

**AFFILIATED INSTITUTIONS
ANNA UNIVERSITY, CHENNAI
R - 2008**

B. TECH. FOOD TECHNOLOGY

II - VIII SEMESTERS CURRICULUM AND SYLLABI

SEMESTER II

SL. No.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	HS2161	<u>Technical English – II*</u>	3	1	0	4
2.	MA2161	<u>Mathematics – II*</u>	3	1	0	4
3.	PH2161	<u>Engineering Physics – II*</u>	3	0	0	3
4.	CY2161	<u>Engineering Chemistry – II*</u>	3	0	0	3
5. a	ME2151	<u>Engineering Mechanics</u> (For non-circuit branches)	3	1	0	4
5. b	EE2151	<u>Circuit Theory</u> (For branches under Electrical Faculty)	3	1	0	4
5. c	EC2151	<u>Electric Circuits and Electron Devices</u> (For branches under I & C Faculty)	3	1	0	4
6. a	GE2151	<u>Basic Electrical & Electronics Engineering</u> (For non-circuit branches)	4	0	0	4
6. b	GE2152	<u>Basic Civil & Mechanical Engineering</u> (For circuit branches)	4	0	0	4
PRACTICAL						
7.	GE2155	<u>Computer Practice Laboratory-II*</u>	0	1	2	2
8.	GS2165	<u>Physics & Chemistry Laboratory - II*</u>	0	0	3	2
9. a	ME2155	<u>Computer Aided Drafting and Modeling</u> <u>Laboratory</u> (For non-circuits branches)	0	1	2	2
9. b	EE2155	<u>Electrical Circuits Laboratory</u> (For branches under Electrical Faculty)	0	0	3	2
9. c	EC2155	<u>Circuits and Devices Laboratory</u> (For branches under I & C Faculty)	0	0	3	2
TOTAL : 28 CREDITS						
10.	-	English Language Laboratory ⁺	0	0	2	-

* Common to all B.E. / B.Tech. Programmes

+ Offering English Language Laboratory as an additional subject (with no marks) during 2nd semester may be decided by the respective Colleges affiliated to Anna University Chennai.

A. CIRCUIT BRANCHES

I Faculty of Electrical Engineering

1. B.E. Electrical and Electronics Engineering
2. B.E. Electronics and Instrumentation Engineering
3. B.E. Instrumentation and Control Engineering

II Faculty of Information and Communication Engineering

1. B.E. Computer Science and Engineering
2. B.E. Electronics and Communication Engineering
3. B.E. Bio Medical Engineering
4. B.Tech. Information Technology

B. NON – CIRCUIT BRANCHES

I Faculty of Civil Engineering

1. B.E. Civil Engineering

II Faculty of Mechanical Engineering

1. B.E. Aeronautical Engineering
2. B.E. Automobile Engineering
3. B.E. Marine Engineering
4. B.E. Mechanical Engineering
5. B.E. Production Engineering

III Faculty of Technology

1. B.Tech. Chemical Engineering
2. B.Tech. Biotechnology
3. B.Tech. Polymer Technology
4. B.Tech. Textile Technology
5. B.Tech. Textile Technology (Fashion Technology)
6. B.Tech. Petroleum Engineering
7. B.Tech. Plastics Technology

SEMESTER III

CODE NO	COURSE TITLE	L	T	P	C
THEORY					
MA2211	Transforms and Partial Differential Equation	3	1	0	4
FT3202	Principles of chemical Engineering	3	0	0	3
FT3203	Bioorganic Chemistry	3	0	0	3
FT3204	Cell Biology	3	0	0	3
FT3205	Microbiology	3	0	0	3
CY3206	Physical Chemistry	3	0	0	3
FT3207	Food Chemistry	3	0	0	3
PRACTICALS					
IB3209	Microbiology Lab	0	0	4	2
PH3210	Physical & Organic Chemistry Lab	0	0	4	2
TOTAL		21	1	8	26

SEMESTER IV

CODE NO	COURSE TITLE	L	T	P	C
THEORY					
MA3211	<u>Probability And Statistics</u>	3	1	0	4
IB3212	<u>Instrumental Methods of Analysis</u>	3	0	0	3
CH3213	<u>Fundamentals of Heat and Mass Transfer</u>	3	0	0	3
FT3214	<u>Food Microbiology</u>	3	0	0	3
CH3222	<u>Biochemical Engineering</u>	3	0	0	3
GE2021	<u>Environmental Science and Engineering</u>	3	0	0	3
IB3217	<u>Genetics</u>	3	0	0	3
PRACTICALS					
CY3219	<u>Instrumental Methods of Analysis lab</u>	0	0	4	2
IB3220	<u>Chemical Engineering Lab</u>	0	0	4	2
TOTAL		21	1	8	26

SEMESTER V

CODE NO	COURSE TITLE	L	T	P	C
THEORY					
IB3302	<u>Molecular Biology</u>	3	0	0	3
FT3302	<u>Biochemical Engineering – II</u>	3	0	0	3
FT3303	<u>Food Analysis</u>	3	0	0	3
FT3304	<u>Food Additives</u>	3	0	0	3
GE2023	<u>Fundamental of Nano science</u>	3	0	0	3
E1	Electives I	3	0	0	3
PRACTICALS					
IB3307	<u>Molecular Biology Lab</u>	0	0	4	2
FT3308	<u>Food Analysis Lab</u>	0	0	4	2
FT3309	<u>Food Production Analysis Lab</u>	0	0	4	2
FT3310	<u>Technical Seminar</u>	0	0	2	1
TOTAL		18	0	14	25

SEMESTER VI

CODE NO	COURSE TITLE	L	T	P	C
THEORY					
IB3311	<u>Chemical Reaction Engineering</u>	3	0	0	3
IB3312	<u>Genetic Engineering</u>	3	0	0	3
FT3313	<u>Separation Process</u>	3	0	0	3
FT3314	<u>Food Processing and Preservation</u>	3	0	0	3
GE2022	<u>Total Quality Management</u>	3	0	0	3
E2	Electives II	3	0	0	3
PRACTICALS					
GE3318	<u>Communication skills Laboratory</u>	0	0	4	2
FT3318	<u>Bio Process Lab</u>	0	0	6	3
FT3319	<u>Genetic Engineering Lab</u>	0	0	4	2
TOTAL		18	0	14	25

SEMESTER VII

CODE NO	COURSE TITLE	L	T	P	C
THEORY					
IB3401	<u>Immunology</u>	3	0	0	3
FT3402	<u>Food Safety, Quality and Regulatory Issues</u>	3	0	0	3
FT3403	<u>Food Process Engineering I</u>	3	0	0	3
FT3404	<u>Food Process Engineering II</u>	3	0	0	3
FT3405	<u>Cereal Pulse and Oil seed Technology</u>	3	0	0	3
GE2025	<u>Professional Ethics in Engineering</u>	3	0	0	3
E3	<u>Elective III</u>	3	0	0	3
PRACTICALS					
FT3408	<u>Skills for Food Product Design & Development</u>	0	0	4	2
FT3409	<u>Food Microbiology, Processing & Preservation Lab</u>	0	0	6	3
TOTAL		21	0	10	26

SEMESTER VIII

CODE NO	COURSE TITLE	L	T	P	C
THEORY					
FT3410	<u>Project Work</u>	0	0	12	6
TOTAL		0	0	12	6

Total Credits : 186

LIST OF ELECTIVES FOR B.TECH. FOOD TECHNOLOGY PROGRAMME

ELECTIVE I

CODE NO	COURSE TITLE	L	T	P	C
FT 3001	<u>Refrigeration and Cold Chain</u>	3	0	0	3
FT 3002	<u>Biology and Chemistry of Food Flavours</u>	3	0	0	3
FT 3003	<u>Biologically Active Phytochemicals in Food</u>	3	0	0	3
FT 3004	<u>Human Nutrition</u>	3	0	0	3

ELECTIVE II

CODE NO	COURSE TITLE	L	T	P	C
IB 3005	<u>Process Economics and Industrial Management</u>	3	0	0	3
MA 3021	<u>Numerical Methods</u>	3	1	0	4
FT 3007	<u>Technical Writing & Communication</u>	3	0	0	3
IB 3008	<u>Metabolic Engineering</u>	3	0	0	3
FT 3009	<u>Dairy Product Processing</u>	3	0	0	3

ELECTIVE III

CODE NO	COURSE TITLE	L	T	P	C
IB 3010	<u>Protein Engineering</u>	3	0	0	3
FT 3011	<u>Entrepreneurship</u>	3	0	0	3
FT 3012	<u>Operation Research</u>	3	0	0	3
IB 3014	<u>Down Stream Processing</u>	3	0	0	3
FT 3014	<u>Genetically Modified Foods</u>	3	0	0	3
GE 3015	<u>Creativity, Innovation & New Product Development</u>	3	0	0	3

AIM:

To encourage students to actively involve in participative learning of English and to help them acquire Communication Skills.

OBJECTIVES:

- To help students develop listening skills for academic and professional purposes.
- To help students acquire the ability to speak effectively in English in real-life situations.
- To inculcate reading habit and to develop effective reading skills.
- To help students improve their active and passive vocabulary.
- To familiarize students with different rhetorical functions of scientific English.
- To enable students write letters and reports effectively in formal and business situations.

UNIT I**12**

Technical Vocabulary - meanings in context, sequencing words, Articles-Prepositions, intensive reading& predicting content, Reading and interpretation, extended definitions, Process description

SUGGESTED ACTIVITIES:

1. Exercises on word formation using the prefix 'self' - Gap filling with preposition.
2. Exercises - Using sequence words.
3. Reading comprehension exercise with questions based on inference – Reading headings
4. and predicting the content – Reading advertisements and interpretation.
5. Writing extended definitions – Writing descriptions of processes – Writing paragraphs based on discussions – Writing paragraphs describing the future.

UNIT II**12**

Phrases / Structures indicating use / purpose – Adverbs-Skimming – Non-verbal communication - Listening – correlating verbal and non-verbal communication - Speaking in group discussions – Formal Letter writing – Writing analytical paragraphs.

SUGGESTED ACTIVITIES:

Reading comprehension exercises with questions on overall content – Discussions analyzing stylistic features (creative and factual description) - Reading comprehension exercises with texts including graphic communication - Exercises in interpreting non-verbal communication.

1. Listening comprehension exercises to categorise data in tables.
2. Writing formal letters, quotations, clarification, complaint – Letter seeking permission for Industrial visits– Writing analytical paragraphs on different debatable issues.

UNIT III**12**

Cause and effect expressions – Different grammatical forms of the same word - Speaking – stress and intonation, Group Discussions - Reading – Critical reading - Listening, - Writing – using connectives, report writing – types, structure, data collection, content, form, recommendations .

SUGGESTED ACTIVITIES:

Exercises combining sentences using cause and effect expressions – Gap filling exercises using the appropriate tense forms – Making sentences using different grammatical forms of the same word. (Eg: object –verb / object – noun)

1. Speaking exercises involving the use of stress and intonation – Group discussions– analysis of problems and offering solutions.
2. Reading comprehension exercises with critical questions, Multiple choice question.
3. Sequencing of jumbled sentences using connectives – Writing different types of reports like industrial accident report and survey report – Writing recommendations.

UNIT IV**12**

Numerical adjectives – Oral instructions – Descriptive writing – Argumentative paragraphs – Letter of application - content, format (CV / Bio-data) - Instructions, imperative forms - Checklists, Yes/No question form – E-mail communication.

SUGGESTED ACTIVITIES:

1. Rewriting exercises using numerical adjectives.
2. Reading comprehension exercises with analytical questions on content – Evaluation of content.
3. Listening comprehension – entering information in tabular form, intensive listening exercise and completing the steps of a process.
4. Speaking - Role play – group discussions – Activities giving oral instructions.
5. Writing descriptions, expanding hints – Writing argumentative paragraphs – Writing formal letters – Writing letter of application with CV/Bio-data – Writing general and safety instructions – Preparing checklists – Writing e-mail messages.

UNIT V**9**

Speaking - Discussion of Problems and solutions - Creative and critical thinking – Writing an essay, Writing a proposal.

SUGGESTED ACTIVITIES:

1. Case Studies on problems and solutions
2. Brain storming and discussion
3. Writing Critical essays
4. Writing short proposals of 2 pages for starting a project, solving problems, etc.
5. Writing advertisements.

TOTAL : 60 PERIODS**TEXT BOOKS:**

1. Chapters 5 – 8. Department of Humanities & Social Sciences, Anna University, 'English for Engineers and Technologists' Combined Edition (Volumes 1 & 2), Chennai: Orient Longman Pvt. Ltd., 2006. Themes 5 – 8 (Technology, Communication, Environment, Industry)

REFERENCES:

1. P. K. Dutt, G. Rajeevan and C.L.N Prakash, 'A Course in Communication Skills', Cambridge University Press, India 2007.
2. Krishna Mohan and Meera Banerjee, 'Developing Communication Skills', Macmillan India Ltd., (Reprinted 1994 – 2007).
3. Edgar Thorpe, Showick Thorpe, 'Objective English', Second Edition, Pearson Education, 2007.

EXTENSIVE READING:

1. Robin Sharma, 'The Monk Who Sold His Ferrari', Jaico Publishing House, 2007

Note:

The book listed under Extensive Reading is meant for inculcating the reading habit of the students. They need not be used for testing purposes.

