First Year-First Semester:

FTBE/Phy/T/111 PHYSICS I

Scalar and vector fields, Gradient of a scalar field, Physical interpretation of gradient,Divergence and curl of a vector field, Conservative vector fields and their potential functions – gravitational and electrostatic examples.

Simple harmonic motion, free vibration, damped and forced vibration, resonance.Wave motion, Superposition principle, phase velocity and group velocity.

Motion of fluid, Bernoulli's theorem, Poiseuille's equation for the flow of liquid through a narrow tube, Motion of a body through a viscous medium: Stokes' law.

Overview of Coulomb's law, Gauss's law, dielectric polarization, Displacement vector, Overview of Biot Savart law and Ampere's Circuital law.

Macroscopic and microscopic description, Thermal equilibrium, Zeroth law of thermodynamics, Heat and Work, First law of thermodynamics and some applications, Reversible and irreversible processes, Carnot cycle, Second law of Thermodynamics, Concept of entropy.

Interference of light waves, Young's experiment, Spatial and temporal coherence, Interference in thin film, Newton's rings, Diffraction of light waves, Fraunhoffer diffraction due to single slit and plane diffraction grating, Polarization of light waves, Polarization by reflection, Brewster's law.

Assumption for the kinetic theory of gases, Expression for pressure, significance of temperature, Deduction of gas laws, Qualitative idea of (i) Maxwell's velocity distribution. (ii) degrees of freedom and equipartition of energy, Specific heat of gases at constant volume and constant pressure.

Equation of state of a gas, Andrews's experiment, Qualitative discussion on van der Waal's equation of state, Critical constants, Law of corresponding states.

FTBE/Chem/T/112 INORGANIC AND ANALYTICAL CHMISTRY

Chemical Bonding: Ionic bonding, Born-Haber Cycle and its application, Born-Lande equation-deviation and application in determining the lattice energy of ionic solids. Covalent Bonding, VSEPR theory, Valence bond approach. Bent's rule, Fajan's rule, percentage of ionic character in covalent compounds, dipole moment and structure of simple inorganic molecules. Hydrogen bond and its application in biomolecules. Molecular orbital theory applied in simple diatomic molecules.

Acids and bases: Different theories of acids and bases. HSAB theory

Coordination Chemistry: Basic principles, different types of ligands, theories of bonding in coordination chemistry (excluding MO theory), coordination polymer, coordination chemistry in biology, hemoglobin, Vitamin – B_{12}, ATP hydrolysis and Na/K ion pump, Chlorophyll and photosynthesis (elementary idea), Type I, II and III copper proteins, Blue copper proteins.

Inorganic Toxicology: Role of different metal ions in biological systems. Toxicity of arsenic, Lead and mercury, Thalasemia and Wilson's disease – chemical remedy in each case.

Preparation, properties and uses of the following useful materials: Bleaching powder, Halogen tablets, Permanganate.

FTBE/Chem/T/113 PHYSICAL CHEMISTRY

Gases, Kinetic Theories, Van-der-walls equation of state, liquid states, continuity of state, critical state, liquefaction of gases, vapour pressure, surface tension, vioscous properties. 1st Law and 2nd Law of thermodynamics, Carnot principle, entropy, thermodynamic potentials, free enegy, equilibrium chemical potential. Gibbs-Helmoltz Equation, Gibbs-Duhem equation, Duhem-Merguel's equation, Clausius –Clapyron Equation , ideal and non-ideal solutions, dilute solution an their colligative properties , osmotic pressure and Van't Hoff's equation. Solid State: types of crystal, isomorphism, Miller index , unit cell, lattice energy and Sp. Heat. Colloids: their nature, classification and preparation.

FTBE/Math/T/114 MATHEMATICS-I
Two dimensional coordinates-Cartesian and polar. Area of triangles. Equation of Straight Lines . Transformation of rectangular axis. Circle, parabola, ellipse and hyperbola. Tangent and Normal. Cartesian Coordinates in space-direction cosine-distance between two points. Equations of planes and straight lines. Elementary idea of Spheres, Cylinders, Ellipsoids, hyperboloids, paraboloids, cones and Surfaces of revolution. Differential Calculus: Geometrical interpretation of the derivatives and application in tangent, normal, sub tangent abnormal, maxima-minima, rates.

