of foods with salt and sugar.
4. Canning & bottling of vegetable and fruit products
5. Filtration and concentration of fruit juices
6. Production of extruded products.
7. Spray drying of juices/milk
8. Pasteurization of milk
9. Retort processing of foods
10. Baking of cakes – plain cakes, sponge cakes, cup cake – quality characteristics; Effect of varying ingredients – emulsifiers, fat, sugar gums and processing conditions
11. Preparation of custard, puddings, mousse, flan, pie, tarts, doughnuts, biscuits
12. Baking of Bread - role of ingredients & processing
13. Candies, toffees, fudges, pralines & brittles – Sugar crystallization & inhibition of crystal formation & soft centered sweets
14. Chocolates – role of ingredients and processing

**TOTAL : 60 PERIODS**

## REFERENCES

1. Rahman, M.S. "Handbook of Food Preservation", Marcel Dekker, 1999.
2. Ranganna, S. "Handbook of Canning and Aseptic Packaging" Vol. I, II & III, Tata McGraw – Hill, New Delhi, 2000
3. Pandey, H. et al., "Experiments in Food Process Engineering". CBS Publishers, 2004.

**FD6512**

**FOOD PRODUCTION ANALYSIS LAB**

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

Analysis of food products for food additives, contaminants, nutrients and compliance to standards.

## LAB EXPERIMENTS

1. Studying the expansion characteristics of snack foods on frying.
2. Rancidity test for fried foods to assess primary and secondary oxidative products.

3. Determination of Vitamin C in fruit juices.
4. Estimation of synthetic Food color in sweets, confectioneries and beverages.
5. Determination of Iron content in foods.
6. Determination of Iodine content in iodized salt.
7. Detection of Annatto color in table butter.
8. Determination of Lead in spices powder.
9. Detection of added MSG in foods.
10. Detection of sulphur-di-oxide in foods.
11. Detection of anti oxidant in foods.
12. Detection of certain emulsifiers and stabilizers in foods.

**TOTAL : 60 PERIODS**

**FD6601**

**BIOCHEMICAL ENGINEERING**

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

**UNIT I INTRODUCTION TO ENZYMES 9**

Classification of enzymes. Mechanisms of enzyme action; concept of active site and energetics of enzyme substrate complex formation; specificity of enzyme action; principles of catalysis – collision theory, transition state theory; role of entropy in catalysis.

**UNIT II KINETICS OF ENZYME ACTION 9**

Kinetics of single substrate reactions; estimation of Michelis – Menten parameters, multisubstrate reactions- mechanisms and kinetics; turnover number; types of inhibition & models –substrate, product. Allosteric regulation of enzymes, Monod changeux wyman model, ph and temperature effect on enzymes & deactivation kinetics.

**UNIT III ENZYME IMMOBILIZATION 6**

Physical and chemical techniques for enzyme immobilization – adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding etc., - examples, advantages and disadvantages.

**UNIT IV OVERVIEW OF FERMENTATION PROCESSES 9**

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

**UNIT V RAW MATERIALS AND MEDIA DESIGN FOR FERMENTATION PROCESS 12**

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

**TOTAL : 45 PERIODS**

**TEXT BOOKS**

1. Bailey, J.E. and Ollis, D.F. "Biochemical Engineering Fundamentals", 2nd Edition, McGraw-Hill, 1986.
2. Blanch, H.W. and D.S. Clark "Biochemical Engineering", Marcal Dekker, Inc., 1997.
3. Lee, James M. "Biochemical Engineering", Prentice – Hall, 1992.

**REFERENCES**

1. Palmer, Trevor "Enzymes : Biochemistry, Biotechnology, Clinical Chemistry", Affiliated East-West Press Pvt. Ltd., 2004.
2. Stanbury, P.F., A. Whitaker and S.J. Hall "Principles of Fermentation Technology", 2<sup>nd</sup> Edition, Butterworth – Heinemann (an imprint of Elsevier), 1995.

3. Wiseman, Alan "Handbook of Enzyme Biotechnology", 3rd Edition, Ellis Harwood Publications, 1999.
4. Hartmeier, Winfried "Immobilized Biocatalysts : An Introduction", Springer – Verlag, 1986

**FD6602**

**BAKING AND CONFECTIONERY TECHNOLOGY**

**L T P C**

**3 0 0 3**

**UNIT I INTRODUCTION TO BAKING**

**9**

Classification of bakery products. Bakery ingredients and their functions-Essential ingredients: Flour, yeast and sour dough, water, salt- Other ingredients: Sugar, color, flavor, fat, milk, milk powder and bread improvers. Leaveners and yeast foods. Shortenings, emulsifiers and antioxidants.

**UNIT II EQUIPMENTS**

**9**

Introduction to utensils and equipments used in bakery industry with their purpose. Bulk handling of ingredients- Dough mixing and mixers, Dividing, rounding, sheeting, and laminating- Fermentation enclosures and brew equipment - Ovens and Slicers. Rheology of dough-Farinograph, Amylograph, Alveograph, and Extensiograph.

**UNIT III BREAD MAKING PROCESS**

**9**

The Chemistry of Dough Development. Bread making methods- Straightdough/bulk fermentation - Sponge and dough- Activated dough development- Chorley wood bread process- Dough retarding and freezing-emergency No time process. Advantages and disadvantages of various methods of bread-making. Characteristics of good bread: Internal characters; external characters. Bread defects/faults and remedies. Spoilage of bread-Causes, detection and prevention.

**UNIT IV BAKERY PRODUCTS**

**9**

Production of cakes and cookies/biscuits. Types of biscuit dough's –Developeddough, short dough's, semi-sweet, enzyme modified dough's and batters. Cake making: Ingredients and their function Structure builders. Tenderizers, moisteners and flavor enhancers. Production process for Wafers- type of flour, raising agents and maturing. Other miscellaneous products- puff pastry, chemically leavened. Problems of baking.

**UNIT V CONFECTIONERY PRODUCTS**

**9**

Definition, importance of sugar confectionery. General technical aspects of industrial sugar confectionery manufacture - compositional effects. Manufacture methods of high boiled sweets: - Ingredients -.prevention of recrystallization and stickiness Types of confectionery products- Caramel, Toffee and Fudge and other confections:- ingredients - Formulation - Processing method- Quality control- Aerated confectionery- Methods of aeration- Manufacturing process- Chemistry of Hydrocolloids, Hydrocolloid pretreatment Processes -product quality parameters, faults and corrective measures.Spoilage of confectionery products.

**TOTAL : 45 PERIODS**

**TEXT BOOKS**

1. Matz, Samuel A., —Bakery Technology and Engineering□, Third Edition, Chapman & Hall, London.
2. Cauvain, Stanley P, and Young, Linda S., —Technology of Bread Making□, Second Edition Aspen publication. Maryland, 1999

**REFERENCES**

1. Edwards W.P. — Science of bakery products□, Published by The Royal Society of Chemistry, UK,2007
2. Samuel A. Matz., —Equipment for Bakers□, Pan Tech International Publication. 1988.
3. Sugar Confectionery manufacture-(Ed) E.B.Jackson, 2<sup>nd</sup> edition, Blackie Academic and professional, Glasgow (1995).

**GE6351 ENVIRONMENTAL SCIENCE AND ENGINEERING**

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

**AIM**

The aim of this course is to create awareness in every engineering graduate about the importance of environment, the effect of technology on the environment and ecological balance and make them sensitive to the environment problems in every professional Endeavour that they participates.