MA2161**MATHEMATICS – II****L T P C
3 1 0 4****UNIT I ORDINARY DIFFERENTIAL EQUATIONS 12**

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 II VECTOR CALCULUS 12

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 III ANALYTIC FUNCTIONS 12

Functions of a complex variable – Analytic functions – Necessary conditions, Cauchy – Riemann equation and Sufficient conditions (excluding proofs) – Harmonic and orthogonal properties of analytic function – Harmonic conjugate – Construction of analytic functions – Conformal mapping : $w = z + c$, cz , $1/z$, and bilinear transformation.

UNIT IV COMPLEX INTEGRATION 12

Complex integration – Statement and applications of Cauchy's integral theorem and Cauchy's integral formula – Taylor and Laurent expansions – Singular points – Residues – Residue theorem – Application of residue theorem to evaluate real integrals – Unit circle and semi-circular contour(excluding poles on boundaries).

UNIT V LAPLACE TRANSFORM 12

Laplace transform – Conditions for existence – Transform of elementary functions – Basic properties – Transform of derivatives and integrals – Transform of unit step function and impulse functions – Transform of periodic functions.

Definition of Inverse Laplace transform as contour integral – Convolution theorem (excluding proof) – Initial and Final value theorems – Solution of linear ODE of second order with constant coefficients using Laplace transformation techniques.

TOTAL : 60 PERIODS**TEXT BOOKS:**

1. Bali N. P and Manish Goyal, "Text book of Engineering Mathematics", 3rd Edition, Laxmi Publications (p) Ltd., (2008).
2. Grewal. B.S, "Higher Engineering Mathematics", 40th Edition, Khanna Publications, Delhi, (2007).

REFERENCES:

1. Ramana B.V, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, New Delhi, (2007).
2. Glyn James, "Advanced Engineering Mathematics", 3rd Edition, Pearson Education, (2007).
3. Erwin Kreyszig, "Advanced Engineering Mathematics", 7th Edition, Wiley India, (2007).
4. Jain R.K and Iyengar S.R.K, "Advanced Engineering Mathematics", 3rd Edition, Narosa Publishing House Pvt. Ltd., (2007).

PH2161

ENGINEERING PHYSICS – II

L T P C
3 0 0 3

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 – extrinsic semiconductors – carrier concentration derivation in n-type and p-type semiconductor – variation of Fermi level with temperature and impurity concentration – compound semiconductors – Hall effect – Determination of Hall coefficient – Applications.

UNIT III MAGNETIC AND SUPERCONDUCTING MATERIALS 9

Origin of magnetic moment – Bohr magneton – Dia and para magnetism – Ferro magnetism – Domain theory – Hysteresis – soft and hard magnetic materials – anti – ferromagnetic materials – Ferrites – applications – magnetic recording and readout – storage of magnetic data – tapes, floppy and magnetic disc drives.

Superconductivity : properties - Types of super conductors – 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 MODERN ENGINEERING MATERIALS 9

Metallic glasses: preparation, properties and applications.
Shape memory alloys (SMA): Characteristics, properties of NiTi alloy, application, advantages and disadvantages of SMA

Nanomaterials: synthesis – plasma arcing – chemical vapour deposition – sol-gels – electrodeposition – ball milling - properties of nanoparticles and applications.

Carbon nanotubes: fabrication – arc method – pulsed laser deposition – chemical vapour deposition - structure – properties and applications.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Charles Kittel ' Introduction to Solid State Physics', John Wiley & sons, 7th edition, Singapore (2007)
2. Charles P. Poole and Frank J.Owenn, 'Introduction to Nanotechnology', Wiley India(2007) (for Unit V)

REFERENCES:

1. Rajendran, V, and Marikani A, 'Materials science'Tata McGraw Hill publications, (2004) New Delhi.
2. Jayakumar, S. 'Materials science', R.K. Publishers, Coimbatore, (2008).
3. Palanisamy P.K, 'Materials science', Scitech publications(India) Pvt. LTd., Chennai, second Edition(2007)
4. M. Arumugam, 'Materials Science' Anuradha publications, Kumbakonam, (2006)

CY2161

ENGINEERING CHEMISTRY – II

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

AIM

To impart a sound knowledge on the principles of chemistry involving the different application oriented topics required for all engineering branches.

OBJECTIVES

- The student should be conversant with the principles electrochemistry, electrochemical cells, emf and applications of emf measurements.
- Principles of corrosion control
- Chemistry of Fuels and combustion
- Industrial importance of Phase rule and alloys
- Analytical techniques and their importance.

UNIT I ELECTROCHEMISTRY

9

Electrochemical cells – reversible and irreversible cells – EMF – measurement of emf – Single electrode potential – Nernst equation (problem) – reference electrodes –Standard Hydrogen electrode -Calomel electrode – Ion selective electrode – glass electrode and measurement of pH – electrochemical series – significance – potentiometer titrations (redox - Fe^{2+} vs dichromate and precipitation – Ag^+ vs Cl^- titrations) and conduct metric titrations (acid-base – HCl vs, NaOH) titrations,

UNIT II CORROSION AND CORROSION CONTROL

9

Chemical corrosion – Pilling – Bedworth rule – electrochemical corrosion – different types – galvanic corrosion – differential aeration corrosion – factors influencing corrosion – corrosion control – sacrificial anode and impressed cathodic current methods – corrosion inhibitors – protective coatings – paints – constituents and functions – metallic coatings – electroplating (Au) and electroless (Ni) plating.

UNIT III FUELS AND COMBUSTION 9

Calorific value – classification – Coal – proximate and ultimate analysis metallurgical coke – manufacture by Otto-Hoffmann method – Petroleum processing and fractions – cracking – catalytic cracking and methods-knocking – octane number and cetane number – synthetic petrol – Fischer Tropsch and Bergius processes – Gaseous fuels- water gas, producer gas, CNG and LPG, Flue gas analysis – Orsat apparatus – theoretical air for combustion.

UNIT IV PHASE RULE AND ALLOYS 9

Statement and explanation of terms involved – one component system – water system – condensed phase rule – construction of phase diagram by thermal analysis – simple eutectic systems (lead-silver system only) – alloys – importance, ferrous alloys – nichrome and stainless steel – heat treatment of steel, non-ferrous alloys – brass and bronze.

UNIT V ANALYTICAL TECHNIQUES 9

Beer-Lambert's law (problem) – UV-visible spectroscopy and IR spectroscopy – principles – instrumentation (problem) (block diagram only) – estimation of iron by colorimetry – flame photometry – principle – instrumentation (block diagram only) – estimation of sodium by flame photometry – atomic absorption spectroscopy – principles – instrumentation (block diagram only) – estimation of nickel by atomic absorption spectroscopy.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. P.C.Jain and Monica Jain, "Engineering Chemistry" Dhanpat Rai Pub, Co., New Delhi (2002).
2. S.S.Dara "A text book of Engineering Chemistry" S.Chand & Co.Ltd., New Delhi (2006).

REFERENCES:

1. B.Sivasankar "Engineering Chemistry" Tata McGraw-Hill Pub.Co.Ltd, New Delhi (2008).
2. B.K.Sharma "Engineering Chemistry" Krishna Prakasan Media (P) Ltd., Meerut (2001).

ME2151

ENGINEERING MECHANICS

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

OBJECTIVE

At the end of this course the student should be able to understand the vectorial and scalar representation of forces and moments, static equilibrium of particles and rigid bodies both in two dimensions and also in three dimensions. Further, he should understand the principle of work and energy. He should be able to comprehend the effect of friction on equilibrium. He should be able to understand the laws of motion, the kinematics of motion and the interrelationship. He should also be able to write the dynamic equilibrium equation. All these should be achieved both conceptually and through solved examples.

UNIT I BASICS & STATICS OF PARTICLES 12

Introduction – Units and Dimensions – Laws of Mechanics – Lame's theorem, Parallelogram and triangular Law of forces – Vectors – Vectorial representation of forces and moments – Vector operations: additions, subtraction, dot product, cross product – Coplanar Forces – Resolution and Composition of forces – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility – Single equivalent force.

UNIT II EQUILIBRIUM OF RIGID BODIES 12

Free body diagram – Types of supports and their reactions – requirements of 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 – Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions – Examples

UNIT III PROPERTIES OF SURFACES AND SOLIDS 12

Determination of Areas and Volumes – First moment of area and the Centroid of sections – Rectangle, circle, triangle from integration – T section, I section, - Angle section, Hollow section by using standard formula – second and product moments of plane area – Rectangle, triangle, circle from integration – T section, I section, Angle section, Hollow section by using standard formula – Parallel axis theorem and perpendicular axis theorem – Polar moment of inertia – Principal moments of inertia of plane areas – Principal axes of inertia – Mass moment of inertia – Derivation of mass moment of inertia for rectangular section, prism, sphere 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 law – Work Energy Equation of particles – Impulse and Momentum – Impact of elastic bodies.

UNIT V FRICTION AND ELEMENTS OF RIGID BODY DYNAMICS 12

Frictional force – Laws of Coloumb friction – simple contact friction – Rolling resistance – Belt friction.

Translation and Rotation of Rigid Bodies – Velocity and acceleration – General Plane motion.

TOTAL: 60 PERIODS

TEXT BOOK:

1. Beer, F.P and Johnson Jr. E.R. “Vector Mechanics for Engineers”, Vol. 1 Statics and Vol. 2 Dynamics, McGraw-Hill International Edition, (1997).

REFERENCES:

1. Rajasekaran, S, Sankarasubramanian, G., “Fundamentals of Engineering Mechanics”, Vikas Publishing House Pvt. Ltd., (2000).
2. Hibbeler, R.C., “Engineering Mechanics”, Vol. 1 Statics, Vol. 2 Dynamics, Pearson Education Asia Pvt. Ltd., (2000).
3. Palanichamy, M.S., Nagam, S., “Engineering Mechanics – Statics & Dynamics”, Tata McGraw-Hill, (2001).
4. Irving H. Shames, “Engineering Mechanics – Statics and Dynamics”, IV Edition – Pearson Education Asia Pvt. Ltd., (2003).
5. Ashok Gupta, “Interactive Engineering Mechanics – Statics – A Virtual Tutor (CDROM)”, Pearson Education Asia Pvt., Ltd., (2002).

UNIT I BASIC CIRCUITS ANALYSIS 12

Ohm's Law – Kirchoffs laws – DC and AC Circuits – Resistors in series and parallel circuits – Mesh current and node voltage method of analysis for D.C and A.C. circuits.

UNIT II NETWORK REDUCTION AND NETWORK THEOREMS FOR DC AND AC CIRCUITS 12

Network reduction: voltage and current division, source transformation – star delta conversion.

Thevenins and Novton & Theorem – Superposition Theorem – Maximum power transfer theorem – Reciprocity Theorem.

UNIT III RESONANCE AND COUPLED CIRCUITS 12

Series and paralled resonance – their frequency response – Quality factor and Bandwidth - Self and mutual inductance – Coefficient of coupling – Tuned circuits – Single tuned circuits.

UNIT IV TRANSIENT RESPONSE FOR DC CIRCUITS 12

Transient response of RL, RC and RLC Circuits using Laplace transform for DC input and A.C. with sinusoidal input.

UNIT V ANALYSING THREE PHASE CIRCUITS 12

Three phase balanced / unbalanced voltage sources – analysis of three phase 3-wire and 4-wire circuits with star and delta connected loads, balanced & un balanced – phasor diagram of voltages and currents – power and power factor measurements in three phase circuits.

TOTAL : 60 PERIODS

TEXT BOOKS:

1. William H. Hayt Jr, Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuits Analysis", Tata McGraw Hill publishers, 6th edition, New Delhi, (2002).
2. Sudhakar A and Shyam Mohan SP, "Circuits and Network Analysis and Synthesis", Tata McGraw Hill, (2007).

REFERENCES:

1. Paranjothi SR, "Electric Circuits Analysis," New Age International Ltd., New Delhi, (1996).
2. Joseph A. Edminister, Mahmood Nahri, "Electric circuits", Schaum's series, Tata McGraw-Hill, New Delhi (2001).
3. Chakrabati A, "Circuits Theory (Analysis and synthesis), Dhanpath Rai & Sons, New Delhi, (1999).
4. Charles K. Alexander, Mathew N.O. Sadik, "Fundamentals of Electric Circuits", Second Edition, McGraw Hill, (2003).

EC2151 ELECTRIC CIRCUITS AND ELECTRON DEVICES L T P C
(For ECE, CSE, IT and Biomedical Engg. Branches) 3 1 0 4

UNIT I CIRCUIT ANALYSIS TECHNIQUES 12

Kirchoff's current and voltage laws – series and parallel connection of independent sources – R, L and C – Network Theorems – Thevenin, Superposition, Norton, Maximum power transfer and duality – Star-delta conversion.

UNIT II TRANSIENT RESONANCE IN RLC CIRCUITS 12

Basic RL, RC and RLC circuits and their responses to pulse and sinusoidal inputs – frequency response – Parallel and series resonances – Q factor – single tuned and double tuned circuits.

UNIT III SEMICONDUCTOR DIODES 12

Review of intrinsic & extrinsic semiconductors – Theory of PN junction diode – Energy band structure – current equation – space charge and diffusion capacitances – effect of temperature and breakdown mechanism – Zener diode and its characteristics.

UNIT IV TRANSISTORS 12

Principle of operation of PNP and NPN transistors – study of CE, CB and CC configurations and comparison of their characteristics – Breakdown in transistors – operation and comparison of N-Channel and P-Channel JFET – drain current equation – MOSFET – Enhancement and depletion types – structure and operation – comparison of BJT with MOSFET – thermal effect on MOSFET.