FTBE/Hu/T/115 HUMANITIES

English component

Basic writing skills: based on Sections 1 and 2 of *English for All* = 8 classes (4 weeks).
Communication skills:
Report writing ,Précis writing ,CVs and resumes ,Reading scientific papers: Scholarly conventions
Two prose extracts from *English for All* (may be changed from time to time: proposal for this year, JBS Haldane, "Scientific Research for Amateurs" and Rabindranath Tagore "The Religion of the Forest")
One short story from *English for All* (may be changed from time to time: proposal for this year, James Thurber, "The Secret Life of Walter Mitty")

Group presentations in class to be encouraged.

Society, Culture and Technology

Understanding technology historically:
Emergence and growth of technology in response to collective needs;Commodity production and expansion of trade; economic imperatives for technological advancement; Technology and work: Technology and industrial production: fordism and post-fordism; Division of labour and social identities: race, ethnicity, gender.

Technology, cultural globalization and global consumerism: Computer, Media and Culture; Information and Communication Technology. Role of communication technology: five components of communication, pyramid of communication; Global television and American cultural imperialism; Internet and Community: Understanding of Community in the Information Age; The virtual individual and the virtual social Power and cyberspace; The Ecology Approach: The natural world and the built environment; nature, man and science; eco-systems and ecofeminism. Technology and sustainable development; The gender question: Sex and gender; science and technology; the malestream; Women and technology. Domestic technology: persistence of gender roles

Books Recommended :

Agarwal, Bina, The Gender and Environment Debate: Lessons from India, *Feminist Studies,*Vol 18, No. 1, 1992.

Bauman, Zigmunt and Tim May: *Thinking Sociologically*, Second Edition, Blackwell Publishing 2001. Chap. 9: The business in everyday life: consumption, technology and lifestyles'.

Cat Cox, Eco-Feminism in Gill Kirkup and Laurie Smith Keller, *Inventing Women: Science, Technology and Gender*, Polity Press, 1992.

Giddens, A, *Sociology* 4th edition, Polity Press 2001, chap 13.

Gorman, Lyn and David McLean, *Media and Society in to the 21st Century: A historical introduction*, Second Edition, 2009; Wiley-Blackwell, p. 155-162.

Jones, Steven G (ed.), *Cyber Society- Revisiting Computer-mediated Communication and Community*, Sage, 1998. Ch. 1, Information, Internet and Community: Notes Toward an Understanding of Community in the Information Age; Ch 7, Revisiting Computer- mediated Communication and Community, Ch. 8, Dissolution and Fragmentation, Problems in on-line Communities.

Jordan, Tim, *Cyber power: The Culture and Politics of Cyberspace and the Internet*, Routledge 1999, Chs. 1, 3, 4 and 5.

Mayer, Paul A (ed.) Computer Media and Communication: a reader. Oxford University Press, 1999. Pp. 141-148, pp. 153-158.

Vilanilam, J V, *Mass Communication in India: a sociological perspective*, Sage Publications, 2005.

FTBE/Phy/S/111 PHYSICS LABORATORY

Determination of Young's modulus by Flexure method; Determination of moment of inertia of a cylindrical body; To determine co-efficient of viscosity by Capillary flow method ; Determination of co-efficient of linear expansion by optical lever method; Determination of focal length of a concave lens by combination method. Determination of refractive index of the material of the glass prism by prism spectrometer;To find the wavelength of a monochromatic light by single slit; To find the wavelength of a monochromatic light by Newton rings; Determination of Galvanometer resistance by half - deflection method; Determination of Galvanometer resistance by Thomson's method; To find high resistance by Galvanometer deflection method. To measure mechanical equivalent of heat, J by electrical method (Joule's) using copper calorimeter (radiation correction to be done);To compare two low resistances by drop of potential method; To determine resistance per unit length of a wire by using Carey Foster bridge; To estimate strength of current by using copper voltmeter a) To compare the EMF's of two cells by using a potentiometer , b) To measure current by using a

potentiometer; To measure the horizontal component of earth's magnetic field using deflection and vibrating magnetometers.