**OBJECTIVE**

At the end of this course the student is expected to understand what constitutes the environment, what are precious resources in the environment, how to conserve these resources, what is the role of a human being in maintaining a clean environment and useful environment for the future generations and how to maintain ecological balance and preserve bio-diversity. The role of government and non-government organization in environment managements.

**UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY**

**14**

Definition, scope and importance of environment – need for public awareness - concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids – 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**

**8**

Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – solid waste management: causes, effects and control measures of municipal solid wastes – role of an individual in prevention of pollution – pollution case studies – disaster management: floods, earthquake, cyclone and landslides.

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 over-utilization of surface and ground water, floods, drought, conflicts over 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. 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.

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 – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. – wasteland reclamation – consumerism and waste products – environment protection act – Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act

– Wildlife protection act – Forest conservation act – enforcement machinery involved in environmental legislation- central and state pollution control boards- 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 – role of information technology in environment and human health – Case studies.

**TOTAL : 45 PERIODS**

#### **TEXT BOOKS:**

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

#### **REFERENCES BOOKS:**

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

**AIM**

The course aims to develop the knowledge of students in the area of vegetable and fruit processing and technology. This course will enable students to appreciate the application of scientific principles in the processing of these materials.

**OBJECTIVES**

On completion of the course the students are expected to

Be able to understand and identify the specific processing technologies used for vegetables and fruits and the various products derived from these materials.

Understand the application of scientific principles in the processing technologies specific to the materials.

Grasp the changes in the composition of foods with respect to the type of processing technology used.

**UNIT I BASIC AGRICULTURAL ASPECTS OF VEGETABLES AND FRUITS 8**

Ability to identify all commercially important fruits and vegetables with their names in important Indian languages, important regions, season, basic aspects of cultivation, harvest ( Good Agricultural practices) permitted pesticides and stages of application, yield

**UNIT II FRESH FRUITS AND VEGETABLES 8**

Climatic and non climatic fruits, ripening process, phytonutrients in fruits and vegetables; Handling, transportation , controlled atmosphere ripening process, grading, cleaning, pretreatments, modified atmosphere packaging, chilling.

**UNIT III FREEZING & DEHYDRATION OF FRUITS AND VEGETABLES 12**

General pre processing, different freezing methods and equipments, problems associated with specific fruits and vegetables; Dehydration – General pre processing, different methods of drying including sun, tray, spray drying and low temperature, osmotic dehydration and other modern methods; Indian Food Regulation and Quality assurance.

**UNIT IV CANNING, PUREES AND JUICES 12**

Canning- General pre processing, specific or salient points in fruits and vegetables like – Blanching, exhausting, processing conditions; Indian Food Regulation and Quality assurance Fruit Juice / pulp/ Nectar/Drinks, concentrates – General and specific processing, different packing including aseptic. Indian Food Regulation and Quality assurance Vegetable

General and specific processing, different packing including aseptic

Purees/paste Indian

Food Regulation and Quality assurance

**UNIT V FRUIT AND VEGETABLE PRODUCTS 5**

Ready to eat vegetable products, Jams/Marmalades, Squashes/cordials, Ketchup/sauces, Chutneys, Fruit Bar, Soup powders, Candied Fruits, Natural colors, Fruit and Vegetable Fibres- General and specific processing, different packing including aseptic. Indian Food Regulation and Quality assurance

**TOTAL : 45 PERIODS**

**TEXT BOOKS**

1. Singh, R. Paul and D.R. Heldman. "Introduction to Food Engineering". 4<sup>th</sup> Edition, Academic Press/ Elsevier, 2009.
2. Gopala Rao, Chandra. "Essentials of Food Process Engineering". B.S. Publications,



- 2006.
3. Toledo, Romeo T. "Fundamentals of Food Process Engineering". 3<sup>rd</sup> Edition. Springer, 2007.
  4. Smith, P.G. "Introduction to Food Process Engineering". Springer, 2004.
  5. Berk, Zeki. "Food Process Engineering and Technology". Academic Press / Elsevier, 2009.

**GE6757**

**TOTAL QUALITY MANAGEMENT**

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

**OBJECTIVE :**

To facilitate the understanding of Quality Management principles and process.

**UNIT I INTRODUCTION 9**

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Quality statements - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention - Costs of quality.

**UNIT II TQM PRINCIPLES 9**

Leadership - Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Quality circles Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.

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

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

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

Control Charts - Process Capability - Concepts of Six Sigma - Quality Function Development (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.

**UNIT V QUALITY SYSTEMS 9**

Need for ISO 9000 - ISO 9001-2008 Quality System - Elements, Documentation, Quality Auditing - QS 9000 - ISO 14000 - Concepts, Requirements and Benefits - TQM Implementation in manufacturing and service sectors..

**TOTAL: 45 PERIODS**

**OUTCOME:**

The student would be able to apply the tools and techniques of quality management to manufacturing and services processes.

**TEXTBOOK:**

1. Dale H. Besterfield, et at., "Total quality Management", Pearson Education Asia, Third Edition, Indian Reprint (2006).

**REFERENCES:**

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8<sup>th</sup> Edition, First Indian Edition, Cengage Learning, 2012.
2. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.

3. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.

**GE6563**

**COMMUNICATION SKILLS LABORATORY**

**L T P C**

**0 0 4 2**

Globalisation has brought in numerous opportunities for the teeming millions, with more focus on the students' overall capability apart from academic competence. Many students, particularly those from non-English medium schools, find that they are not preferred due to their inadequacy of communication skills and soft skills, despite possessing sound knowledge in their subject area along with technical capability. Keeping in view their pre-employment needs and career requirements, this course on Communication Skills Laboratory will prepare students to adapt themselves with ease to the industry environment, thus rendering them as prospective assets to industries. The course will equip the students with the necessary communication skills that would go a long way in helping them in their profession.

**OBJECTIVES:**

- To equip students of engineering and technology with effective speaking and listening skills in English.
- To help them develop their soft skills and interpersonal skills, which will make the transition from college to workplace smoother and help them excel in their job.
- To enhance the performance of students at Placement Interviews, Group Discussions and other recruitment exercises.

<b>I. PC based session</b>	<b>(Weightage 40%)</b>	<b>24 periods</b>
----------------------------	------------------------	-------------------

**A. ENGLISH LANGUAGE LAB**

**(18 Periods)**

**1. LISTENING**

**COMPREHENSION:**

**(6)**

Listening and typing – Listening and sequencing of sentences – Filling in the blanks - Listening and answering questions.

**2. READING COMPREHENSION:**

**(6)**

Filling in the blanks - Close exercises – Vocabulary building - Reading and answering questions.

**3. SPEAKING:**

**(6)**

Phonetics: Intonation – Ear training - Correct Pronunciation – Sound recognition exercises – Common Errors in English.

Conversations: Face to Face Conversation – Telephone conversation – Role play activities (Students take on roles and engage in conversation)

**B. DISCUSSION OF AUDIO-VISUAL MATERIALS**

**(6 PERIODS)**

**(Samples are available to learn and practice)**

**1. RESUME / REPORT PREPARATION / LETTER WRITING**

**(1)**

Structuring the resume / report - Letter writing / Email Communication - Samples.