UNIT V SPECIAL SEMICONDUCTOR DEVICES (Qualitative Treatment only) 12

Tunnel diodes – PIN diode, varactor diode – SCR characteristics and two transistor equivalent model – UJT – Diac and Triac – Laser, CCD, Photodiode, Phototransistor, Photoconductive and Photovoltaic cells – LED, LCD.

TOTAL : 60 PERIODS

TEXT BOOKS:

1. Joseph A. Edminister, Mahmood, Nahri, "Electric Circuits" – Shaum series, Tata McGraw Hill, (2001)
2. S. Salivahanan, N. Suresh kumar and A. Vallavanraj, "Electronic Devices and Circuits", Tata McGraw Hill, 2nd Edition, (2008).
3. David A. Bell, "Electronic Devices and Circuits", Oxford University Press, 5th Edition, (2008).

REFERENCES:

1. Robert T. Paynter, "Introducing Electronics Devices and Circuits", Pearson Education, 7th Edition, (2006).
2. William H. Hayt, J.V. Jack, E. Kemmebly and Steven M. Durbin, "Engineering Circuit Analysis", Tata McGraw Hill, 6th Edition, 2002.
3. J. Millman & Halkins, Satyabranta Jit, "Electronic Devices & Circuits", Tata McGraw Hill, 2nd Edition, 2008.

GE2151 BASIC ELECTRICAL AND ELECTRONICS ENGINEERING
 (Common to branches under Civil,
 Mechanical and Technology faculty) **L T P C**
4 0 0 4

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.

^m
 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

TEXT BOOKS:

1. N. Mittle “Basic Electrical Engineering”, Tata McGraw Hill Edition, New Delhi, 1990.
2. R.S. Sedha, “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).

GE2152 **BASIC CIVIL & MECHANICAL ENGINEERING** **L T P C**
(Common to branches under Electrical and I & C Faculty) 4 0 0 4

A – CIVIL ENGINEERING

UNIT I SURVEYING AND CIVIL ENGINEERING MATERIALS 15

Surveying: Objects – types – classification – principles – measurements of distances – angles – leveling – determination of areas – illustrative examples.

Civil Engineering Materials: Bricks – stones – sand – cement – concrete – steel sections.

UNIT II BUILDING COMPONENTS AND STRUCTURES 15

Foundations: Types, Bearing capacity – Requirement of good foundations.

Superstructure: Brick masonry – stone masonry – beams – columns – lintels – roofing – flooring – plastering – Mechanics – Internal and external forces – stress – strain – elasticity – Types of Bridges and Dams – Basics of Interior Design and Landscaping.

TOTAL : 30 PERIODS

B – MECHANICAL ENGINEERING

UNIT III POWER PLANT ENGINEERING 10

Introduction, Classification of Power Plants – Working principle of steam, Gas, Diesel, Hydro-electric and Nuclear Power plants – Merits and Demerits – Pumps and turbines – working principle of Reciprocating pumps (single acting and double acting) – Centrifugal Pump.

UNIT IV IC ENGINES 10

Internal combustion engines as automobile power plant – Working principle of Petrol and Diesel Engines – Four stroke and two stroke cycles – Comparison of four stroke and two stroke engines – Boiler as a power plant.

UNIT V REFRIGERATION AND AIR CONDITIONING SYSTEM 10

Terminology of Refrigeration and Air Conditioning. Principle of vapour compression and absorption system – Layout of typical domestic refrigerator – Window and Split type room Air conditioner.

TOTAL: 30 PERIODS

REFERENCES:

1. Shanmugam G and Palanichamy M S, “Basic Civil and Mechanical Engineering”, Tata McGraw Hill Publishing Co., New Delhi, (1996).
2. Ramamrutham. S, “Basic Civil Engineering”, Dhanpat Rai Publishing Co. (P) Ltd. (1999).
3. Seetharaman S. “Basic Civil Engineering”, Anuradha Agencies, (2005).
4. Venugopal K and Prahu Raja V, “Basic Mechanical Engineering”, Anuradha Publishers, Kumbakonam, (2000).
5. Shantha Kumar S R J., “Basic Mechanical Engineering”, Hi-tech Publications, Mayiladuthurai, (2000).

GE2155	COMPUTER PRACTICE LABORATORY – II	L T P C
	<u>LIST OF EXPERIMENTS</u>	0 1 2 2

- | | | |
|---------------------------------|---|-----------|
| 1. UNIX COMMANDS | | 15 |
| | Study of Unix OS - Basic Shell Commands - Unix Editor ‘ | |
| 2. SHELL PROGRAMMING | | 15 |
| | Simple Shell program - Conditional Statements - Testing and Loops | |
| 3. C PROGRAMMING ON UNIX | | 15 |
| | Dynamic Storage Allocation-Pointers-Functions-File Handling | |

TOTAL : 45 PERIODS

HARDWARE / SOFTWARE REQUIREMENTS FOR A BATCH OF 30 STUDENTS

HARDWARE

1 UNIX Clone Server
 33 Nodes (thin client or PCs)
 Printer – 3 Nos.

SOFTWARE

- . OS – UNIX Clone (33 user license or License free Linux)
- . Compiler - C

GS2165	PHYSICS LABORATORY – II	L T P C
		0 0 3 2

LIST OF EXPERIMENTS

1. Determination of Young’s modulus of the material – non uniform bending.
 2. Determination of Band Gap of a semiconductor material.
 3. Determination of specific resistance of a given coil of wire – Carey Foster Bridge.
 4. Determination of viscosity of liquid – Poiseuille’s method.
 5. Spectrometer dispersive power of a prism.
 6. Determination of Young’s modulus of the material – uniform bending.
 7. Torsional pendulum – Determination of rigidity modulus.
- **A minimum of FIVE experiments shall be offered.**
 - **Laboratory classes on alternate weeks for Physics and Chemistry.**
 - **The lab examinations will be held only in the second semester.**

GS2165

CHEMISTRY LABORATORY – II

L T P C
0 0 3 2

LIST OF EXPERIMENTS

1. Conduct metric titration (Simple acid base)
2. Conduct metric titration (Mixture of weak and strong acids)
3. Conduct metric titration using BaCl_2 vs Na_2SO_4
4. Potentiometric Titration (Fe^{2+} / KMnO_4 or $\text{K}_2\text{Cr}_2\text{O}_7$)
5. PH titration (acid & base)
6. Determination of water of crystallization of a crystalline salt (Copper sulphate)
7. Estimation of Ferric iron by spectrophotometry.

- A minimum of FIVE experiments shall be offered.
- Laboratory classes on alternate weeks for Physics and Chemistry.
- The lab examinations will be held only in the second semester.

ME2155

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.

EE2155

ELECTRICAL CIRCUIT LABORATORY
(Common to EEE, EIE and ICE)

L T P C
0 0 3 2

LIST OF EXPERIMENTS

1. Verification of ohm's laws and kirchoff's laws.
2. Verification of Thevemin's and Norton's Theorem
3. Verification of superposition Theorem
4. Verification of maximum power transfer theorem.
5. Verification of reciprocity theorem
6. Measurement of self inductance of a coil
7. Verification of mesh and nodal analysis.
8. Transient response of RL and RC circuits for DC input.
9. Frequency response of series and parallel resonance circuits.
10. Frequency response of single tuned coupled circuits.

TOTAL: 45 PERIODS

EC2155

CIRCUITS AND DEVICES LABORATORY

L T P C
0 0 3 2

1. Verification of KVL and KCL
2. Verification of Thevenin and Norton Theorems.
3. Verification of superposition Theorem.
4. Verification of Maximum power transfer and reciprocity theorems.
5. Frequency response of series and parallel resonance circuits.
6. Characteristics of PN and Zener diode
7. Characteristics of CE configuration
8. Characteristics of CB configuration
9. Characteristics of UJT and SCR
10. Characteristics of JFET and MOSFET
11. Characteristics of Diac and Triac.
12. Characteristics of Photodiode and Phototransistor.

TOTAL : 45 PERIODS

1. LISTENING: 5
Listening & answering questions – gap filling – Listening and Note taking- Listening to telephone conversations

2. SPEAKING: 5
Pronouncing words & sentences correctly – word stress – Conversation practice.

CLASSROOM SESSION 20

1. Speaking: Introducing oneself, Introducing others, Role play, Debate - Presentations:
Body language, gestures, postures.
Group Discussions etc
2. Goal setting – interviews – stress time management – situational reasons

EVALUATION

(1) Lab Session – 40 marks

- Listening – 10 marks
- Speaking – 10 marks
- Reading – 10 marks
- Writing – 10 marks

(2) Classroom Session – 60 marks

- Role play activities giving real life context – 30 marks
- Presentation – 30 marks

NOTE ON EVALUATION

1. Examples for role play situations:
 - a. Marketing engineer convincing a customer to buy his product.
 - b. Telephone conversation – Fixing an official appointment / Enquiry on availability of flight
or
train tickets / placing an order. etc.
2. Presentations could be just a Minute (JAM activity) or an Extempore on simple topics or visuals could be provided and students could be asked talk about it.

REFERENCES:

1. Hartley, Peter, Group Communication, London: Routledge, (2004).
2. Doff, Adrian and Christopher Jones, Language in Use – (Intermediate level), Cambridge University Press, (1994).
3. Gammidge, Mick, Speaking Extra – A resource book of multi-level skills activities , Cambridge University Press, (2004).
4. Craven, Miles, Listening Extra - A resource book of multi-level skills activities, Cambridge, Cambridge University Press, (2004).
5. Naterop, Jean & Rod Revell, Telephoning in English, Cambridge University Press, (1987).

LAB REQUIREMENTS

1. Teacher – Console and systems for students
2. English Language Lab Software
3. Tape Recorders.

FT3202

PRINCIPLES OF CHEMICAL ENGINEERING
(Common for IBT, Food and Pharmaceutical Technology)

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 8

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 MATERIAL BALANCES 10

Material balance calculations for non reactive operations, once through operations, recycle operations, bypass operations. Material balance calculations for reactive processes, recycle, bypass processes – Application problems in unit operations and processes.

UNIT III ENERGY BALANCES 8

Calculation of enthalpy changes, heat capacity, Latent heats, Data sources, Thermo chemical calculations. Heat of solution, Simultaneous material and energy balances.

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”, 6th Edition, Mc Graw Hill, 2001.
2. Bhatt, B.I. and S.M. Vora “Stoichiometry (SI Units)”, 3rd Edition, Tata McGraw- Hill, 1996.

REFERENCES

1. Himmelblau, D.M. “Basic Principles and Calculations in Chemical Engineering”, 6th Edition, PHI, 2006.
2. Geankoplis, C.J. “Transport Processes and Separation Process Principles”, 4th Edition, PHI, 2006.
3. Foust, A.S. et al., “ Principles of Unit Operations”, 2nd 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”, 6th Edition, Vol. I & II, Butterworth – Heinman / Elsevier, 2004.

FT3203**BIO-ORGANIC CHEMISTRY**
(Common for IBT, Food and Pharmaceutical Technology)**L T P C**
3 0 0 3**UNIT I INTRODUCTION TO CHEMISTRY 13**

Chirality, Enantiomers, Diastereomers, Enantiotopic Faces, Absolute configuration RS nomenclature, Bijvoet's method of determining absolute configuration. Conformers: Ethane, butane, cyclohexane – Reactivity due to change in conformers Reactions: SN1, SN2, E1, E2, Addition of electrophile on a double bond, Hydride transfer mechanisms Cannizzaro's reaction. Reactivity: Kinetics of Reactions, First order and kinetics of enzyme Determination of ΔG^\ddagger , ΔH^\ddagger , ΔS^\ddagger . Thermodynamics: Boltzmann's equation, Gibbs – Helmholtz equation. Acid – Base catalysis – Structure of water.

UNIT II INTRODUCTION TO ORGANIC SYNTHESIS 10

Useful Organic Transformations Retrosynthetic Analysis.
Case Studies: Synthesis of Cholesterol, Synthesis of Chlorophyll.

UNIT III ENZYMES 5

MM kinetics – other mechanisms for enzyme action – Methods for following enzyme reactions – Analysis of Enzymatic reactions.

UNIT IV MECHANISMS 13

Case Studies: Lipase, Carboxypeptidases, Monooxygenases – Esterases Case Study: Engineering an Enzyme – Subtilisin. Case Study: Allosteric ATPase Mechanisms of enzymes in a Pathway: Case Study: Serratia marcescens & Prodigiosin. Domain Movements in Enzymes MD simulations Case Study: Lipase.

UNIT V BIOLOGICAL SUPERMOLECULES 4

Supramolecular Systems – Ion Channels – photosynthesis – artificial enzymes – catalytic antibodies – ribozymes..

TOTAL: 45 PERIODS**TEXT BOOKS**

1. Page, M.I., and A. Williams, "Organic and Bioorganic Mechanisms," Pearson India Edition, 1997
2. Ariya, K. and T. Kumtake, "Supramolecular Chemistry: Fundamentals and Applications", Springer India Edition, 2006.
3. Morrison, R.T. and T.N. Boyd "Organic Chemistry", 6th Edition, Prentice Hall of India, 2003.
4. Palmer, Trevor "Enzymes: Biochemistry, Biotechnology, Clinical Chemistry", Affiliated East-West Press Pvt. Ltd., 2004.

REFERENCE

1. Fersht, Alan "Structure and Mechanism in Protein Science: A Guide to Enzyme Catalysis and Protein Folding", W.H. Freeman, 1998.

FT3204**CELL BIOLOGY****L T P C**
3 0 0 3**AIM**

To introduce students to the principles of cell biology to emphasize the role of organelles and their functions; signal transduction and crosstalk between the cells – towards biotechnological applications.