FTBE/ME/S/112 WORKSHOP PRACTICE I

Forging: Introduction to forging tools, furnaces and forging machines; to practice basic forging operations-drawing out, upsetting, necking etc.; introduction to forge welding. Introduction to moulding practice-preparation of moulding sand and use of moulder's tools; making of moulds by using selected pattern's; introduction to melting and pouring practice; experiments sand testing like permeability, moisture content, shutter index, mould strength, grain fineness number etc.; demonstration of injection moulding machine. Sheet metal works and welding.

FTBE/ME/S/113 ENGINEERING DRAWING I

Conversions of drawing (ISI) , Drawing primitives: instruments, letters, lines, title block, geometric curves & shapes, scale and dimension. Projections: orthographic and isometric, sectional views. Drawing of bolts, nuts, studs, keys etc.

First Year-Second Semester:

FTBE/T/121 MICROBIOLOGY I

The importance of microbes in food and fermentation industries. The microscope Morphology, growth condition and reproduction of bacteria, yeasts and moulds. Bacterial growth and its estimation. Dyes and staining techniques. Nutrition of bacteria. Techniques of pure culture. Thermal death point. Preservation of microbial culture. Bacterial genetics. Bacterial viruses. Microbial respiration. Disinfection and disinfectants. Pasteurization, sterilization and arnoldization. Energy metabolism of microbes. Nitrogen fixation. Preservation of pure culture.

FTBE/T/122 BIOCHEMISTRY & NUTRITION I

Introduction to biochemistry – definition, objectives and scope; acids, bases and buffers; overview of chemistry of carbohydrates, proteins and lipids; overview of isolation and purification of proteins (chromatographic separations, isoelectric focussing, gel electrophoresis/SDS-PAGE, ELISA), uultracentrifugation molecular weight of protein;; denaturation and renaturation of proteins; biological membranes, membrane proteins, passive and active transport.

Overview of dietary metabolism, biological oxidation, bioenergetics, electron transport chain, oxidative and substrate level phosphorylations, metalobomics, oxidative stress and antioxidants.

Ccarbohydrate, it's metabolism and regulation: definition and classification; metabolic pathways for breakdown of carbohydrates – glycolysis – aerobic and anaerobic, anaerobic fate of pyruvate; metabolism of hexoses other than glucose by feeder pathways; pentose phosphate pathway, Citric acid cycle, Cori cycle, glycogen metabolism, gluconeogenesis; regulation of blood glucose concentration, energy balances.
Lipid, it's metabolism and regulation: Definition, classification, structures, physical and chemical properties of lipids and fatty acids, pathways for breakdown (oxidation pathways of even, odd chains and unsaturated fatty acids) and biosynthesis of fatty acids and lipids, ketone bodies; lipoproteins, digestion and absorption of lipids, fatty liver, lipotropic agents, energy balances.

Protein, it's metabolism and regulation: definitions, classification, essential and non-essential amino-acids, structures and properties; peptides – peptide bonds and some important peptides; classification and structures of proteins (primary, secondary, tertiary and quaternary); amino acid deamination, transamination, urea cycle, digestion and absorption of proteins, nitrogen pool, evaluation of protein quality, amino-acids as biosynthetic precursors, protein biosynthesis .Brief introduction to nucleic acids –structures of DNA and RNA, replication, transcription and translation.

FTBE/T/123 CHEMICAL ENGG. FUNDAMENTALS

Units and Dimensions. Unit conversions.
Stoichiometric and composition relationship: gas laws; Gaseous mixtures, vapour pressure, humidity, etc.

Material Balances for non-reacting systems: degree of freedom analysis for simple unit, multiple units with recycle and bypass.
Material Balances for reacting systems: Degree of freedom analysis with single chemical reactions, multiple chemical reactions.
Energy balance: Review: Thermophysics: Thermo Chemistry law, Law of Hess, Standard Heat of Reaction, Combustion, & Formation.
Heat Balance for non-reacting processes and reacting processes. Theoretical flame temperature. Adiabatic reactions temperature, flame temperature, combustions calculations.