2. **PRESENTATION SKILLS:** (1)  
 Elements of effective presentation – Structure of presentation - Presentation tools –  
 Voice Modulation – Audience analysis - Body language – Video samples
3. **SOFT SKILLS:** (2)  
 Time management – Articulateness – Assertiveness – Psychometrics –  
 Innovation and Creativity - Stress Management & Poise - Video Samples
4. **GROUP DISCUSSION:** (1)  
 Why is GD part of selection process ? - Structure of GD – Moderator – led and other  
 GDs - Strategies in GD – Team work - Body Language - Mock GD -Video samples
5. **INTERVIEW SKILLS:** (1)  
 Kinds of interviews – Required Key Skills – Corporate culture – Mock interviews-  
 Video samples.

<b>II. Practice Session</b>	<b>(Weightage – 60%)</b>	<b>24 periods</b>
-----------------------------	--------------------------	-------------------

1. **Resume / Report Preparation / Letter writing:** Students prepare their own resume and report. (2)
2. **Presentation Skills:** Students make presentations on given topics. (8)
3. **Group Discussion:** Students participate in group discussions. (6)
4. **Mock Interviews:** Students participate in Interviews (8)

### TEXT BOOKS

1. Anderson, P.V, **Technical Communication**, Thomson Wadsworth, Sixth Edition, New Delhi, 2007.
2. Prakash, P, **Verbal and Non-Verbal Reasoning**, Macmillan India Ltd., Second Edition, New Delhi, 2004.

### REFERENCES

1. John Seely, **The Oxford Guide to Writing and Speaking**, Oxford University Press, New Delhi, 2004.
2. Evans, D, **Decisionmaker**, Cambridge University Press, 1997.
3. Thorpe, E, and Thorpe, S, **Objective English**, Pearson Education, Second Edition, New Delhi, 2007.
4. Turton, N.D and Heaton, J.B, **Dictionary of Common Errors**, Addison Wesley Longman Ltd., Indian reprint 1998.

1. Teacher console and systems for students.
2. English Language Lab Software
3. Career Lab Software

**Requirement for a batch of 60 students**

Sl.No.	Description of Equipment	Quantity required
1.	<b>Server</b>	1 No.
	o PIV system	
	o 1 GB RAM / 40 GB HDD	
	o OS: Win 2000 server	
	o Audio card with headphones (with mike)	
o JRE 1.3		
2.	<b>Client Systems</b>	60 No.
	o PIII or above	
	o 256 or 512 MB RAM / 40 GB HDD	
	o OS: Win 2000	
	o Audio card with headphones (with mike)	
o JRE 1.3		
3.	Handicam Video Camera (with video lights and mic input)	1 No.
4.	Television - 29"	1 No.
5.	Collar mike	1 No.
6.	Cordless mikes	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 - <b>Desirable</b>	1 No.

**FD6612**

**BIO PROCESS LAB**

**L T P C**

**0 0 4 2**

**AIM**

To enable the students to understand the concepts and operation of equipment in handling of enzymes and cultivation of microbes in industrial scale .

**OBJECTIVE**

To sterilize the bioreactor

To operate the bioreactor

To design experiments to evaluate the performance of the bioreactor

To develop enzyme immobilized processes.

1. Growth of bacteria – estimation of biomass, calculation of specific growth rate, yield

- coefficient
2. Medium optimization – Plackett Burman design, response surface methodology
  3. Enzyme kinetics – Michelis Menton parameter, effect of temperature and pH
  4. Enzyme immobilization – gel entrapment, cross linking
  5. Preparation of bioreactor, utilities for bioreactor operation
  6. Thermal death kinetics
  7. Batch sterilization design
  8. Batch cultivation, estimation of  $k_{la}$  – dynamic gassing method, exhaust gas analysis – carbon balancing, gas balancing
  9. Fed batch cultivation, exhaust gas analysis – carbon balancing, gas balancing
  10. Estimation of  $k_{la}$  – sulphite oxidation method
  11. Estimation of overall heat transfer coefficient

**TOTAL : 60 PERIODS**

**REFERENCES**

1. Bailey, J.E. and Ollis, D.F. “Biochemical Engineering Fundamentals” 2<sup>nd</sup> Edition, McGraw – Hill, 1988.
2. Lee, James M. “Biochemical Engineering”, PHI, U.S.A.
3. Stanbury, P.F. et al. “Principles of Fermentation Technology”, 2<sup>nd</sup> Edition, Butterworth – Heinemann / Elsevier, 1995.
4. El-Mansi, E.M.T. et al., “Fermentation Microbiology and Biotechnology”, 2<sup>nd</sup> Edition, CRC / Taylor & Francis, 2007.
5. Peppler, H.J. and D. Perlman “ Microbial Technology” (vol. I Microbial Processes and Vol. I Fermentation Technology)” 2<sup>nd</sup> Edition, Academic Press / Elsevier, 2004.

<b>FD6613</b>	<b>BAKING AND CONFECTIONERY LABORATORY LAB</b>	<b>L T P C 0 0 4 2</b>
---------------	--	----------------------------

1. Study of ingredients (major and minor): characteristics of flour, yeast, shortening, sugar, egg and salts.
2. Experiment on leavening action of baking powder, sodium- bicarbonate and ammonium-bi-carbonate.
3. Determination sedimentation value of flour
4. Estimation of gluten content (atta, and maida)
5. Estimation of water absorption power (atta, and maida)
6. Determination dough rising capacity of yeast
7. Studies of dough characteristics farinographic and extensographic
8. Preparation of biscuits-different types.
9. Preparation of bread-different types.
10. Preparation of toffees.
11. Preparation of sugar boiled confectionary.
12. Preparation of candy.

**REFERENCES / MANUALS/SOFTWARE:**

Sugar Confectionery manufacture-(Ed) E.B.Jackson, 2<sup>nd</sup> edition. Blackie Academic and professional, Glasgow(1995).

**TOTAL : 60 PERIODS**

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

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

**UNIT II DNA LIBRARIES 9**

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

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

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

**UNIT IV TRANSGENIC TECHNOLOGY 9**

DNA microinjection, Retroviral vectors, Transgenic animals – Knock in and knock out animals, Transgenic plants – Ti plasmid.

**UNIT V APPLICATIONS OF RDNA TECHNOLOGY IN FOODS (Remove company names) 9**

Genetically engineered proteins: Bovine Somatotropin in Milk; Genetically engineered bacteria:Chymosin Lite beer; Tryptophan; Transgenic plants: Calgene Flavr Savr™ tomato,MonsantoRound-Up™ Ready, Ciba Geigy Basta™ resistant crops; Edible vaccines:Cholera vaccine in potatoes; Transgenic Fish: Atlantic salmon.

**TOTAL : 45 PERIODS****TEXTBOOKS**

1. Rees, Andy "Genetically Modifies Food: A Short Guide for the Confused". Pluto Press, 2006.
2. Ahmed, Farid E. "Testing of Genetically Modified Organisms in Food". Food Products Press, 2004.

**REFERENCE**

1. Halford, Nigel G. "Genetically Modified Crops". Imperial College Press, 2003.

**FD6702 MEAT, FISH AND POULTRY PROCESS TECHNOLOGY****L T P C  
3 0 0 3****UNIT I INTRODUCTION 9**

Recent trends in meat processing. Types of Meat and its sources, composition,structure, of meat and meat products. Ante mortem handling, slaughtering of animals, Mechanical deboning, inspection and grading of meat. Post-mortem changes of meat. Color, flavors, microbiology and spoilage factors of meat and meat products.

**UNIT II MEAT PROCESSING 9**

Factors affecting post-mortem changes, properties and shelf-life of meat. Meat tenderization and Meat quality evaluation. Modern abattoirs, slaughter house and its features. Preservation of meat- aging, pickling, smoking. Dried and Cured meat. Canned meat, Frozen meat, Cooked and Refrigerated meat, Sausages.