OBJECTIVES

- To provide to the students the fundamentals of cell biology and ability to solve problems in cell biology.
- To help students understand the pathway mechanisms.

- UNIT I CELL STRUCTURE AND FUNCTION OF THE ORGANELLES 9**
Eukaryotic, Prokaryotic cells, Subcellular Organelles and Functions Principles of membrane organization membrane proteins, cytoskeletal proteins eg. RBC cytoskeletal contractile proteins Actin, myosin, Actin Polymerization Act- myosin complex, mechanism of myosin-ATpase activity, contraction; microtubules, microfilaments activity in Organelle movement.
- UNIT II CELL DIVISION AND CONNECTION 9**
Cell cycle – Mitosis, Meiosis, Molecules controlling cell cycle, Extra cellular matrix, role of matrix in cell enthore : Gap junctions, Tight junctions, Desmosomes, Hemidesmosomes.
- UNIT III TRANSPORT ACROSS CELL MEMBRANE 9**
Passive and Active Transport, Permeases, Ion channels, ATP pumps. $\text{Na}^+ / \text{K}^+ / \text{Ca}^{+2\text{T}}$ pumps uniport, symport antiporter system. Ligand gated / voltage gated channels, Agonists and Antagonists.
- UNIT IV SIGNAL TRANSDUCTION 9**
Receptors – extracellular signaling, Cell surface / cytosolic receptors and examples, Different classes of receptors antocrine / paracrine / endocrine models, Secondary messengers molecules.
- UNIT V SIGNAL AMPLIFICATION AND CROSSTALK 9**
Signal amplification and crosstalk caspases and cell death, Role of Ras and Raf in oncogenesis, introduction to gene therapy.

TOTAL: 45 PERIODS

REFERENCES

1. Lodish, Harvey etal., “Molecular Cell Biology,” 6th Edition. W.H.Freeman, 2008.
2. Alberts, Bruce, “Molecular Biology of Cell”, 5th Edition, Garland Science, 2008.
3. Cooper, G.M. “The Cell: A Molecular Approach, 4th Edition, ASM Press, 2007.
4. Alberts, Bruce etal., “Essentail Cell Biology”, 2nd Edition, Garland Science, 2004

FT3205

MICROBIOLOGY

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

AIM

To introduce students to the principles of Microbiology to emphasize structure and biochemical aspects of various microbes.

OBJECTIVE

- To provide to the students the fundamentals of Microbiology and solve the problems in microbial infection and their control.

- UNIT I INTRODUCTION 6**
Basics of microbial existence; history of microbiology, classification and nomenclature of microorganisms, microscopic examination of microorganisms, light and electron microscopy; principles of different staining techniques like gram staining, acid fast, capsular staining, flagellar staining.
- UNIT II MICROBES- STRUCTURE AND MULTIPLICATION 12**
Structural organization and multiplication of bacteria, viruses, algae and fungi, with special mention of life history of actinomycetes, yeast, mycoplasma and bacteriophages.
- UNIT III MICROBIAL NUTRITION, GROWTH AND METABOLISM 12**
Nutritional requirements of bacteria; different media used for bacterial culture; growth curve and different methods to quantify bacterial growth; aerobic and anaerobic bioenergetics and utilization of energy for biosynthesis of important molecules.

UNIT IV CONTROL OF MICROORGANISMS 6

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

UNIT V INDUSTRIAL AND ENVIRONMENTAL MICROBIOLOGY 9

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

TOTAL: 45 PERIODS

TEXT BOOKS

1. Pelczar M.J., E.C.S. Chan and N.R. Krieg. "Microbiology". 5th Edition, Tata McGraw Hill, 1993
2. Prescott, L.M., J.P. Harley, and D.A. Klein. "Microbiology," 7th Edition, Mc Graw-Hill, 2008
3. Casida, L.E. "Industrial Microbiology". New Age International, 1968.
4. Reed, Gerald "Prescott & Dunn's Industrial Microbiology" 4th Edition, CBS, 1987.

REFERENCES

1. Schlegel, Hans G. "General Microbiology", Cambridge University Press, 1993.
2. Stanier, Roger Y et al., "General Microbiology" 5th Edition, Macmillan, 1986.
3. Talaro, Kathleen and Arthur Talaro. "Foundations in Microbiology" 2nd Edition, Wm.C. Brown Publishers, 1996.

CY3206

PHYSICAL CHEMISTRY

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

AIM

To understand important concepts in physical chemistry.

OBJECTIVES

- To understand the different states of matter, theoretical principles governing the solid, liquid, mesomorphic and solid states and to know methods for experimental determination of characteristic properties of the states.
- To understand the principles of thermodynamics in deciding the spontaneity of reactions and energy changes involved in physical and chemical processes.
- To understand the principles of photochemistry and catalysis.

UNIT I PROPERTIES OF MATTER. GASEOUS AND LIQUID STATES 12

Gaseous state Ideal gas – Gas laws –kinetic theory – Maxwell's distribution of molecular velocities – collision frequency -mean free path – real gas- van der Waal's equation of state – critical constants – law of corresponding states – liquefaction of gases (CO₂, NH₃, air, O₂ and N₂) Joule – Thomson effect - inversion temperature. Liquid state Equilibrium vapour pressure – surface tension - viscosity-dipole moment – refractive index - optical rotation - methods of determination - relationship to molecular structure

UNIT II PROPERTIES OF MATTER MESOMORPHIC AND SOLID STATES 9

Mesomorphic state or liquid crystals Thermotropic and lyotropic mesomorphism - classification of thermotropic liquid crystals – smectic- nematic – cholesteric - disc shaped - polymer -- molecular arrangements in liquid crystals. Solid state crystal structure - laws of crystallography -7 crystal systems-14 Bravais lattices - X-rays and crystal structure - Bragg's equation - types of crystals – molecular – covalent –ionic – metallic – lattice energy - Born-Lande's equation - experimental determination using Born-Haber cycle - packing in metallic crystals - lattice-defects.

UNIT III THERMODYNAMICS I LAW AND THERMOCHEMISTRY 8

System – surroundings – properties – macroscopic – intensive – extensive processes – isothermal – adiabatic – reversible – irreversible - thermodynamic equilibrium - Zeroth law of thermodynamics – building thermometer - celsius scale - perfect gas/ absolute temperature scale. Internal energy - work done – isothermal , reversible and irreversible expansions – compressions - enthalpy - heat capacity at constant volume

C_v – at constant pressure C_p - relationship between C_p and C_v - work done In adiabatic, reversible and irreversible expansions - compressions. thermochemistry - enthalpy changes – physical and chemical processes - Kirchoffs' equation - Hess' law of constant heat summation - enthalpy of combustion - Bomb calorimeter - bond energies – applications

UNIT IV THERMODYNAMICS II AND III LAW 8

Spontaneous process- cyclic process – Carnot cycle - efficiency of a heat engine – entropy – concept - physical significance-changes accompanying processes – Free energy – Helmholtz – Gibbs - criteria for reversible and irreversible processes – Gibbs-Hermholtz equation-free energy and physical equilibria-Clapeyron and Clausius equation - free energy and chemical equilibria - vant Hoff reaction isotherm - standard free energy changes - Third law - Nernst heat theorem - determination of entropy from thermal measurements - residual entropy

UNIT V PHOTOCHEMISTRY AND CATALYSIS 8

Absorption of light - consequences – laws of photochemistry -quantum yield - photochemical processes – primary – secondary - kinetics of photochemical reactions - hydrogen and chlorine -hydrogen and bromine – photosensitization – quenching - lasers. Catalysis – catalyst – promoter – inhibitor - poisoning of catalyst -homogeneous catalysis - acid-base - metal salts - heterogeneous-adsorption – physisorption – chemisorption - surface area - industrially important processes – oxidation – cracking - reforming

TOTAL: 45 PERIODS**TEXT BOOKS**

1. Puri, B.R., L.R.Sharma and M.S.Pathania “Principles of Physical Chemistry:”.41st Edition. Vishal Publishing, 2006.
2. Atkins, Peter “Physical Chemistry” 9th Edition, Oxford University Press, 2009

REFERENCES

1. Bhal, B.S.,G.D. Tuli and Arun Bhal “Essentials of Physical Chemistry”. S.Chand & Co., 2010
2. Glasstone, Samuel “Thermodynamics for Chemists”. Narahari Press, 2008

FT3207**FOOD CHEMISTRY****L T P C
3 0 0 3****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 hydrolysates – 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". 3rd Edition. Springer, 1999.
4. Vaclavik, V. A. and Christian E. W. "Essentials of Food Science". 2nd 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". 4th Edition, CRC Press, 2008
3. Belitz, H.-D, Grosch W and Schieberle P. "Food Chemistry", 3rd 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.

EXPERIMENTS

1. Introduction, Laboratory Safety, Use of Equipment; Sterilization Techniques;
2. Culture Media-Types and Use; Preparation of Nutrient broth and agar
3. Culture Techniques, Isolation and Preservation of Cultures- Broth: flask, test tubes; Solid: Pour plates, streak plates, slants, stabs
4. Microscopy – Working and care of Microscope
5. Microscopic Methods in the Study of Microorganisms; Staining Techniques- Simple, Differential- Gram's Staining
6. Quantification of Microbes: Sampling and Serial Dilution; Bacterial count in Soil – TVC
7. Effect of Disinfectants- Phenol Coefficient
8. Antibiotic Sensitivity Assay
9. Growth Curve in Bacteria and Yeast
10. Effect of pH, Temperature, UV radiation on Growth Bacteria

TOTAL: 60 PERIODS

Equipment Needed for 20 Students

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

TEXT BOOKS

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

1. Determination of Heat of ionisation / Neutralisation of acids.
2. Determination of rate constants and activation energy of simple first and second order reactions.
3. General acid catalysed reactions – Catalytic coefficients and Dissociation Constants.
4. Determination of molecular weight of substances.
5. Experiments based on the principles of Electrochemistry. Applications of Thermodynamic principles and Surface Chemistry.
6. Systematic qualitative analysis of organic compounds by solubility , elemental analysis, group detection, physical constant and derivatization
7. Estimation of selected organic compounds such as aniline / phenol, formaldehyde/acetone, glucose, glycerol.
8. Neutral equivalence of acids and bases and estimations of the following functions groups-amide, ester, acid, amino nitro.
9. Separation and purification of binary mixtures of the type: water soluble water insoluble – water insoluble, liquid-solid and liquid-liquid.
10. Preparation of simple organic compounds involving importance unit operations.

TOTAL: 60 PERIODS

REFERENCES

1. Shoemaker, D.P., C.W. Garland and J.W. Nibler "Experiments in Physical Chemistry", 5th Edition, McGraw-Hill, 1989.
2. Furniss, B.S. et al., "Vogel's Textbook of Practical Organic Chemistry", 5th Edition, [EIBS] Addison Wesley Longman Ltd., 1989.
3. Leonard, J., B. Lygo and G. Procter "Advanced Practical Organic Chemistry", 2nd Edition, Stanley Thomes Pvt. Ltd., 1998.

MA3211

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 – χ^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.

L: 45, T: 15, TOTAL : 60 PERIODS

TEXT BOOKS

1. Milton, J. S. and Arnold, J.C., "Introduction to Probability and Statistics", Tata 4th 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", 7th 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", 8th Edition. Pearson Education, Asia, 2007.
3. Ross, S.M., "Introduction to Probability and Statistics for Engineers and Scientists," 3rd 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.

AIM

To introduce students to the principles and methods of biological instruments.

OBJECTIVE

- To provide to the students the fundamentals of instrument knowledge and their applications in biology.

UNIT I OPTICAL SPECTROSCOPY 10

Design of Experiments – Error Analysis – S/N ratio – Limit of Detection – UV –VIS Spectroscopy, Applications, Instruments – single beam, double beam and Photo-diode array – applications – IR & Raman – Uses – Design – FT-IR, Raman.

UNIT II CHROMATOGRAPHY 10

Distribution coefficients – solid-liquid, liquid-liquid and gas chromatography – theory of chromatography-normal phase & reverse phase chromatography – gel permeation – ion exchange & affinity chromatography – HPLC- Instrumentation & case studies.

UNIT III STRUCTURAL ELUCIDATION 10

Nuclear Magnetic Resonance – Introduction-spin states – ¹H, ¹³C NMR – Instrumentation-use in structural elucidation. Electron Paramagnetic Resonance-concept & instrumentation – use in metal containing proteins & membrane studies. X-Ray : X-ray spectroscopy –Auger – EELS Instrumentation & applications in Biology- X-ray diffraction- Instrumentation –small molecule & macromolecular crystallography.

UNIT IV MASS SPECTROMETRY 10

Introduction – Instrumentation – CI, EI-Methods of Ionization- Methods for separation of Ions – Method for Detection. MALDI - TOF, ESI and FT-MS.

UNIT V ELECTROCHEMICAL MEASUREMENTS 5

Different types of electrochemical apparatus – Measuring Electrode potentials- Red-Ox proteins – Porous Silicon.

TOTAL : 45 PERIODS

TEXTBOOKS

- Skoog, D.A., f.J. Holler and S.R. Crouch “Principles of Instrumental f Analysis”.6th Edition, Thomson/Brooks/Cole, 2002.
- Willard, H.H. etal., “Instrumental Methods of Analysis”.7th Edition. CBS Publishers, 1986.
- Braun, Robert D. “Introduction to Instrumental Analysis” Pharma Book Syndicate, 1987.
- Ewing, G.W. “Instrumental Methods of Chemical Analysis” 5th Edition, Tata McGraw-Hill, 1985

**CH3213 FUNDAMENTALS OF HEAT AND MASS TRANSFER L T P C
(Common for Food and Pharmaceutical Technology) 3 0 0 3****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" 3rd 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", 2nd Edition, Tata McGraw-Hill, 2007.
4. Geankoplis, C.J. "Transport Processes and Separation Process Principles (Includes unit Operations) 4th Edition, PHI, 2003.