Books Recommended :

1	Toledo, R.T.	:	Elements of Food Engineering
2	Himmelblau, D.M.	:	Basic Principles and Calculations in Chemical Engineering: Prentice Hall (1997)
3	Folder, R.m., Roussenu R.W.	:	Elementary Principles of Chemical Process, John Willey & Sons.
4	Reklaitis, G.V.	:	Introduction to Material and energy Balances, John Willey (1983)
5.	Thompson and Krekler	:	Introduction to chemical Engineering
6.	Ghosal Dutta Sanyal	:	Introductionn to chemical Engineering

FTBE/Phy/T/124 PHYSICS II

Wave particle duality, de Broglie waves and uncertainty principle, Concept of wave function and its physical interpretation. normalization, 1-D Schrödinger equation –1-D (infinite) potential well. Time dependent Schrodinger equation for a free particle, stationary states. Postulates of quantum mechanics, expectation values of physical observables, energy eigen values and eigen functions for particle in a box, Square well potential, reflection and transmission coefficient in potential barriers. Statistical description of a system of particles, Phase space, Microstates and macrostates, Boltzmann's formula for the entropy, Boltzmann distribution function (derivation not reqd.) Classical ideal gas, Equipartition theorem and its applications. Time-varying field, Faraday's law of electromagnetic induction, Transient phenomena in electric circuits (series L-R, series C-R), Electrical oscillations in L-C circuit. Alternating voltage applied to series L-C-R circuit and the idea of electrical resonance.Generalization of Ampere's circuital law, Maxwell's equations, Poynting theorem,Poynting vector. Maxwell's wave equation in free space and its solution.

FTBE/Chem/T/125 ORGANIC CHEMISTRY

Valency of carbon and tetrahedral model, Chain and ring structures. Double and triple bonds. Purification of organic compounds: solids and liquids. Determination of molecular weights of organic compounds by chemical methods. Classification of organic compounds. Study of aliphatic compounds: saturated hydrocarbons, unsaturated hydrocarbons. Halogen derivatives of hydrocarbon. Monohydric and polyhydric saturated and unsaturated alcohols, Ethers, aldehydes and ketones. Monobasic and poly basic saturated and unsaturated fatty acids. Acid chlorides, anhydrides, amides. Di-esters of organic and inorganic acids. Sulphonic acids and sulphonates. Amines, nitriles. Oragnometallic compounds, Grignard reagent. Carbohydrates. Hydroxy fatty acids and compounds related to them. Amino acids, dialdehydes, diketones, aldehydic and ketonic acids. Stereoisomerism

FTBE/EE/T/126 FUNDAMENTALS OF ELECTRICAL ENGINEERING

DC Circuits: Kirchhoff's Laws. Maxwell's Loop Current Methods of Analysis. Star-Delta Conversion. Superposition Theorem. Thevenin's Theorem. Maximum Power Transfer.
Magnetic Circuit: MMF, Flux ,Reluctance. B-H Loop. Hysteresis and Eddy current loss. Magnetic circuit analysis with air gap. AC 1 -phase: Periodic Waves and Sinusoids. Average and RMS Values, Form Factor, Peak. Factor. Phasor concept of Sinusoids. Impedance and Admittance. Power, Power Factor, V A, V AR. Series R-L-C Circuit ,Parallel R-L-C circuit. Resonance. Balanced 3-phase: 3-phase AC balanced circuits. Phase-sequence. Star and Delta connections. Power, V A, V AR, Power Factor _or balanced 3-phase circuits. Power Measurement: Wattmeter circuit connection. Power Measurement by two wattmeter methods in 3phase system. DC Machines: Construction and general priciple of operation. Generator EMF Equation. Field connection ,shunt series and compound. Generator characteristics. Motor-equation and general operation. starting and speed control, torque -speed curve. 1-PhaseTransformer: Construction. EMF equation. Phasor diagram. Equivalent circuits. Losses and Efficiency. Open circuit and Short circuit test. 3-Phase Induction Machine: Types of induction machines. Rotating magnetic field, slip ,torque equation, torque speed curve.DOL starting and reduced voltage starting. 3-Phase Synchronous Machines: Alternator, constructional features, EMF equation, synchronous reactance, power -angle characteristics. Concept of synchronous motor. Meters: DC and AC Ammeters and Voltmeters. Megger. Multiplier.

Recommended Books :

1. Electrical Science by Prof. S. Chowdhury, Prof. R. Chakraborty & Prof. P. K. Chatterjee.
2. Electrical Machines by Prof. P.K. Mukherjee & Prof. S. Chakravorti.

FTBE/ME/S/121 ENGINEERING DRAWING II

Dimensions. Development of sectional views from isometric views of single machine parts.Development of third view based on other two views. Pipe joints, expansion joints. Surface development problems e.g angle joints, tee joints etc. Sketching and drawing of simple machine parts e.g bench vice, plummer block, split pulley, piston and connecting rod of engine etc. Tracing and printing of drawing.