**UNIT III FISH PROCESSING 9**

Types of fish, composition, structure, and spoilage factors of fish. Post-mortem changes in fish. Handling and transportation of fish. Bacteriology of fish, Chilling of fish, Freezing and Individual quick freezing.

Canning and smoking operations, Salting and drying of fish, pickling. Radiation processing of fish and fish products. Seafood quality Assurance, Advances in fishery by products technology.

**UNIT IV POULTRY 9**

Introduction, Types and characteristics of poultry products, composition, nutritive value, calculation of nutritive value of poultry products. Unit operation involved in poultry processing.

**UNIT V EGG PROCESSING 9**

Structure, composition, nutritive value, calculation of nutritive value and functional properties of eggs, Factor affecting egg quality and measures of egg quality. Preservation of egg by different methods. Egg powder processing.

**TOTAL : 45 PERIODS**

**TEXT BOOKS**

1. Govindan. T.K, —Fish Processing Technology□, Oxford and IBH Publishers, New Delhi, 1985.
2. Lawrie, R.A. —Meat Science□, Second Edition. Pergamon Press, Oxford, UK. 1975.
3. Stadelmen, W.J. and Cotterill, O.J., —Egg Science and Technology□, Second Edition, AVI, Westport, 1977.

**REFERENCES**

1. Joseph Kerry, John Kerry and David Ledwood. —Meat Processing□, Woodhead Publishing Limited, England (CRC Press), 2002.
2. Mead, G. —Poultry Meat Processing and Quality□, Woodhead Publishing, England, 2004.
3. Wheaton, F.W. and Lawson, T.B., —Processing of Aquatic Food Products□, John Wiley & Sons Publishers, New York. 1985.

**FD6703 DAIRY PROCESS TECHNOLOGY L T P C  
3 0 0 3**

**OBJECTIVES:**

At the end of the course the students would be exposed to fundamental knowledge in

- Properties of Milk
- Processing of Milk and Manufacture of dairy products
- Sanitation and effluent treatment in dairy industry

**UNIT I PROPERTIES OF MILK 7**

Milk-Types-Composition-Physical-Chemical and Thermal Properties-Heat Capacity, Density-Freezing-Boiling point-Expansion-Agitation-Viscosity-Classification of milk Market and Special Milk Handling-effects of Merits on Milk-toxicity of metals.

**UNIT II PROCESSING AND QUALITY PARAMETERS OF MILK 10**

Processing of Milk- Pasteurization-HTST, UHT, sterilization, Homogenization, Filtering and Clarification of Milk-cream separation-Methods and Equipment's-Emulsification – Fortification, packaging of milk and milk products, judging and grading of milk, national and international standards of milk and milk products.

**UNIT III MILK PRODUCTS 12**

Traditional dairy products, Manufacturing of Yogurt, Cheese, Butter, Ghee, Ice-cream, malted products, evaporated milk products - properties, Classification-processing Methods, Equipment used, standards and quality parameters.

**UNIT IV MILK POWDER PROCESSING AND MILK SUBSTITUTES 9**

Processing of Milk Powder- Composition - Properties- methods of drying, substitutes for milk and milk products – casein, lactose and other by-products, weaning foods, therapeutic foods, fortification and enrichment.

**UNIT V STORAGE SANITATION AND EFFLUENT TREATMENT 7**

Storage of Milk in Tanks-Storage of ice cream and other milk products - in cold storage -Cleaning and Sanitation-Importance-Detergents-Properties-Cleaning procedures-Cleaning in place-Dairy effluent treatment and disposal.

**TOTAL: 45 PERIODS**

**TEXT BOOKS:**

1. Ananthakrishnan, C.P., and Sinha, N.N., "Technology and Engineering of Dairy Plant Operations, Laxmi Publications, New Delhi. Pp.319, 1984.
2. Warner, J.N., "Principles of Dairy Processing", Wiley Eastern Pub. Co., New York, 1975.
3. Walstra, P. et al., "Diary Technology : Principles of Milk Properties and Processes". Marcel Dekker, 1999
4. Spreer, Edgar "Milk and Dairy Product Technology". Marcel Dekker, 2005.

**REFERENCE:**

1. Tufail Ahmed., "Dairy Plant Engineering and Management", Kitab Mahal Publishers, Allahabad, 1997.
2. Lampert, Lincoln M. "Modern Dairy Products: Composition, Food Value, Processing, Chemistry, Bacteriology, Testing, Imitation Dairy Products". Chemical Publishing Company, 1998.
3. Selia, Jane dos Reis Coimbra and Jose A. Teixeir "Engineering Aspects of Milk and Dairy Products". Jane Selia dos Reis Coimbra & Jose A. Teixeir, CRC Press, 2009

**FD6704 CREATIVITY, INNOVATION AND NEW PRODUCT DEVELOPMENT LT P C 3 0 0 3**

**AIM**

To study the various issues related to Creativity, Innovation and New Product Development.

**OBJECTIVE**

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

**UNIT I INTRODUCTION 9**

The process of technological innovation - factors contributing to successful technological innovation - the need for creativity and innovation - creativity and problem solving - 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 PLANNING 9**

Design of proto type - testing - quality standards - marketing research - introducing new products

**UNIT IV NEW PRODUCT DEVELOPMENT 9**

Research and new product development - Patents - Patent search - Patent laws - International code for patents - Intellectual property rights (IPR).

**UNIT V MODEL PREPARATION & EVALUATION 9**

Creative design - Model Preparation - Testing - Cost evaluation - Patent application

**TOTAL: 45 PERIODS**

**TEXT BOOKS**

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

**REFERENCES**

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

**GE6075 PROFESSIONAL ETHICS IN ENGINEERING LT P C  
3 0 0 3**

**OBJECTIVES:**

- To enable the students to create an awareness on Engineering Ethics and Human Values, to instill Moral and Social Values and Loyalty and to appreciate the rights of others.

**UNIT I HUMAN VALUES 10**

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

**UNIT II 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 – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories

**UNIT III ENGINEERING AS SOCIAL EXPERIMENTATION 9**

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.

**UNIT IV SAFETY, RESPONSIBILITIES AND RIGHTS 9**

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality –

**UNIT V GLOBAL ISSUES**

**8**

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership – Code of Conduct – Corporate Social Responsibility

**TOTAL : 45 PERIODS**

**OUTCOME:**

- Upon completion of the course, the student should be able to apply ethics in society, discuss the ethical issues related to engineering and realize the responsibilities and rights in the society

**TEXTBOOKS:**

1. Mike W. Martin and Roland Schinzinger, “Ethics in Engineering”, Tata McGraw Hill, New Delhi, 2003.
2. Govindarajan M, Natarajan S, Senthil Kumar V. S, “Engineering Ethics”, Prentice Hall of India, New Delhi, 2004.