REFERENCES

1. Coulson, J.M. and etal. "Coulson & Richardson's Chemical Engineering", 6th 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", 6th Edition, Mc Graw Hill, 2003.

FT3214

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	ROLE OF MICROBES IN SPOILAGE OF FOODS	9
Factors affecting spoilage of foods, Microbial flora associated with various food groups their spoilage potential. Microbiological spoilage problems associated with typical food products.		
UNIT II	CONTROL OF MICROBES IN FOODS	9
Use of antimicrobial chemicals- organic acids, sugars, sodium chloride, nitrites, phosphates, sulphites, Benzoates, Sorbates / Propionates naturally occurring antimicrobials; Physical methods- Low and high temperatures, drying, radiation and high pressure; Tolerance of microbes to chemical and physical methods in various foods.		
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, Gram Negative and Gram positive food borne pathogens; 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; Applications of immunological, techniques to food industry; Detection methods for E. coli, Staphylococci, Yersinia, Campylobacter, B. cereus, Cl. Botulimum & Salmonella, Listeria monocytogenes Norwalk virus, Rotavirus, Hepatitis A virus from food samples.		

TOTAL : 45 PERIODS

TEXT BOOKS

1. Frazier, William C. "Food Microbiology" 4th Edition. Tata McGraw-Hill, 1988.
2. Banwart, G.J. "Basic Food Microbiology" 2nd Edition. CBS Publishers, 1998.
3. Vijaya Ramesh. " Food Microbiology". MJP Publishers, Chennai, 2007.
4. Jay, J.M. "Modern Food Microbiology". 4th Edition. CBS Publishers, 2003.
5. Adams, M.R. and M.O. Moss." Food Microbiology". New Age International, 2002
6. Khetarpaul, Neelam. "Food Microbiology" Daya Publishing House, 2006.

REFERENCES

1. Montville, Thomas J. and Karl R. Matthews " Food Microbiology : An Introduction". ASM Press, 2005.
2. Ray, Bibek and Arun Bhunia. "Fundamental Food Microbiology" 4th Edition, CRC Press, 2008
3. Pawsey, R. K. "Case Studies in Food Microbiology for Food Safety and Quality". The Royal Society of Chemistry, 2001.
4. Forsythe, S.J. "The Microbiology of Safe Food". Blackwell Science, 2000.
5. Doyle, Michael P. "Food Microbiology : Fundamentals and Frontiers". 2nd Edition, ASM Press, 2001.
6. Parry, Thelma J. and R.K. Pawsey. "Principles of Microbiology : For Students of Food Technology". 2nd Edition, Hutchinson Education, 1984.

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", 2nd 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.

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', 2nd edition, Pearson Education (2004).
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw- Hill, NewDelhi, (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)

IB3217

GENETICS

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

AIM

To introduce students to the principles of classical genetics and to emphasize the role of genetics in modern biology.

OBJECTIVES

- To provide to the students the fundamentals of classical genetics and ability to solve problems in genetics.
- To help students understand sex determination mechanisms.
- To enable students appreciate genetic recombination and mapping techniques.

UNIT I CLASSICAL GENETICS 9

Mendelian genetics, symbols and terminology, monohybrid crosses, ratios, dominance , recessiveness, backcross, testcross, codominance, incomplete dominance, lethals Principles of segregation, Punnett square, dihybrid cross, ratios, trihybrids,, geneic interation, epistasis, forked line method for genetic problems.Pedigrees,probability and statistics for geneticists.

UNIT II SEX DETERMINATION, SEX LINKAGE AND PEDIGREE ANALYSIS 9

Sex determination , patterns, sex chromosomes, dosage compensation, Lyon's hypothesis, dosage compensation in Drosophila, sex determination in humans, SRY, XX-XY mechanism, Y chromosome and sex determination in mammals. Balance concept of sex determination in Drosophila. Identification of sex chromosomes.

Sex Linkage- human sex-linked disorders hemophilia, Fragile X, Lesh-Nyhan and Hunter syndrome. Pedigree analysis, penetrance, expressivity, dominant , recessive and sex-linked inheritance. Sex limited, sex influenced traits, mosaics and gynandromorphs.

UNIT III STUCTURE OF CHROMOSOMES AND VARIATION IN CHROMOSOME STRUCTURE AND NUMBER 9

Organization of prokaryotic and eukaryotic chromosomes. Proof that DNA is genetic material. Cytogenetic variation, human karyotypes, polytene chromosomes, polyploidy, sterile polyploids, polyteny. Aneuploidy- monosomy, trisomy in humans, deletions and duplications in chromosome number. Rearrangements of chromosome structure, inversion, translocation, compound chromosomes, phenotypic effects of chromosome rearrangements.

UNIT IV LINKAGE, CROSSING OVER AND CHROMOSOME MAPPING IN EUKARYOTES 9

Linkage, Crossing over, recombination, exception to Mendelian principles, frequency of recombination, evidence of crossing over, chiasmata, chromosome mapping with two- point and three-point testcrosses. Recombination mapping and map distance, linkage analysis in humans , detection of linked loci by pedigree analysis and somatic cell genetics. Human gene map.

UNIT V GENETICS OF BACTERIA AND VIRUSES 9

Structure and life cycle of bacterial viruses, mapping the bacteriophage genome, deletion mapping. Genetic exchange in Bacteria. Transformation, process and mapping, Conjugation, F⁺X F⁻ mapping, HFR, sexduction, conjugation and gene mapping, mapping closely linked genes, origin of plasmids. Transduction – Generalized, Specialized and gene mapping in bacteria significance of sexuality in bacteria.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Gardner, E.J., M.J. Simmons and D.P. Snustad "Principles of Genetics". 8th Edition. John Wiley & Sons, 1991.
2. Sinnott, E.W., L.C. Dunn. "Principles of Genetics". 5th Edition, Tata McGraw-Hill, 1973.
3. Tamarin, R.H. "Principles of Genetics" 7th Edition, Tata McGraw-Hill, 2002.
4. Sambamurthy, A.V.S.S. "Genetics". 2nd Edition, Narosa, 2005.

REFERENCES

1. Klug, William S. and M.R. Cummings. "Essentials of Genetics". 5th Edition, Pearson Education, 2005.
2. Russell, Peter J. "I Genetics : A Molecular Approach". 2nd Edition, Pearson Education, 2006.
3. Brooker, R.J. "Genetics : Analysis and Principles". 2nd Edition, McGraw-Hill, 2004.

CY3219 INSTRUMENTAL METHODS OF ANALYSIS LAB
(Common for IBT, Food and Pharmaceutical Technology)**L T P C**
0 0 4 2

1. Precision and validity in an experiment using absorption spectroscopy.
2. Validating Lambert-Beer's law using KMnO₄
3. Finding the molar absorbtivity and stoichiometry of the Fe (1,10 phenanthroline)₃ using absorption spectrometry.
4. Finding the pKa of 4-nitrophenol using absorption spectroscopy.

5. UV spectra of nucleic acids.
6. Chemical actinometry using potassium ferrioxalate.
7. Estimation of SO_4^{2-} by nephelometry.
8. Estimation of Al^{3+} by fluorimetry.
9. Limits of detection using aluminium alizarin complex.
10. Chromatography analysis using TLC.
11. Chromatography analysis using column chromatography.

TOTAL : 60 PERIODS

TEXTBOOKS

1. Skoog, D.A. et al. "Principles of Instrumental Analysis", 5th 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", 7th Edition, CBS, 1986.
4. Ewing, G.W. "Instrumental Methods of Chemical Analysis", 5th Edition, McGraw-Hill, 1985.

IB3220

CHEMICAL ENGINEERING LAB

L T P C

(Common for IBT, Food and Pharmaceutical Technology)

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", 6th Edition, Mc Graw Hill, 2001.
2. Geankoplis, C.J. "Transport Processes and Separation process Principles", 4th Edition, PHI, 2006.

IB3302

MOLECULAR BIOLOGY

L T P C

3 0 0 3

UNIT I CLASSICAL GENETICS

5

Mendelian genetics, linkage, crossing over, classical experiments – Hershey and Chase; Avery, McLeod & McCarty. Bacterial conjugation, transduction and transformation.

UNIT II STRUCTURE OF NUCLEIC ACIDS AND DNA REPLICATION

15

Conformation of DNA and RNA; replication in prokaryotes, D-loop and rolling circle mode of replication, replication of linear viral DNA. Organisation of eukaryotic chromosome – cot value, replication of telomeres in eukaryotes

UNIT III	TRANSCRIPTION	8
In prokaryotes and eukaryotes, features of promoters and enhancers, transcription factors, nuclear RNA splicing, ribozyme.		
UNIT IV	TRANSLATION	10
Elucidation of genetic code, mechanism, codon usage, suppressor mutation		
UNIT V	REGULATION OF GENE EXPRESSION	7
Lac and trp operon, ϕ phage life cycle, mutation and repair of DNA		

TOTAL : 45 PERIODS

TEXT BOOKS

1. Friefelder, David, "Molecular Biology", 2nd Edition, Narosa Publishing House, 1999.
2. Lewin Benjamin, "Genes IX" Jones and Bartlett, 2008.
3. Weaver, R.F. "Molecular Biology", 3rd Edition, McGraw Hill, 2005.

REFERENCES

1. Waston, J.D. "Molecular Biology of the Gene", 5th Edition, Pearson Education, 2004.
2. Walker, J.M. and R. Rapley "Molecular Biology and Biotechnology" 4th Edition, Panima, 2002.
3. Karp, Gerald. "Cell and Molecular Biology :Concepts and Experiments."2nd Edition, John Wiley & Sons, 1999.

FT 3302	BIOCHEMICAL ENGINEERING II	L T P C
		3 0 0 3

UNIT I **STERILIZATION KINETICS** **5**
Thermal death kinetics of microorganisms, batch and continuous heat sterilization of liquid media, filter sterilization of liquid media, air sterilization and design of sterilization equipment - batch and continuous.

UNIT II **METABOLIC STOICHIOMETRY AND ENERGETICS** **12**
Stoichiometry of cell growth and product formation, elemental balances, degrees of reduction of substrate and biomass, available electron balances, yield coefficients of biomass and product formation, maintenance coefficients energetic analysis of microbial growth and product formation, oxygen consumption and heat evolution in aerobic cultures, thermodynamic efficiency of growth.

UNIY III **KINETICS OF MICROBIAL GROWTH AND PRODUCT FORMATION - UNSTRUCTURED KINETIC MODELS** **8**
Modes of operation - batch, fed batch and continuous cultivation. Simple unstructured kinetic models for microbial growth, Monod model, growth of filamentous organisms, product formation kinetics - leudeking-piret models, substrate and product inhibition on cell growth and product formation.

UNIT IV **KINETICS OF MICROBIAL GROWTH AND PRODUCT FORMATION-STRUCTURED KINETIC MODELS** **8**
Study of structured models for analysis of various bioprocess – compartmental models, models of cellular energetics and metabolism, single cell models, plasmid replication and plasmid stability model.

UNIT V **BIOREACTOR SCALE – UP** **12**
Regime analysis of bioreactor processes, oxygen mass transfer in bioreactors – Mass transfer Coefficient- methods for the determination of mass transfer coefficients; mass transfer correlations. Power requirements of Bioreactors. Scale-up considerations on heat transfer oxygen transfer, power consumption and impeller tip speed.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Lee, James M. "Biochemical Engineering", PHI, 1992.
2. Shuler, M.L. and Kargi, F. "Bioprocess Engineering : Basic Concepts", 2nd Edition, PHI, 2002.
3. Bailey, J.E. and Ollis, D.F. "Biochemical Engineering Fundamentals" 2nd Edition, McGraw – Hill, 1988.
4. Blanch, H.W. and Clark, D.S. "Biochemical Engineering", Marcel Decker Inc., 1997.

REFERENCES

1. Moser, Anton. "Bioprocess Technology : Kinetics and Reactors", Springer – Verlag, 1988.
2. Stanbury, P.F. et al. "Principles of Fermentation Technology", 2nd Edition, Butterworth – Heinemann / Elsevier, 1995.

FT 3303

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; tintometer in color intensity determination; application of Atomic Absorption Spectrophotometer 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; HPLC and GC in food analysis; FAME analysis in oils and fats.

UNIT V ELECTROPHORESIS, REFRACTOMETRY AND POLARIMETRY 5

Basic principles; application of the technique; Brix value of fruit juices; total soluble solids in fruit products; Refractive indices of oils and fats; specific rotations of sugars.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Pomeranz, Yeshajahu. "Food Analysis : Theory and Practice". 3rd Edition. Aspen Publishers / Springer, 2000.
2. Kirk, R.S. and R. Sawyer "Pearson's Composition and Analysis of Food". 9th Edition. Longman,
3. Nielsen, S. Suzanne. "Food Analysis". 3rd 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" 2nd Rev. Edition. Vol. I, II & III, Marcel & Dekker, 2004.
3. Nollet, Leo M.L. " Food Analysis by HPLC". 2nd Rev. Edition, Marcel & Dekker, 2000
4. Otles, Semih. "Handbook of Food Analysis Instruments". CRC Press, 2009.