FTBE/ME/S/122 WORKSHOP PRACTICE II

Introduction to fitter's tools, gauges, measuring instruments etc.; marking of jobs; fitter's job involving chipping, filing, sawing, drilling; use of taps and dies; pipe fittings and plumbing. Introduction to machine tools - lathes, drilling machines, shaping machines, planning machines, slotting machines, milling machines,

grinding machines; machine shop work involving different operations by using the above mentioned machines through making of jobs.

FTBE/Chem/S/123 ORGANIC CHEMISTRY LABORATORY

Elemental analysis, Functional group analysis. Estimation of formaldehyde, acetone. Preparation of aspirin (acetylation), Aniline (reduction), ethyl acetate (esterification).

Second Year-First Semester:

FTBE/T/211 FLUID FLOW

Fluid Statics: Normal forces in fluids, Pressure Measurements, Forces on Submerged bodies, Buoyancy and Stability.
Fluid properties: Newtonian and non-Newtonian Fluids, Introduction to rheology of food materials. Nature of Turbulence, Eddy Viscosity, Flow in Boundary Layers, Basic Equation of Fluid Flow. Bernoulli's Equation.
Navier stokes equations: Applications of Dimensional analysis to Fluid Flow. Problems
Flow of Incompressible Fluids: Laminar and Turbulent flow in pipes, Velocity Distribution in Pipes, Frictional losses in Pipes and Fittings, Fanning equation, Estimation of economic pipe diameter.
Flow of compressible fluids : Compressible Flow and Flow through nozzles.
Flow Measurements: Manometer*,* Pitot tube, Orifice, Venturi, Rotameter and Notches, wet gas meter etc.
Fluid Machinery: Classification and Performance of Pumps, Compressors, and Blowers, Selection and Specification ,

Books Recommended.

1	Mc Cabe, Warren L., Smith, Juluam C.	:	Unit Operations of Chemical Engineering, 5th edition, Mc Graw Hill
2	Foust, Alan S., Wenseli, Leonard A., Clump, Curtis W., Maus, Louis and Anersen, L	:	Principles of Unit Operations, John Wiley
3	Coulson, J.M. and Richardson, J.F.	:	Chemical Engineering, Vol. I, Pergamon
4	Badger, Walter L. and Banchero, Julius T.	:	Introduction to Chemical Engineering, Mc Graw – Hill Kogakusha Ltd., New Delhi
5	Fox, R.W. and mc Donald A.T.	:	Introduction to Fluid Mechanics (SI Version) 4th Ed. John Wiley and Sons. 1996
6	Chattopadhyay, P.	:	Unit Opeations of Chemical Engineering, Vol.I, Khanna Publishers, New Delhi.

FTBE/T/212 BIOCHEMISTRY & NUTRITION II

Enzymes and nucleic acids: introduction, classification, nomenclature, structures and functions of co-enzymes and co-factors, active site, mechanisms of enzyme action, factors affecting enzyme activity, specificity of enzymes, kinetics of enzyme action, enzyme inhibition, regulatory enzymes, isozymes, modulators of enzymes, nature and function of enzymes involved in digestion;

Vitamins and minerals: occurrence, chemistry, structures, functions, deficiency diseases, role in metabolism and daily requirements of vitamin A, D, E, K, C, B_1, B_2, niacin, pyridoxine, cyanacobalamin, folic acid, choline, *p*-aminobenzoic acid, minerals and structural and functional constituents in human metabolism, specific role of iron, calcium, phosphorus, iodine, sodium, chlorine, potassium, copper and magnesium.

Introduction to human nutrition-:definitions of food, nutrition and health and interrelationship between them, functions of food, nutritional aspects of carbohydrates (including glycemic index and load), proteins and fats, concept of a balanced diet and principles of meal planning, overview of human dietary requirements (RDA), factors affecting bioavailability of nutrients, concepts of enrichments, fortification and supplementation, best cooking procedures to minimize cooking losses, nutritional status of Indian populations, problems of under and over nutrition, pediatric and geriatric foods, concept of nutraceuticals, emerging common degenerative disorders related to nutrition.