**REFERENCES:**

1. Charles B. Fleddermann, “Engineering Ethics”, Pearson Prentice Hall, New Jersey, 2004.
2. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, “Engineering Ethics – Concepts and Cases”, Cengage Learning, 2009
3. John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, New Delhi, 2003
4. Edmund G Seebauer and Robert L Barry, “Fundamentals of Ethics for Scientists and Engineers”, Oxford University Press, Oxford, 2001
5. Laura P. Hartman and Joe Desjardins, “Business Ethics: Decision Making for Personal Integrity and Social Responsibility” Mc Graw Hill education, India Pvt. Ltd., New Delhi 2013.
6. World Community Service Centre, ‘ Value Education’, Vethathiri publications, Erode, 2011

**Web sources:**

1. [www.onlineethics.org](http://www.onlineethics.org)
2. [www.nspe.org](http://www.nspe.org)
3. [www.globalethics.org](http://www.globalethics.org)
4. [www.ethics.org](http://www.ethics.org)

**FD6711 SKILLS FOR FOOD PRODUCT DESIGN AND DEVELOPMENT L T P C  
0 0 4 2**

**OVERVIEW (THEORY)**

**5**

Organization and assignment of team, Definition of roles; Product Concepts; factors to consider; concept methodology; consumer testing; Product attributes; Concept testing approaches; Development of product specifications: Prototype development; role of ingredients and processing in defining attributes; scale up; Process flow sheet development; factors to consider in process development; process optimization; Factors to consider beyond formulation and processing - shelf life requirements; product performance testing; market positioning, Packaging and labeling, costing; Marketing: developing test market strategies

### 3. GROUP PROJECTS TO DEVELOP FOOD PRODUCTS AT LABORATORY SCALE

#### (PRACTICAL)

40

**Project Identification:** Products/Processes Review, Project Feasibility, Design and Product Specification

**Project Planning:** Identifying Objectives, Identifying Tools/Methods, Use of Information/Communication Technology

**Project Execution:** Product Trials and Standardization, Product Quality Profiling – Sensory, Microbial, Nutrient, Shelf Life, Costing, Packaging and Labeling, Product Scale up feasibility

**Project Presentation:** Documentation and Report, Viva Voce

**TOTAL : 45 PERIODS**

#### TEXTBOOKS

1. Brody, Aaron L. and John B. Lord. "Developing New Food Products for a Changing Marketplace". 2nd Edition, CRC Press, 2008.
2. Side, Catherine. "Food Product Development : Based on Experience". IOWA State Press, 2002.
3. MacFie, Hal. "Consumer-Led Food Product Development".CRC Press, 2007.

#### REFERENCES

1. Fuller, G. W. "New Food Product Development from Concept to Marketplace". CRC Press, 1994.
2. Lyon, D. H. "Guidelines for Sensory Analysis in Food Product Development and Quality Control".Chapman and Hall, 1992.
3. Robinson, J., H. Roberts, E. Barnard, and T. Shepard. "Design and Make It Food Technology". Nelson Thomes, 2001.
4. Gould, W. A."Research and Development Guidelines for the Food Industry". Woodhead, 1991.

**FD6712**

**DAIRY PROCESS TECHNOLOGY LAB**

**L T P C  
0 0 6 3**

#### Properties of milk

1. Determination of viscosity, density and specific gravity of milk
2. Determination of redox potential, acidity and pH of milk

#### Analysis of milk

3. Platform test - Methylene Blue Reduction Test, clot on boiling test
4. Determination of protein in milk by formol titration (pynes method)
5. Determination of lactose content of milk by polarimeter
6. Estimation of milk fat by Gerber method or Milko tester
7. Phosphatase test
8. Determination of adulterant and preservatives of milk
9. Efficiency of sterilization in preparation of sterilized milk by turbidity test.

#### Milk products and Quality Analysis

10. Preparation and analysis of Yoghurt
11. Preparation and analysis of Cottage cheese
12. Preparation and analysis of Ice-cream/ Cream
13. Preparation and analysis of Butter/ Ghee

**TOTAL : 60 PERIODS**

**FD6801**

**FOOD LAWS & SAFETY**

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

**OBJECTIVE**

To study various food laws, importance and functions of food safety management systems, to impart knowledge on food laws and safety in food processing.

**UNIT I HISTORICAL PERSPECTIVES INCLUDING NECESSITY OF FOOD LAWS 9**

Establishment of US Pure Food Law in early 1900s and of Food & Drug Administration to enforce safety of food products; Urbanisation of population and necessity of processed and preserved foods and the necessity of ensuring quality of food to prevent adulteration. Prevention of Food Adulteration Act 1954 & Rules 1955 established in India to enforce safety and purity of food products; Various aspects of defining adulteration, taking samples of food for analysis by public analyst, prosecution for adulteration and punishment; Standards of various food products; FPO; Infant Milk Substitute Act; Laws relating to vegetable oils; Use of permitted additives like colours, preservatives, emulsifiers, stabilisers, antioxidants etc. Food Safety & Standards Act 2006 and the provisions therein; Integrated Food Law - Multi departmental - multilevel to single window control system, consumer protection Act.

**UNIT II FOOD SAFETY IN PROCESSING 9**

Building and equipment design; microbiological quality of water, air; Safety in food procurement, storage, handling and manufacture; Food safety in retail food businesses; international food service operators, institutional food service operators; application of the principals of modern hygiene; Food handlers, habits, clothes, illness;

**UNIT III KEY SAFETY PRINCIPLES 9**

Training & Education for safe methods of handling food; cleaning and sanitization of processing plants; principles of cleaning and sterilization ; sterilization & disinfection- different methods used- detergents, heat, chemicals; selecting and installing equipment; Cleaning of equipment and premises. Safety limits of sanitizers; pest control; management and disposal of waste.

**UNIT IV FOOD SAFETY MANAGEMENT SYSTEM 9**

Food safety and quality management systems- Physical, chemical and Microbial hazards and their control in food industry; Good laboratory practice (GLP); Quality systems standards including ISO; - ISO 9000; total quality management (TQM); hazard analysis of critical control points (HACCP); good manufacturing practices (GMP);

**UNIT V MANAGEMENT 9**

Good Manufacturing Practice and HACCP; Surveillance networks, Consumer and food service operator education; GM Foods, safety and labeling; International Food Standards ISO 9000 and related standards; Impact of food safety on global trade.

**TOTAL : 45 PERIODS**

**TEXT BOOKS**

1. Rees, Naomi and David Watson —International Standards for Food Safety□, Aspen Publication, 2000.
2. Schmidt, Ronald H. and Rodrick, G.E. —Food Safety Handbook□, Wiley Interscience, UK, 2005.

## REFERENCES

1. Mehta, Rajesh and J. George —Food Safety Regulations, Concerns and Trade : The Developing Country Perspective□, Macmillan, 2005.
2. The Prevention of Food Adulteration Act, 1954□, Commercial Law Publishers India) Pvt. Ltd.,

**FD6811**

**PROJECT WORK**

**L T P C**

**0 0 12 6**

### AIM

The project work aims to train the students on systematic analysis of a problem and to enable them to bring out a solution it.

### OBJECTIVE

The objective of the project is to make use of the knowledge gained by the student at various stages of the degree course.

Each student is required to submit a report on the project assigned to him/her by the department. The report should be based on the literature collected from the many sources and the actual analysis done by the student on the given project.

**FD6001**

**BIOLOGY AND CHEMISTRY OF FOOD FLAVOURS**

**L T P C**

**3 0 0 3**

### UNIT I INTRODUCTION

**9**

Problems in flavour research – classification of food flavours; chemical compounds responsible for flavour.

### UNIT II FLAVOUR COMPOUNDS

**9**

Chemical compound classes and their flavour responses; flavour development during biogenesis, flavour development during food processing; use of biotechnology to develop flavours.

### UNIT III THE CHEMICAL SENSES

**9**

Anatomy of the chemical senses; neural development of the chemical senses; receptor mechanisms, neural coding; the control of eating.