FT 3304

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". 2nd 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 Publishing, 2007.
5. Hutchings, John B. "Food Color and Appearance". Aspen Publication, 1999.

GE2023**FUNDAMENTALS OF NANOSCIENCE****L T P C****3 0 0 3****UNIT I INTRODUCTION****10**

Nanoscale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering-Classifications of nanostructured materials- nano particles- quantum dots, nanowires-ultra-thinfilms-multilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties. Introduction to properties and motivation for study (qualitative only).

UNIT II PREPARATION METHODS**10**

Bottom-up Synthesis-Top-down Approach: Precipitation, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.

UNIT III PATTERNING AND LITHOGRAPHY FOR NANOSCALE DEVICES**5**

Introduction to optical/UV electron beam and X-ray Lithography systems and processes, Wet etching, dry (Plasma /reactive ion) etching, Etch resists-dip pen lithography

UNIT IV PREPARATION ENVIRONMENTS**10**

Clean rooms: specifications and design, air and water purity, requirements for particular processes, Vibration free environments: Services and facilities required. Working practices, sample cleaning, Chemical purification, chemical and biological contamination, Safety issues, flammable and toxic hazards, biohazards.

UNIT V CHARECTERISATION TECHNIQUES**10**

X-ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques- AFM, SPM, STM, SNOM, ESCA, SIMS-Nanoindentation

TOTAL : 45 PERIODS**TEXT BOOKS**

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

REFERENCES

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

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

TOTAL: 60 PERIODS

REFERENCE

1. Ausubel, F.M. "Short Protocols in Molecular Biology", 4th Edition, John Wiley, 1999.

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. Determination of moisture in spices powder by distillation method.
2. pH, conductivity, TDS and hardness of water
3. Determination of Peroxide Value in edible oils.
4. Isolation and identification of synthetic food colors in sweets, confectionery, beverages.
5. Determination of total fat in liquid milk.
6. Determination of protein content in ice cream
7. Determination of total sugars in soft drinks.
8. Determination of Gluten in refined wheat flour (maida).
9. Determination of added common salt in table butter.
10. Detection of vanaspathi in ghee.
11. Detection of argemone oil in edible oil.
12. Detection of oil soluble color in spices powder.
13. Microscopic examination of wheat starch, rice starch and chicory in coffee.

FT 3309

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

IB3311

CHEMICAL REACTION ENGINEERING

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

AIM

To understand kinetics of reaction and rate equations
To understand design principles of reactors.

OBJECTIVES

- To estimate kinetic parameter
- To apply design equations.

UNIT I KINETICS OF HOMOGENEOUS REACTIONS 10

Principles of Homogeneous reactions – and rate equations-estimation of rate constants using constant volume and constant pressure Batch reactor-data for typical reactions – Arrhenius equation-Non elementary reaction kinetics-Multiple reactions-yield Concepts.

UNIT II IDEAL REACTORS 8

Performance equations for single batch reactor, ideal CSTR, ideal PFR-Application to design.

UNIT III MULTIPLE REACTORS & NON ISOTHERMAL REACTORS 8

Multiple reactor systems – selection of suitable reactor systems for multiple reactions-recycle reactor-Principles in non isothermal reaction and reactors.

UNIT IV NON IDEAL FLOW & REACTORS 10

Non Ideal reactors- Non Ideal Flow-Tracer experiments and application-TIS model, Axial Dispersion model-for tubular reactors. Exchange volume and By Pass and dead volume models for CSTRS.

UNIT V MULTIPHASE REACTIONS & REACTORS 9

Gas-Liquid Reactions-kinetics-G-L reactor design Principles-Principle of Catalysis-types of Catalytic reactors-Concept of effectiveness factor in Catalytic reactions-G-L-S-reactors – slurry reactor.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Levenspiel, Octave "Chemical Reaction Engineering", 3rd Edition, John – Wiley & Sons, 1999.
2. Fogler, H.S. "Elements of Chemical Reaction Engineering", 2nd Edition, Prentice Hall, 1999.
3. Richardson, J.E. and D.G. Peacock "Coulson & Richardson's Chemical Engineering", Vol.3 (Chemical & Biochemical Reactors & Process control) 3rd Edition, Butterworth – Heinemann / Elsevier, 2006.

REFERENCES

1. Missen, R.W. et al., "Chemical Reaction Engineering and Kinetics", John – Wiley, 1999.
2. Davis, Mark E and Robert J. Davis "Fundamentals of Chemical Reaction Engineering" McGraw – Hill, 2005.
3. Harriot, Peter "Chemical Reactor Design" Marcel Dekker, 2003.
4. Sila, Harry "Chemical Process Engineering : Design and Economics" Marcel Dekker, 2003.
5. Nauman, E. Bruce "Chemical Reactor Design, Optimization, and Scaleup", McGraw – Hill, 2002.

IB3312

GENETIC ENGINEERING

L T P C
3 0 0 3

UNIT I BASICS OF RECOMBINANT DNA TECHNOLOGY

4

Role of genes within cells, genetic elements that control gene expression, restriction and modifying enzymes, safety guidelines of recombinant DNA research.

UNIT II CREATION OF RECOMBINANT MOLECULES

10

Restriction mapping, design of linkers and adaptors. Characteristics of plasmid and phage vectors, prokaryotic and eukaryotic expression vectors. Insect, Yeast and Mammalian vectors.

UNIT III CONSTRUCTION OF LIBRARIES

15

Construction of cDNA and genomic libraries. Screening of libraries with DNA probes and with antisera.

UNIT IV POLYMERASE CHAIN REACTION

10

Inverse PCR, Nested PCR, Taqman assay, Molecular beacons, RACE PCR, RAPD, site directed mutagenesis, methods of nucleic acid sequencing- Sangers method, (Kunkel's Method).

UNIT V APPLICATIONS OF RECOMBINANT DNA TECHNOLOGY

6

Cloning in plants, Ti plasmid, and transgenic and knockout animals.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Primrose, S.Twyman, R. "Principles of Gene Manipulation and Genomics" 7th Edition, Blackwell Publishing, 2006.
2. Brown, T.A. "Gene Cloning & DNA Analysis : An Introduction", 5th Edition, Blackwell Publishing, 2006.
3. Watson, James., "Molecular Biology of the Gene" 5th Edition, Pearson Education, 2004.
4. Glick, B.R. and J.J. Pasternak "Molecular Biotechnology : Principles and Applications of Recombinant DNA", 3rd Edition, ASM, 2003.

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

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", 4th 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". 2nd 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.

UNIT I INTRODUCTION 9

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of manufacturing and service quality - Basic concepts of TQM - Definition of TQM – TQM Framework - Contributions of Deming, Juran and Crosby – Barriers to TQM.

UNIT II TQM PRINCIPLES 9

Leadership – Strategic quality planning, Quality statements - Customer focus – Customer orientation, Customer satisfaction, Customer complaints, Customer retention - Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement – PDCA cycle, 5s, Kaizen - Supplier partnership – Partnering, Supplier selection, Supplier Rating.

UNIT III TQM TOOLS & TECHNIQUES I 9

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

UNIT IV TQM TOOLS & TECHNIQUES II 9

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

UNIT V QUALITY SYSTEMS 9

Need for ISO 9000- ISO 9000-2000 Quality System – Elements, Documentation, Quality auditing- QS 9000 – ISO 14000 – Concepts, Requirements and Benefits – Case studies of TQM implementation in manufacturing and service sectors including IT.

TOTAL: 45 PERIODS**TEXT BOOK:**

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

REFERENCES:

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

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.

I. PC based session**(Weightage 40%)****24 periods****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.

II. Practice Session	(Weightage – 60%)	24 periods
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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. **Interview Skills:** Students participate in Mock 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.

LAB REQUIREMENT

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.	Server	1 No.
	○ PIV system	
	○ 1 GB RAM / 40 GB HDD	
	○ OS: Win 2000 server	
	○ Audio card with headphones (with mike)	
○ JRE 1.3		
2.	Client Systems	60 No.
	○ PIII or above	
	○ 256 or 512 MB RAM / 40 GB HDD	
	○ OS: Win 2000	
	○ Audio card with headphones (with mike)	
○ 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 - Desirable	1 No.

FT 3318

BIO PROCESS LAB

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

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 : 90 PERIODS

REFERENCES

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

FT3319

GENETIC ENGINEERING LAB

L T P C
0 0 4 2

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

TOTAL : 60 PERIODS

REFERENCE

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

IB3401

IMMUNOLOGY

L T P C
3 0 0 3

UNIT I INTRODUCTION 6

Cells of immune system; innate and acquired immunity; primary and secondary lymphoid organs; antigens: chemical and molecular nature; haptens; adjuvants; types of immune responses; theory of clonal selection.

UNIT II CELLULAR RESPONSES 12

Development, maturation, activation and differentiation of T-cells and B-cells; TCR; antibodies: structure and functions; antibodies: genes and generation of diversity; antigen-antibody reactions; monoclonal antibodies: principles and applications; antigen presenting cells; major histocompatibility complex; antigen processing and presentation; regulation of T-cell and B-cell responses.

UNIT III INFECTION AND IMMUNITY 16

Injury and inflammation; immune responses to infections: immunity to viruses, bacteria, fungi and parasites; cytokines; complement; immunosuppression, tolerance; allergy and hypersensitivity; AIDS and Immunodeficiencies; resistance and immunisation; Vaccines.

UNIT IV	TRANSPLANTATION AND TUMOR IMMUNOLOGY	8
Transplantation: genetics of transplantation; laws of transplantation;; tumor immunology.		
UNIT V	AUTOIMMUNITY	3
Autoimmunity, Autoimmune disorders and diagnosis.		

TOTAL : 45 PERIODS

TEXTBOOKS

1. Male, David et al., "Immunology", 7th Edition, Mosby Publication, 2007.
2. Kindt, T.J. et al., "Immunology", 6th Edition, W.H. Freeman, 2007.
3. Janeway, C.A. et al., "Immunology : The Immune Systems in Health and Diseases", 6th Edition, Garland Science, 2005.

REFERENCES

1. Coico, R. et al., "Immunology : A Short Course", 5th Edition, Wiley – Liss, 2003.
2. Parham, Peter "The Immune System", 2nd Edition, Garland Science, 2005.
3. Abbas, A.K. et al., "The Cellular and Molecular Immunology", 6th Edition, Sanders / Elsevier, 2007.
4. Weir, D.M. and Stewart, John "Immunology", 8th Edition, Churchill Pvt. Ltd., 2000.
5. Lydyard, P.M. "Instant Notes in Immunology", Viva Books Pvt. Ltd., 2000.

FT 3402	FOOD SAFETY, QUALITY AND REGULATORY ISSUES	L T P C
		3 0 0 3

AIM

To sensitize students about food safety and risks.

OBJECTIVES

- To characterize different type of food hazards, physical, chemical and biological in the industry and food service establishments
- To help become skilled in systems for food safety surveillance
- To be aware of the regulatory and statutory bodies in India and the world
- To ensure processed food meets global standards

UNIT I	INTRODUCTION	15
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Definition of food safety and concept of safe food; characterization of food hazards- physical, chemical and biological; adulteration, filth, plastics, pesticides, heavy metals; Changes due to food processing, trans fatty acids, pyrolytic and thermal decomposition products, urethane, mycotoxins, scrombotoxin, migration, cross - contamination, nitrates and related products, sulfites, phenolic antioxidants, non-nutritive sweeteners, colour additives, fat substitutes, chemical preservatives, veterinary drugs and antibiotics.

UNIT II	MICROBIAL HAZARDS AND NATURAL SOURCE HAZARDS	8
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Allergens, goitrogens, lathyrogens, alkaloids, lectins, aflatoxins. Implementation of FSIS program for pathogen reduction; prevention of food-borne illness, dose-response, model risk assessment, management and communication; exposure assessment, monitoring; Structured model for microbial risk reduction, microbial biofilms, prevention of microbial hazards; Sanitation, antimicrobial plastics, intelligent packaging, headspace gas modification.

UNIT III	MONITORING AND REGULATION	10
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HACCP, GMP; Surveillance networks, Consumer and food service operator education, function and roles of USFDA, USDA and EPA; Food Safety and Standards Act India 2006; Prevention of Food Adulteration Act, India, 1954; Responsibilities of the Food service operator, consumer protection, food audit.

UNIT IV SPECIAL FOODS SAFETY, HEALTH CLAIMS AND LABELING 5
Infant foods, formula foods, PKU, regulatory, industrial and international implications; fortified foods, sports nutrition, nutraceuticals, medical foods; Health claims; Labeling

UNIT V WORLD-WIDE FOOD SAFETY ISSUES 7
GM Foods, safety and labeling; International Food Standards ISO 9000 and related standards; Impact of food safety on global trade; Food safety in retail food businesses; international food service operators, institutional food service operators; application of the principals of modern hygiene .

TOTAL : 45 PERIODS

TEXT BOOKS

1. Entis, Phyllis. "Food Safety : Old Habits, New Perspectives." ASM Press, 2007.
2. Hester, R.E. and R.M. Harrison. "Food Safety and Food Quality". Royal Society of Chemistry, 2001.
3. Mortimore, Sara and Carol Wallace. "HACCP" (Food Industry Briefing Series), Blackwell Science Publication, 2001.
4. Paster, Tara. "The HACCP : Food Safety Training Manual." John Wiley & Sons, 2007.
5. Schmidt, Ronald H. and Gary E. Rodrick. "Food Safety Handbook". John Wiley & Sons, 2003.
6. Mehta, Rajesh and J. George. " Food Safety Regulations Concerns and Trade: The Developing Country Perspective". Macmillan, 2005.