### UNIT IV FLAVOUR ANALYSIS

**9**

Subjective versus Objective methods of analysis; psychophysics and sensory evaluation; Instrumental analysis; sample handling and artifacts; data handling

### UNIT V TEACHING FLAVOUR CONCEPTS

**9**

Problem based learning; tongue and nose; Onion-Beverage-Maillard reaction-Thio-stench

**TOTAL : 45 PERIODS**

## TEXT BOOKS



**AIM**

The course aims to develop the knowledge of students in the basic area of Human Nutrition. This is necessary for effective understanding of food processing and technology subjects. This course will enable students to appreciate the relationship between food and the nutrients as well as function and contribution of nutrients to health of individuals.

**OBJECTIVES**

On completion of the course the students are expected to

- Be able to understand the physiological and metabolic functions of nutrients.
- Be able to understand methods of nutritional assessment, RDA and Dietary Recommendations & Guidelines..
- Understand and use effectively, diet planning principles, exchange lists, food labels and nutrition facts for balanced nutrition and healthy diets.

**UNIT I AN OVERVIEW OF NUTRITION 9**

Six classes of nutrients, calculating energy values from food, using the RDA, nutritional assessment of individuals and populations, dietary recommendations; research methods in nutrition; Planning a Healthy Diet: Diet planning principles, dietary guidelines; diet planning guides such as food groups, exchange lists, personal diet analysis; food labels: serving sizes, nutrition facts, daily values, descriptive terms, health claims.

Digestion, Absorption and Transport: Anatomy and physiology of the digestive tract, mechanical and chemical digestion, absorption of nutrients.

**UNIT II CARBOHYDRATES: SUGARS, STARCH AND FIBER 9**

Digestion and absorption of carbohydrates, lactose intolerance; Glycemic and Non-glycemic carbohydrates, blood glucose regulation, recommendations of sugar intake for health, health effects of fiber and starch intake, artificial sweeteners; Nutrition and Diabetes: Complications of diabetes mellitus, importance of blood sugar regulation, dietary recommendations for NIDDM and IDDM

**UNIT III LIPIDS AND PROTEINS 9**

Lipid digestion, absorption and transport;

Functions of the triglycerides; essential fatty acids- n-3 and n-6 fatty acids; trans fatty acids, Medium Chain Triglycerides, phospholipids and sterols; Health effects and recommended intakes of lipids. Hyperlipidemia, atherosclerosis and cardiovascular disease.

Digestion and absorption of proteins; Functions of the proteins; amino acids; Protein quality, methods of assessing protein quality; Recommended intakes of proteins; protein and amino acid supplements; Protein Energy Malnutrition, Marasmus and Kwashiorkor; Chronic Energy Deficiency- short term and long term effects.

**UNIT IV METABOLISM, ENERGY BALANCE AND BODY COMPOSITION 9**

Review of catabolic and anabolic pathways of glucose, fats and amino acids; Energy Balance and Body Composition: Energy balance; body weight and body composition; health implications; obesity, BMR and BMI calculations; Weight Control: Fat cell development; hunger, satiety and satiation; dangers of weight loss; how to identify unsafe weight loss schemes; treatment of obesity; attitudes and behaviors toward weight control.

**UNIT V VITAMINS AND MINERALS****9**

Water Soluble Vitamins: B vitamins examined individually (Thiamine, Riboflavin, Niacin, Pyridoxine, Biotin, folate and B12, choline, pantothenic acid, carnitine) and in concert; B vitamin deficiencies, toxicities, and food sources; vitamin C roles and recommended intake, deficiency, toxicity and food sources

Fat Soluble Vitamins: A, D, E, and K: Function, recommended intakes, toxicities, food sources of vitamin A, D, E, and K; vitamin E as antioxidant; beta carotene and vitamin A

Water and the Major Minerals: Water balance and recommended intakes; fluid/electrolyte balance, acid-base balance; function, recommended intakes, and regulation of sodium, potassium, and calcium.

Trace Minerals: Food sources, function, recommended intakes, toxicities, deficiencies and transport of iron and zinc; importance of selenium, copper, fluoride, and chromium.

**TOTAL : 45 PERIODS****TEXT BOOKS**

1. Gibney, Michael J. et al., "Introduction to Human Nutrition". Blackwell, 2002.
2. Gibney, Michael J. et al., "Public Health Nutrition". Blackwell, 2004.
3. Sanders, Tom and Peter Emery " Molecular Basis of Human Nutrition". Taylor & Francis, 2003.
4. Gibney, Michael J. et al., "Clinical Nutrition". Blackwell, 2005.

**REFERENCES**

1. Spark, Arlene. "Nutrition in Public Health : Principles, Policies, and Practice". CRC Press, 2007.
2. Mann, Jim and Stewart Truswell "Essentials of Human Nutrition". 3<sup>rd</sup> Edition. Oxford University Press, 2007.
3. Gropper, Sareen S. "Advanced Nutrition and Human Metabolism". 5<sup>th</sup> Edition, Smith Wadsworth Publishing, 2008.

**FD6004 PROCESS ECONOMICS AND INDUSTRIAL MANAGEMENT L T P C  
3 0 0 3****AIM**

To introduce process economics and industrial management principles to chemical engineers.

**OBJECTIVE**

The objective of this course is to teach principles of cost estimation, feasibility analysis, management, organization and quality control that will enable the students to perform as efficient managers.

**UNIT I PRINCIPLES OF PRODUCTION MANAGEMENT AND ORGANISATION****15**

Planning, organization, staffing, coordination, directing, controlling, communicating, organization as a process and a structure; types of organizations Method study; work measurement techniques; basic procedure; motion study; motion economy; principles of time study; elements of production control; forecasting; planning; routing; scheduling; dispatching; costs and costs control, inventory and inventory control.



**UNIT II ENGINEERING ECONOMICS FOR PROCESS ENGINEERS - INTEREST, INVESTMENT COSTS AND COST ESTIMATION 10**

Time Value of money; capital costs and depreciation, estimation of capital cost, manufacturing costs and working capital, invested capital and profitability.

**UNIT III PROFITABILITY, INVESTMENT ALTERNATIVE AND REPLACEMENT 8**

Estimation of project profitability, sensitivity analysis; investment alternatives; replacement policy; forecasting sales; inflation and its impact.

**UNIT IV ANNUAL REPORTS AND ANALYSIS OF PERFORMANCE 4**

Principles of accounting; balance sheet; income statement; financial ratios; analysis of performance and growth.

**UNIT V ECONOMIC BALANCE AND QUALITY AND QUALITY CONTROL 8**

Essentials of economic balance – Economic balance approach, economic balance for insulation, evaporation, heat transfer. Elements of quality control, role of control charts in production and quality control.

**TOTAL : 45 PERIODS**

**TEXT BOOKS**

1. Peters, M. S. and Timmerhaus, C. D., " Plant Design and Economics for Chemical Engineers ", 5<sup>th</sup> Edn., McGraw Hill, 2002.
2. Holand, F.A., Watson, F.A. and Wilkinson, J.K., " Introduction to process Economics ", 2<sup>nd</sup> Edn., John Wiley, 1983.
3. Narang, G.B.S. and Kumar, V., " Production and Costing ", Khanna Publishers, New Delhi, 1988.

**REFERENCES**

1. Allen, L.A., " Management and Organization", McGraw Hill.
2. Perry, R. H. and Green, D., " Chemical Engineer's Handbook ", 7<sup>th</sup> Edn., McGraw Hill.

**FD6005 FUNCTIONAL FOODS AND NUTRACEUTICALS L T P C  
3 0 0 3**

**OBJECTIVES**

- To understand the basic concepts of Nutraceuticals and functional food, their chemical nature and methods of extraction.
- To understand the role of Nutraceuticals and functional food in health and disease

**UNIT I INTRODUCTION AND SIGNIFICANCE 6**

Introduction to Nutraceuticals and functional foods; importance, history, definition, classification, list of functional foods and their benefits, Phytochemicals, zoo chemicals and microbes in food, plants, animals and microbes

**UNIT II ANALYSIS OF PHYTOCHEMICALS 12**

Qualitative and quantitative methods: phytoestrogens in plants; isoflavones; flavonols, polyphenols, tannins, saponins, lignans, Chitin; Carotenoids - Factors affecting bioavailability, chemical and histochemical characterization of cell wall polysaccharides in almond seed in relation to lipid bioavailability.

**UNIT III ASSESSMENT OF ANTIOXIDANT ACTIVITY 12**



Natural food toxicants - toxicity of mushroom alkaloids, seafood, vegetables, fruits, pulses, and antinutritional compounds. Biological factors that influence toxicity, toxin absorption in the G.I. track, Industrial microflora, blood, brain barrier, storage and excretion of toxins

**UNIT IV DETERMINATION OF TOXICANTS IN FOOD SAMPLING 12**

Quantitative and qualitative analysis of toxicants in foods; Biological determination of toxicants Assessment of food safety – Risk assessment and risk benefit indices of human exposure, acute toxicity, mutagenicity and carcinogenicity, reproductive and developmental toxicity, neurotoxicity and behavioural effect, immunotoxicity.

**UNIT V TOXICANTS FORMED DURING FOOD PROCESSING 12**

Intentional direct additives, preservatives, nitrate, nitrite, and N-nitroso compound flavour enhancers, food colours, indirect additives, residues and contaminants, heavy metals, other organic residues and packaging materials. Toxicity of heated and processed foods, food carcinogens and mutagens - Polycyclic aromatic hydrocarbons, N-nitrosamines, Acrylamide and their mode of action

**TOTAL : 45 PERIODS**

**TEXTBOOKS**

1. Helferich, William and Carl K. Winter "Food Toxicology" CRC Press, 2001.
2. Alluwalla, Vikas "Food Hygiene and Toxicology" Paragon International Publishers, 2007
3. Shibamoto, Taka yuki and Leonard F. Bjeldanzes "Introduction to Food Toxicology" 2<sup>nd</sup> Edition. Academic Press, 2009.
4. Maleki, Soheila J. A. Wesley Burks, and Ricki M. Helm "Food Allergy" ASM Press, 2006.

**REFERENCES**

1. Labbe, Ronald G. and Santos Garcia "Guide to Food Borne Pathogens" John Wiley & Sons, 2001.
2. Cliver, Dean O. and Hans P. Riemann "Food Borne Diseases" 2<sup>nd</sup> Edition., Academic Press/Elsevier, 2002.
3. Riemann, Hans P. and Dean O. Cliver "Food Borne Infections and Intoxications" 3<sup>rd</sup> Edition., Academic Press/Elsevier, 2006.

**FD6007 ENTREPRENEURSHIP L T P C  
3 0 0 3**

**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**

**TEXT BOOK**

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

**FD6008** **TRADITIONAL FOODS** **L T P C**  
**3 0 0 3**

**AIM**

To help students understand the diversity of foods, food habits and patterns in India with focus on traditional foods.

**OBJECTIVES**

- To understand the historical and traditional perspective of foods and food habits
- To understand the wide diversity and common features of traditional Indian foods and meal patterns.

**UNIT I HISTORICAL AND CULTURAL PERSPECTIVES** **9**

Food production and accessibility - subsistence foraging, horticulture, agriculture and pastoralization, origin of agriculture, earliest crops grown. Food as source of physical sustenance, food as religious and cultural symbols; importance of food in understanding human culture - variability, diversity, from basic ingredients to food preparation; impact of customs and traditions on food habits, heterogeneity within cultures (social groups) and specific social contexts - festive occasions, specific religious festivals, mourning etc. Kosher, Halal foods; foods for religious and other fasts.

**UNIT II TRADITIONAL METHODS OF FOOD PROCESSING** **9**

Traditional methods of milling grains – rice, wheat and corn – equipments and processes as compared to modern methods. Equipments and processes for edible oil extraction, paneer, butter and ghee manufacture – comparison of traditional and modern methods. Energy costs, efficiency, yield, shelf life and nutrient content comparisons. Traditional methods of foodpreservation – sun-drying, osmotic drying, brining, pickling and smoking.

**UNIT III TRADITIONAL FOOD PATTERNS** **9**

Typical breakfast, meal and snack foods of different regions of India. Regional foods that have gone Pan Indian / Global. Popular regional foods; Traditional fermented foods, pickles and preserves, beverages, snacks, desserts and sweets, street foods; IPR issues in traditional foods

**UNIT IV COMMERCIAL PRODUCTION OF TRADITIONAL FOODS** **12**

Commercial production of traditional breads, snacks, ready-to-eat foods and instant mixes, frozen foods – types marketed, turnover; role of SHGs, SMES industries, national and multinational companies; commercial production and packaging of traditional beverages such as tender coconut water, neera, lassi, buttermilk, dahi.

Commercial production of intermediate foods – ginger and garlic pastes, tamarind pastes, masalas (spice mixes), idli and dosa batters.

**UNIT V HEALTH ASPECTS OF TRADITIONAL FOODS 6**

Comparison of traditional foods with typical fast foods / junk foods – cost, food safety, nutrient composition, bioactive components; energy and environmental costs of traditional foods; traditional foods used for specific ailments /illnesses.

**TOTAL : 45 PERIODS**

**TEXT BOOKS**

1. Sen, Colleen Taylor “Food Culture in India” Greenwood Press, 2005.
2. Davidar, Ruth N. “Indian Food Science: A Health and Nutrition Guide to Traditional Recipes: East West Books, 2001.

**FD6009 CEREAL, PULSE & OIL SEED TECHNOLOGY L T P C  
3 0 0 3**

**AIM**

The course aims to develop the knowledge of students in the area of Cereal, pulse and oil seed processing and technology. This is necessary for effective understanding specific aspects of food processing related to these foods. This course will enable students to appreciate the application of scientific principles in the processing of these materials.

**OBJECTIVES**

On completion of the course the students are expected to

- Be able to understand and identify the specific processing technologies used for cereals, pulses and oil seeds and the various products derived from these materials.
- Understand the application of scientific principles in the processing technologies specific to the materials.
- Grasp the changes in the composition of foods with respect to the type of processing technology used.

**UNIT I CEREALS 15**

Cereal Grains- Basic agricultural aspects, structure and composition; Storage, Insect control; Processing: Wheat- milling, (Atta and maida), quality aspects of flour, wheat proteins and their function, rheology of flour; wheat based baked products – Bread, Biscuit, Cakes, Extruded products, Pizza, Chapatis, malting and malt products; Rice- Milling, Parboiling, Quick cooking rice, Traditional Indian Products- Puffed Rice, flaked rice, Idli/Dosa/vada mixes and other savouries; Corn- Wet and dry milling, Corn Products – Corn flakes, Corn starch, canned corn products, puffed product; Oats- Milling, Oat Products – Steel cut, rolled oats, quick cooking; Traditional and Fermented cereal products

**UNIT II OTHER CEREALS AND MILLETS 6**

Sorghum, Pearl Millet, Finger millet, Foxtail Kodo Millet - Basic agricultural millet, aspects, structure and composition; storage, insect control; processing - pearling, Milling, Malting, Malt based foods, flaked and fermented products; Traditional and Nutritional products based on finger millet.