REFERENCES

1. Fortin, N.D. "Food Regulation : Law, Science, Policy and Practice". Wiley, 2009.
2. Lightbourne, Muriel. " Food Security, Biological diversity and Intellectual Property Rights". Ashgate, 2009.

FT 3403

FOOD PROCESS ENGINEERING I

**LT P C
3 0 0 3**

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 Purees/pastes - General and specific processing, different packing including aseptic. 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". 4th 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". 3rd 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.

FT 3404

FOOD PROCESS ENGINEERING II

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

AIM

The course aims to develop the knowledge of students in the area of animal product 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 meat and such foods 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 FISH & FISH PROCESSING 8

Marine and fresh water fish, shell fish- composition and nutrition commercially important fish and shell fish, names in important Indian languages, important regions, season; spoilage factors, ship board operations, storage and transport.

Processing and Preservation-chilling, freezing, canning, smoking, curing, salting and drying, fish meal and fish oils; safety issues, Indian regulation and quality assurance.

UNIT II MEAT & MEAT PROCESSING 10

Common and commercially important meats; pre and post slaughter handling, meat inspection and grading; animal welfare and safety in slaughter plant.

Structure and composition of meat, carcass chilling, ageing; storage of fresh meat- Modified atmosphere packaging, packaging of retail cuts; Processing and preservation- artificial tenderizing, chilling, freezing, curing, smoking, sausage manufacture, ready-to-eat meats and meat products; Kosher and Halal certification, safety issues, regulation and quality assurance.

UNIT III POULTRY & EGGS 9

Types of poultry, production, classification & designation, grading.

Processing plant operations- slaughter, bleeding, scalding, defeathering, eviscerating, chilling, packaging; composition and nutrition, poultry meat products; safety issues, regulation and quality assurance.

Eggs- structure, composition, quality factors, storage, pasteurization, freezing and drying, egg substitutes; regulation and Quality assurance.

UNIT IV MILK AND MILK PRODUCTS 9

Processing of Milk – Pasteurisation, homogenisation, sterilization, HTST and UHT processes; Processing and preservation of milk products- cream, sour cream, butter, ghee, skimmed milk concentrate and skimmed milk powder, whey concentrate and whey powder, yoghurt, cheese and other products; Traditional Indian products- curd, lassi, buttermilk, khoa, kulfi, shrikhand, icecream ; packaging of dairy products- sachets, aseptic packs; chilled and frozen storage; Food Regulation and Quality assurance.

UNIT V EXTRUDED FOOD PRODUCTS 9

Principle, types and design of extruders, factors affecting extrusion performance, types of extruded foods- pasta , meat substitutes, textured plant and milk proteins, specialty foods ; uses and advantages of extrusion technology; packaging of extruded products; regulation and quality assurance.

TOTAL : 45 PERIODS

TEXTS BOOKS

1. Berk, Zeki. "Food Process Engineering and Technology". Academic Press / Elsevier, 2009.
2. Toldra, Fidel. "Meat Biotechnology". Springer, 2008.
3. Jongen, Wim. "Fruit and Vegetable Processing : Improving Quality". CRC / Woodhead Publishing, 2002.
4. Arthey, David and P.R. Ashurst. "Fruit Processing : Nutrition, Products and Quality Management". 2nd Edition, 2001.
5. Reddy, Y.S. "Extraction Techniques for Food Processing". Gene-Tech Books, 2006.
6. Chintamani, Raghuraj. "Fruit & Vegetable Biotechnology" Dominant Publishers, 2008.

REFERENCES

1. Saravacos, G.D. and Z.B. Maroulis. "Food Process Engineering Operations". CRC Press, 2010.
2. Lbarz, Albert and G.V. Barbosa-Canovas. "Introduction to Food Process Engineering". CRC Press, 2010.

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 millet, Kodo Millet - Basic agricultural 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, soya 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". 2nd 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". 3rd Edition. American Association of Cereal Chemists, 2010.
2. Hosney, R.C. "Principles of Cereal Science and Technology" 2nd Edition, American Association of Cereal Chemists, 1994.
3. Karl Kulp. "handbook of Cereal Science and Technology". 2nd Rev. Edition. CRC Press, 2000.
4. Kole, Chittaranjan. Genome Mapping and Molecular Breeding in Plants". Springer, 2006

GE2025

PROFESSIONAL ETHICS IN ENGINEERING

L T P C
3 0 0 3

UNIT I ENGINEERING ETHICS

9

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

UNIT II ENGINEERING AS SOCIAL EXPERIMENTATION

9

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

UNIT III ENGINEER'S RESPONSIBILITY FOR SAFETY

9

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis – Reducing Risk – The Government Regulator's Approach to Risk - Chernobyl Case Studies and Bhopal

UNIT IV RESPONSIBILITIES AND RIGHTS

9

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

UNIT V GLOBAL ISSUES

9

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

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Mike Martin and Roland Schinzinger, "Ethics in Engineering", McGraw Hill, New York, 2005.
2. Charles E Harris, Michael S Pritchard and Michael J Rabins, "Engineering Ethics – Concepts and Cases", Thompson Learning, 2000.

REFERENCES:

1. Charles D Fleddermann, "Engineering Ethics", Prentice Hall, New Mexico, 1999.
2. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, 2003
3. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, 2001.
4. Prof. (Col) P S Bajaj and Dr. Raj Agrawal, "Business Ethics – An Indian Perspective", Biztantra, New Delhi, 2004.
5. David Ermann and Michele S Shauf, "Computers, Ethics and Society", Oxford University Press, (2003)

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

1. 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.

1. Water
 - Microbiological quality of water (MPN)
 - Water activity in foods
2. Milk and Dairy products
 - Microbiological quality of milk
 - Enumeration of Lactic acid bacteria from fermented foods
 - Preparation of Yoghurt & Quality Parameters
3. Vegetables & Fruits
 - Yeast & Mould count from fruits
 - Preparation of fruit syrups, squashes, sauces – Refractive index, viscosity
 - Drying of vegetables & fruits- drying rates

- Freezing of vegetables- freezing rates
- 4. Cereal & Pulse Products
 - Gelatinization of starch
 - Viscosity of starch pastes and sauces
 - Sugar syrups, caramelization
- 5. Edible oils
 - Refractive index
 - Expansion Characteristics of snack foods
 - Shelf life of fried snacks,
- 6. Spices, Salt & Sugar
 - Enumeration of spores from pepper
 - Inhibitory effect of spices on microbial load in fish
 - Salt & sugar tolerance of microbes
- 7. Flesh foods
 - Enumeration & Isolation of *E. coli* from processed meat/chicken
 - Thermal destruction of microbes : TDT & TDP
- 8. Processed & Packaged foods
 - Enumeration & Isolation of *Staphylococci* from ready to eat street foods
 - Effect of packaging on shelf life
- 9. Hygiene & Sanitation
 - Effect of cleaning and disinfection on microbial load
- 10. Sensory Evaluation & Market testing of foods

TOTAL : 90 PERIODS

REFERENCES

1. Bell, Chris "Food Microbiology and Laboratory Practice", Blackwell, 2005.
2. McLandsborough, Lynne "Food Microbiology Laboratory", CRC, 2005.

FT3410

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.

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, COP etc; 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.
2. James, S.J. and C. James. “ Meat Refrigeration”. CRC / Woodhead Publishing, 2002.
5. Stringer, Mike and C. Dennis. “Chilled Foods : A Comprehensive Guide”. 2nd 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.

FT 3002	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

1. Fisher, Carolyn and Thomas R. Scott. "Food Flavours : Biology and Chemistry". The Royal Society of Chemistry, 1997.
2. Heath, H.B. and G. Reineccius. " Flavor Chemistry and Technology". CBS Publishers, 1996.
3. Reineccius, Gary. "Flavor Chemistry and Technology". 2nd Edition, Taylor & Francis, 2006.
4. Shahidi, Fereidoon and Chi-Tang Ho. "Flavor Chemistry of Ethnic Foods". Kluwer Academic / Plenum, 1999.
5. Ashurst, Philip R. "Food Flavorings". 3rd Edition, Aspen Publications, 1999.

REFERENCES

1. Hofmann, Thomas. "Challenges in Taste Chemistry and Biology". American Chemical Society Publications, 2004.
2. Charalambous, G. "Food Flavors: Generation, Analysis and Process Influence". Elsevier, 1995.

FT 3003	BIOLOGICALLY ACTIVE PHYTOCHEMICALS IN FOOD	L T P C 3 0 0 3
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UNIT I	BIOSYNTHESIS AND SIGNIFICANCE	9
Phytochemicals in food, the plants as chemical factories, synthesis of isotopically labeled phytoestrogens		
UNIT II	ANALYSIS OF PHYTOCHEMICALS	9
Qualitative and quantitative methods: phytoestrogens in plants; isoflavones; flavanols, polyphenols, tannins, saponins, lignans Multiresidue method for penicillins and cephalosporins in Bovine muscle.		

UNIT III ASSESSMENT OF ANTIOXIDANT ACTIVITY 9

In vitro and In vivo methods for the assessment of antioxidant activity, Comparison of different In Vitro methods to evaluate the antioxidant , Prediction of the antioxidant activity of natural phenolics from electrotopological state indices

UNIT IV CARATENOIDS 9

Factors affecting bioavailability , chemical and histochemical characterisation of cell wall polysaccharides in almond seed in relation to lipid bioavailability.

UNIT V OPTIMISING PHYTOCHEMICAL 9

Optimising phytochemical release by process technology, Variation of Antioxidant Activity during technological treatments , new food grade peptidases from plant sources .

TOTAL : 45 PERIODS

TEXT BOOKS

1. Gilbert, John and H. Z. Senyuva "Bioactive Compounds in Food". Blackwell Publishing, 2008.
2. Meskin, Mark S., W.R. Bidlack and R.K. Randolph. "Phytochemicals : Nutrient-Gene Interactions". CRC / Taylor & Francis, 2006.

REFERENCES

1. Premier, Robert. "Phytochemicals in Food". Blackwell, 2010.
2. Johnson, Ian and Gary Williams. "Phytochemical Functional Foods". CRC Press,2003.

FT 3004

HUMAN NUTRITION

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

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.

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". 3rd Edition. Oxford University Press, 2007.
3. Gropper, Sareen S. "Advanced Nutrition and Human Metabolism". 5th Edition, Smith Wadsworth Publishing, 2008.

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 cost 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 ", 5th Edn., McGraw Hill, 2002.
2. Holand, F.A., Watson, F.A. and Wilkinson, J.K., " Introduction to process Economics ", 2nd 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 ", 7th Edn., McGraw Hill.

UNIT I SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS 10 + 3

Solution of algebraic and transcendental equations - Fixed point iteration method – Newton-Raphson method- Solution of linear system of equations - Gauss Elimination method – Pivoting - Gauss-Jordan methods – Iterative methods of Gauss-Jacobi and Gauss-Seidel - Matrix Inversion by Gauss-Jordan method - Eigenvalues of a matrix by Power method and by Jacobi's method.

UNIT II INTERPOLATION AND APPROXIMATION 8 + 3

Interpolation with unequal intervals - Lagrange interpolation – Newton's divided difference interpolation – Cubic Splines - Interpolation with equal intervals - Newton's forward and backward difference formulae.

UNIT III NUMERICAL DIFFERENTIATION AND INTEGRATION 9 + 3

Approximation of derivatives using interpolation polynomials - Numerical integration using Trapezoidal, Simpson's 1/3 and Simpson's 3/8 rules – Romberg's method - Two point and three point Gaussian quadrature formulae – Evaluation of double integrals by Trapezoidal and Simpson's rules.

UNIT IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATION 9 + 3

Single step-methods - Taylor's series method - Euler's method - Modified Euler's method - Fourth order Runge-Kutta method for solving first and second order equations - Multi-step methods - Milne's and Adams-Bashforth predictor-corrector methods for solving first order equations.

UNIT V BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS 9 + 3

Finite difference methods for solving two-point linear boundary value problems. Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain – One dimensional heat-flow equation by explicit and implicit (Crank Nicholson) methods - One dimensional wave equation by explicit method.

L : 45 , T : 15 , TOTAL : 60 PERIODS

TEXT BOOKS

1. Grewal, B.S. and Grewal, J.S., "Numerical Methods in Engineering and Science", 40th Edition, Khanna Publishers, 2007.
2. Sankara Rao, K. "Numerical Methods for Scientists and Engineers", 3rd Edition Prentice Hall of India, 2007.

REFERENCES

1. Chapra, S. C and Canale, R. P. "Numerical Methods for Engineers", 5th Edition, Tata McGraw-Hill, 2007.
2. Gerald, C. F. and Wheatley, P. O., "Applied Numerical Analysis", 6th Edition, Pearson Education Asia, 2006.
3. Brian Bradie, "Friendly Introduction to Numerical analysis", Pearson Education Asia, 2007.

FT 3007	TECHNICAL WRITING AND COMMUNICATION	L T P C 3 0 0 3
UNIT I	RESEARCH & WRITING	9
	The project/term paper, selecting a topic, using a library, compiling a working bibliography, taking notes, plagiarism, outlining, writing drafts, guides to writing.	
UNIT II	MECHANICS OF WRITING	9
	Spelling, punctuation, numbers, titles and quotations.	
UNIT III	FORMAT OF A TERM/PROJECT REPORT	9
	Typing, paper, margins, spacing, heading and title of paper, page numbers, tables and illustrations, corrections and insertions, binding.	
UNIT IV	PREPARATION OF CITATIONS	9
	General guidelines, placement, arrangement, citing books, citing articles in periodicals, documenting sources, what is a document, parenthetical documentation, information required in parenthetical documentation, readability, sample references.	
UNIT V	ABBREVIATIONS AND REFERENCES	9
	Introduction, time, common scholarly abbreviations and references words, publishers names, symbols and abbreviations used in proof-reading and correction, literary and scientific indexing.	
	TOTAL : 45 PERIODS	

TEXT BOOK

1. Gibaldi W.S. "Achter Handbook for Writers of Research Papers ", Wiley Eastern, 1987.

REFERENCE

1. "Chicago Manual of Style 14th Edition", Chicaco, University of Chicaco Press, 1996.

IB3008	METABOLIC ENGINEERING	L T P C 3 0 0 3
UNIT I	INTRODUCTION TO EXAMPLES OF PATHWAY MANIPULATION - QUALITATIVE TREATMENT	9
	Enhancement of Product Yield and Productivity, Extension of substrate Range, Extension of Product spectrum and Novel products, Improvement of Cellular properties, Xenobiotic degradation.	
UNIT II	MATERIAL BALANCES AND DATA CONSISTENCY	9
	Comprehensive models of cellular reactions; stoichiometry of cellular reactions, reaction rates, dynamic mass balances, yield coefficients and linear rate equations, analysis of over determined systems- identification of gross measurement errors. Introduction to MATLAB®	
UNIT III	METABOLIC FLUX ANALYSIS	9
	Theory, overdetermined systems, underdetermined systems- linear programming, sensitivity analysis, methods for the experimental determination of metabolic fluxes by isotope labeling, applications of metabolic flux analysis.	
UNIT IV	METABOLIC CONTROL ANALYSIS	9
	Fundamentals of Metabolic Control Analysis, control coefficients and the summation theorems, Determination of flux control coefficients, MCA of linear pathways, branched pathways, theory of large deviations	

UNIT V ANALYSIS OF METABOLIC NETWORKS 9

Control of flux distribution at a single branch point, Grouping of reactions, case studies, extension of control analysis to intermetabolite, optimization of flux amplifications, consistency tests and experimental validation.

TOTAL : 45 PERIODS

TEXT BOOKS

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

REFERENCES

1. Voit, E.O. "Computational Analysis of Biochemical Systems : A Practical Guide for Biochemists and Molecular Biologists". Cambridge University Press, 2000.
2. Scheper, T. "Metabolic Engineering" Vol 73 (Advances in Biochemical Engineering Biotechnology) Springer, 2001.
3. Rhodes, P.M. and P.F. Stanbury "Applied Microbial Physiology: Practical Approach". IRL Press, 1997.
4. Caldwell, D.R. "Microbial Physiology & Metabolism". Wm. C. Brown, 1995.
5. Rehm, H.J. and G. Reed, "Biotechnology : Products of Primary Metabolism Vol.6 and Biotechnology : Products of Secondary Metabolism Vol.7, VCH / Wiley, 1997.

FT 3009

DAIRY PRODUCT PROCESSING

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

AIM

The course aims to develop the knowledge of students in the area of dairy product 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 milk and the various products derived from milk.
- 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 PROCESSING OF MILK 9

Technology of milk and dairy products; Pasteurisation sterilization, HTST and UHT processes.

UNIT II MILK PRODUCTS 9

Manufacture of condensed milk, milk powder, cheese, ice-cream, butter, ghee, malted products, evaporated and dried products.

UNIT III MILK SUBSTITUTES 9

Substitutes for milk and milk products. Casein , lactose and other by-products.

UNIT IV TECHNOLOGY OF BABY FOODS 9

Weaning foods, therapeutic foods. Fortification and enrichment. Traditional dairy products. Milk confections.

UNIT V QUALITY PARAMETERS**9**

Judging and grading of milk; National and international standards of milk and milk products, in plant sanitation and hygiene.

TOTAL : 45 PERIODS**TEXT BOOKS**

1. Eckles, C.H., W.B. Combs, and H. Macy " Milk and Milk Products". 4th Edition, Tata McGraw-Hill, 1973.
2. Andrews, A.T. and J. Varley "Biochemistry of Milk Products". Woodhead Publication, 2004.
3. Kapoor, Ajay. "Diary Science and Technology" Vishvabharti Publications, 2005.
4. Anantakrishnan, C.P., A.O. Khan, and P.N. Padmanabhan "Milk Products Preparation and Quality Control". Shri Lakshmi Publications, 1993.
5. Kapoor, Ajay "Milk and its Products". Vishvabharti Publications, 2005.
6. Atherton, Henry V. and J.A. Newlander "Chemistry & Testing of Dairy Products". 4th Edition, CBS Publishers, 1987.
7. Welch, R.A.S. et al., "Milk Composition Production and Biotechnology". CAB International, 1997.
8. Spreer, Edgar "Milk and Dairy Product Technology". Marcel Dekker, 2005.
9. Walstra, P. et al., "Diary Technology : Principles of Milk Properties and Processes". Marcel Dekker, 1999.

REFERENCES

1. Lampert, Lincoln M. "Modern Dairy Products: Composition, Food Value, Processing, Chemistry, Bacteriology, Testing, Imitation Dairy Products". Chemical Publishing Company, 1998.
2. Selia, Jane dos Reis Coimbra and Jose A. Teixeira "Engineering Aspects of Milk and Dairy Products". Jane Selia dos Reis Coimbra & Jose A. Teixeira, CRC Press, 2009.

IB3010**PROTEIN ENGINEERING****L T P C
3 0 0 3****UNIT I BONDS AND ENERGIES IN PROTEIN MAKEUP****5**

Covalent, Ionic, Hydrogen, Coordinate, hydrophobic and Vander walls interactions in protein structure. Interaction with electromagnetic radiation (radio, micro, infrared, visible, ultraviolet, X-ray) and elucidation of protein structure.

UNIT II AMINO ACIDS AND THEIR CHARACTERISTICS**5**

Amino acids (the students should be thorough with three and single letter codes) and their molecular properties (size, solubility, charge, pKa), Chemical reactivity in relation to post-translational modification (involving amino, carboxyl, hydroxyl, thiol, imidazole groups) and peptide synthesis.

UNIT III PROTEIN ARCHITECTURE**12**

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

UNIT IV STRUCTURE-FUNCTION RELATIONSHIP 15

DNA-binding proteins: prokaryotic transcription factors, Helix-turn-Helix motif in DNA binding, Trp repressor, Eucaryotic transcription factors, Zn fingers, helix-turn helix motifs in homeodomain, Leucine zippers, Membrane proteins: General characteristics, Transmembrane segments, prediction, bacteriorhodopsin and Photosynthetic reaction center, Immunoglobulins: IgG Light chain and heavy chain architecture, abzymes and Enzymes: Serine proteases, understanding catalytic design by engineering trypsin, chymotrypsin and elastase, substrate-assisted catalysis other commercial applications.

UNIT V PROTEIN ENGINEERING 8

Advantages and purpose, overview of methods, underlying principles with specific examples: thermal stability T4-lysozyme, recombinant insulin to reduce aggregation and inactivation, *de novo* protein design.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Voet, D. and Voet, G., "Biochemistry". 3rd Edition, John Wiley and Sons, 2001.
2. Branden C. and Tooze J., "Introduction to Protein Structure", 2nd Edition, Garland Publishing, 1999.
3. Creighton, T.E. "Proteins : Structure and Molecular Properties", 2nd Edition, W.H. Freeman, 1993.

REFERENCES

1. Whitford, David "Proteins : Structure and Function". John Wiley & Sons, 2005.
2. Holland, I Barry & etal., "ABC Proteins : From Bacteria to Man". Academic Press Elsevier, 2003.
3. Alberghina, L. "Protein Engineering in Industrial Biotechnology". Harwood Academic Publications, 2000.
4. Moody P.C.E. and Wilkinson A.J. "Protein Engineering". IRL Press, Oxford, 1990.
5. Rees, A.R., Sternberg, M.J.E. and Wetzel, R. "Protein Engineering : A Practical Approach". IRL Press, 1992.

**FT 3011 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.

FT 3012**OPERATION RESEARCH****L T P C
3 0 0 3****UNIT I****9**

Concept and Scope of Operation Research (OR) – Development of OR - Phases of OR – Models in OR. Linear Programming: Methods of solution – Graphical and SIMPLEX methods of solution – VARIATIONS – Duality in LP – Revised SIMPLEX method – Application for business and Industrial Problems.

UNIT II**9**

Integer programming: Formulation – Graphical Representation – Gomory's Cutting Plane Method. Transportation and Assignment Problems: Initial solution – Methods of improving the initial solution – travelling salesman Problem. Dynamic Programming – Principle of Optimality

UNIT III**9**

Sequencing and Scheduling Problems: Job sequencing – Jobs through Two Machines, Two Jobs through Machines and n Jobs through Machines. PERT and CFM techniques – Critical Path – Normal and crash time. Resource allocation – Resource Leveling and Smoothing

UNIT IV**9**

Inventory Problems: Deterministic model –Costs – Decision Variables – Economic order Quantity – Instantaneous and Non – Instantaneous receipt of goods with and without Shortage – Quantity Discount – Probabilistic inventory Model – Inventory systems– Safety Stock – Reorder Level (ROL) Reorder Point (ROP) determination.

UNIT V**9**

Maintenance and Replacement Problems: Models for routine maintenance and preventive maintenance decisions – Replacement models that deteriorate with time and those that fail completely. (srp/rm/vec)

TOTAL : 45 PERIODS**TEXT BOOKS**

1. Sharma, S.D. "Operation Research" Kedarnath Ramnath & Co.
2. Gillet, Billy E. "Introduction to Operation Research", TMH Publishing Co.,
3. Gupta, P.K. and Manomohan "Operation Research and Quantitative Analysis", S.Chand & Co.,

REFERENCE

1. Hambleis, S. and Stevens "Operation Research" McGraw – Hill, Taha, H.A. "Operation Research", Macmillian.

IB3014

DOWNSTREAM PROCESSING

L T P C
3 0 0 3

UNIT I DOWNSTREAM PROCESSING 10

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

UNIT II PHYSICAL METHODS OF SEPERATION 6

Unit operations for solid-liquid separation - filtration and centrifugation.

UNIT III ISOLATION OF PRODUCTS 12

Adsorption, liquid-liquid extraction, aqueous two-phase extraction, membrane separation – ultrafiltration and reverse osmosis, dialysis, precipitation of proteins by different methods.

UNIT IV PRODUCT PURIFICATION 12

Chromatography – principles, instruments and practice, adsorption, reverse phase, ion-exchange, size exclusion, hydrophobic interaction, bioaffinity and pseudo affinity chromatographic techniques.

UNIT V FINAL PRODUCT FORMULATION AND FINISHING OPERATIONS 5

Crystallization, drying and lyophilization in final product formulation.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Belter, P.A., Clussler, E.L. "Bioseparation – Downstream Processing & Biotechnology". John – Wiley Interscience, 1998.
2. Asenjo, Juan A. "Separation Processes in Biotechnology". Taylor & Francis / CRC, 1990.
3. Scopes, R.K. "Protein Purification : Principles and Practice". Narosa Publication, 1994.

REFERENCES

1. Ghosh, Raja "Principles of Bioseparations Engineering". World Scientific, 2006.
2. "Product Recovery in Bioprocess Technology". (BIOTOL – Biotechnology by Open Learning Series). Butterworth – Heinmann / Elsevier, 2004.

FT 3014

GENETICALLY MODIFIED FOODS

L T P C
3 0 0 3

UNIT I GENETIC ENGINEERING AND FOODS I 9

Genetically engineered proteins, Bovine Somatotropin in Milk ;Genetically engineered bacteria, Chymosin Lite beer; Tryptophan ,Transgenic plants , Calgene Flavr Savr™ tomato; Methionine-enriched oil ,

UNIT II GENETIC ENGINEERING AND FOODS II 9

Frost-resistance Drought and Salinity resistance , Herbicide Resistance , Monsanto Round-Up™ Ready ,Ciba Geigy Basta™ resistant crops Insect Resistance :*Bacillus thuringiensis* toxin ,Ciba Geigy, B.t. maize ,Monsanto Golden Harvest Seeds ,Fungal Resistance Bintje potatoes ,Virus Resistance

UNIT III PLANT PHARMACEUTICALS 9

Beta -carotene in rice ,transgenic "heart-healthy" canola oil; Edible vaccines ,Hepatitis B vaccine in maize ,Cholera vaccine in potatoes

UNIT IV TRANSGENIC ANIMALS 9
 Growth hormone gene in pigs, alpha-lactalbumin and lactoferrin in milk ,Transgenic Fish ,Atlantic salmon

UNIT V ANIMAL CLONING 9
 Biotechnology ; Benefits, Risks and Public Perceptions; The Environment, The Third World ,The Western World, Europe's Mistrust

TOTAL : 45 PERIODS

TEXT BOOKS

- Ahmed, Farid E. "Testing of Genetically Modified Organisms in Foods". Haworth Press, 2004.
- Rees, Andy "Genetically Modified Food : A Short Guide for the Confused". Pluto Press, 2006.
- Halford, Nigel G. "Genetically Modified Crops". Imperial College Press, 2003.

GE3015 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 DEVELOPMENT 9

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

UNIT IV NEW PRODUCT PLANNING 9

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

UNIT V MODEL PREPARATION & EVALUATION 9

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

TOTAL: 45 PERIODS

TEXT BOOKS

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

REFERENCES

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