**UNIT III SUGARS 6**  
Honey- Composition and Quality aspects; Sugars- Manufacture of table sugar, High Fructose corn syrup and Glucose syrup; Jaggery – sources, manufacture, uses in traditional food products; stages of sugar saccharine products

**UNIT IV PULSES AND LEGUMES 12**  
Basic agricultural aspects, structure, composition, storage, insect control, processing- Milling/splitting, dhal milling, products – puffed, flakes, flour, legume-based traditional products, flour based Indian sweets and savouries, soya milk, soy protein Isolate, soya paneer

**UNIT V OIL SEEDS AND NUTS 6**  
Basic agricultural aspects structure, composition, Storage, Insect control; processing: traditional and modern methods of oil extraction, refining, bleaching, deodorizing, hydrogenation; oil blends; applications of different oils and fats in food processing & products.

**TOTAL : 45 PERIODS**

**TEXTS BOOKS**

1. Matz, Samuel A. "The Chemistry and Technology of Cereals as Food and Feed". 2<sup>nd</sup> Edition, CBS, 1996.
2. Morris, Peter C. and J.H. Bryce. " Cereal Biotechnology". CRC/Wood head Publishing, 2004.

**REFERENCES**

1. Delcour, Jan A. and R. Carl Hosney. " Principles of Cereal Science and Technology". 3<sup>rd</sup> Edition. American Association of Cereal Chemists, 2010.
2. Hosney, R.C. "Principles of Cereal Science and Technology"2<sup>nd</sup> Edition, American Association of Cereal Chemists, 1994.
3. Karl Kulp. "handbook of Cereal Science and Technology". 2<sup>nd</sup> Rev. Edition. CRC Press, 2000.
4. Kole, Chittaranjan. Genome Mapping and Molecular Breeding in Plants". Springer, 2006

**GE6083 DISASTER MANAGEMENT L T P C  
3 0 0 3**

**OBJECTIVES:**

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

**UNIT I INTRODUCTION TO DISASTERS 9**  
Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Disasters: Types of disasters – Earthquake, Landslide, Flood, Drought, Fire etc - Classification, Causes, Impacts including social, economic, political, environmental, health, psychosocial, etc.- Differential impacts- in terms of caste, class, gender, age, location, disability - Global

trends in disasters: urban disasters, pandemics, complex emergencies, Climate change- Dos and Don'ts during various types of Disasters.

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

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

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

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

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

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

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

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

**TOTAL: 45 PERIODS**

**OUTCOMES:**

The students will be able to

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

**TEXTBOOK:**

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

## REFERENCES

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

**FD6010**

**FOOD PROCESS EQUIPMENT DESIGN**

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

### OBJECTIVE

To understand the construction requirements, process design, fabrication and installation of equipments and to enhance the knowledge in the design of food processing equipments.

### UNIT I INTRODUCTION

**9**

Material of construction: Introduction to material selection; Material properties; Environmental effects on material selection; Mechanical properties & strength of materials.

### UNIT II CONSTRUCTION REQUIREMENTS

**9**

Design basis: Design code; Design pressure, stress & factor of safety; Corrosion allowance; Weld joint efficiency factor; Design loadings; Criteria of failure.

### UNIT III DESIGN OF PIPES AND PRESSURE VESSELS

Design of pipe and pipe fittings. Process vessels under internal and external pressure; Design of attachments and closures;

### UNIT IV DESIGN OF SUPPORTS

**9**

Design of flange connections & threaded fasteners; Design of supports; Bracket or Lug supports, Leg Supports, Skirt Supports

### UNIT V DESIGN OF PROCESS EQUIPMENTS

**9**

Process Design of double pipe heat exchanger; Shell & Tube Heat Exchanger. Design of Evaporator; Agitation Vessels and centrifugal separator. Design of Rotary Dryer.

**TOTAL : 45 PERIODS**

### TEXT BOOKS

1. B. C. Bhattacharya. —Introduction to Chemical Equipment Design — Mechanical Aspects, CBS Publishers, Delhi, 1991.
2. Ananthakrishnan.C.P. and M.N.Sinha. —Technology and Engineering of Dairy Plant Operations, Laxmi Publications, New Delhi, 1997.

### REFERENCE BOOKS

1. Groff, Gane K. and Muthu, John F., —Operations Management Selected Readings, D.B.Taraporevala Sons and Co, Bombay, 1975.
2. Thuesen, H.G., Febrycky, W.J. and Thuesen, G.J., —Engineering Economy, Prentice-Hall Inc, New Jersey, 1978.
3. Stoner, A.F. James. —Management, Prentice-Hall of India, New Delhi, 1994.





**UNIT I****10**

Introduction to food safety and security: Hygienic design of food plants and equipments, Food Contaminants (Microbial, Chemical, Physical), Food Adulteration (Common adulterants), Food Additives (functional role, safety issues), Food Packaging & labeling. Sanitation in warehousing, storage, shipping, receiving, containers and packaging materials. Control of rats, rodents, mice, birds, insects and microbes. Cleaning and Disinfection, ISO 22000 – Importance and Implementation

**UNIT II****8**

Food quality: Various Quality attributes of food, Instrumental, chemical and microbial Quality control. Sensory evaluation of food and statistical analysis. Water quality and other utilities.

**UNIT III****9**

Critical Quality control point in different stages of production including raw materials and processing materials. Food Quality and Quality control including the HACCP system. Food inspection and Food Law, Risk assessment – microbial risk assessment, dose response and exposure response modelling, risk management, implementation of food surveillance system to monitor food safety, risk communication

**UNIT IV****9**

Indian and global regulations: FAO in India, Technical Cooperation programmes, Bio-security in Food and Agriculture, World Health Organization (WHO), World Animal Health Organization (OIE), International Plant Protection Convention (IPPC)

**UNIT V****9**

Codex Alimentarius Commission - Codex India – Role of Codex Contact point, National Codex contact point (NCCP), National Codex Committee of India – ToR, Functions, Shadow Committees etc.

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

1. Handbook of food toxicology by S. S. Deshpande
2. The food safety information handbook by Cynthia A. Robert, 2009
3. Nutritional and safety aspects of food processing by Tannenbaum SR
4. Microbiological safety of food by Hobbs BC, 1973
5. Food Safety Handbook by Ronald H. Schmidt, Gary E. Rodrick

**OBJECTIVES :**

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

**UNIT I****9**

Human Rights – Meaning, origin and Development. Notion and classification of Rights – Natural, Moral and Legal Rights. Civil and Political Rights, Economic, Social and Cultural Rights; collective / Solidarity Rights.

<b>UNIT II</b>	<b>9</b>
Evolution of the concept of Human Rights Magna carta – Geneva convention of 1864. Universal Declaration of Human Rights, 1948. Theories of Human Rights.	
<b>UNIT III</b>	<b>9</b>
Theories and perspectives of UN Laws – UN Agencies to monitor and compliance.	
<b>UNIT IV</b>	<b>9</b>
Human Rights in India – Constitutional Provisions / Guarantees.	
<b>UNIT V</b>	<b>9</b>
Human Rights of Disadvantaged People – Women, Children, Displaced persons and Disabled persons, including Aged and HIV Infected People. Implementation of Human Rights – National and State Human Rights Commission – Judiciary – Role of NGO's, Media, Educational Institutions, Social Movements.	
<b>TOTAL : 45 PERIODS</b>	

**OUTCOME :**

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

**REFERENCES:**

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