Recommended Books

1. Lehninger : Biochemistry
2. Stryer : Biochemistry
3. Conn and Stumpf, John Wiley & Sons, New York, 1995. : Outlines of Biochemistry
4. G.L. Zuleay, W.C. Brown Publishers, Boston, 1998. : Biochemistry
5. Swaminathan : Nutrition
6. Gopalan, Rama Sastri & Balasubramanium : Nutritive Value of Indian Foods

FTBE/T/213 PRINCIPLES OF FOOD PRESERVATION

Preservation by removal of heat- freezing process, rate of freezing, effects of freezing of foods, preliminary introduction to freezers and cold storage, dehydrofreezing, glass transition temperature, cryopreservation and cryoprotectants, lyophilization, antifreeze proteins, frozen storage and thawing of foods.

Preservation by addition of heat- basic concepts of thermal destruction of microorganisms – D, Z and F values, assessment of adequacy of thermal processing of foods, canning and retorting of foods –construction of sanitary tin cans and retort pouches, testing of cans, can lacquers and can sealing compounds, spoilage of canned foods, cooking, blanching, pasteurization, sterilization of foods, extrusion, baking, roasting, frying, dielectric, ohmic, microwave, pulsed electric field, infrared heating and extrusion cooking.

Preservation by removal of water- water activity and its effect on keeping quality of foods, sorption isotherms and their use, effect of dehydration on foods, dying techniques, factors affecting rate of drying, preliminary introduction to types of dryers and their suitability to different foods, intermediate moisture foods.

Preservation by irradiation – sources of radiations, units and doses, effect on microorganisms and different nutrients, dose requirements, safe limits at regulatory issues, irradiation mechanism and survival curve of microorganism post irradiation.

Other methods of preservation- curing, pickling, smoking, fermentation, addition of chemical preservatives, high pressure processing, hurdle technology.

Books Recommended :
1 Potter, N.N. : Food Science

2	Desrosier and Desrosier	:	Technology of Food Preservation
3	Frazier	:	Food Microbiology
4.	A Crues	:	Food Preservation Technology

FTBE/ME/T/214 BASICS OF MECHANISMS

Introduction: Mechanism and machine, pairs of element, linkages, degrees of freedom. Velocity and acceleration analyses of simple mechanisms. Power transmission devices: belt & pulley, gear, cam & cam follower, clutch, brake.

FTBE/ME/T/215 MECHANICS OF SOLID

Fundamentals of Vector algebra and application in statics. Newton's law of motion, concept of free body diagram . Strength of material, equilibrium problems of rigid bodies. Bending moment and shear force diagram. Stress-strain and Hook's law. Torsion of circular shafts, stresses and deflection of beam, stability of columns. Euler's formula. Stresses in thin pressure vessel.

FTBE/Math/T/216 MATHEMATICS II

Successive differentiation, partial differentiation, Euler's theorem, Rolle's theorem, mean value theorem, Tyalor's and Maclaurin's Expressions. Curvature, radius and centre of curvature . De Moiver's theorem. Exponential value of Sin and Cos. Gregory's series. Heyperbolic functions, Fourier's series and application, Maxima and minima. Lagrange's method of undetermined multipliers. Linear partial differential equations with constant coefficients. Solution of one dimensional wave and diffusion equations and two dimensional Laplace equation and Polsson's equation and applications. Series solution of ordinary linear differential equation. Bessel functions. Recurrence relations. Legendre polynomials. Recurrence relations and orthogonal property.

FTBE/S/211 MICROBIOLOGY LABORATORY

General procedure for asceptic work. Study of microscope. Preparation of media for bacteria, yeasts and moulds. Morphology of bacteria, yeasts and moulds. Gram staining of bacteria. Observation of shape, size of bacteria. Motility of bacteria. Spore staining of bacteria (observation of spore in bacteria). Techniques of pure culture (pour plate and streak plate method). Bacterial count in a food sample. Determination of thermal death point of bacteria. Determination of thermal death point. Methylene blue test for milk. Respiration of bacteria. Bacteriological examination of water and milk. Growth curve of bacteria.

FTBE/Chem/S/212 INORGANIC CHEMISTRY LABORATORY

Qualitative analysis of Inorganic Salts (acid and basic radicals); Weighing, preparation of standard solutions, standardization of secondary standard solutions; Acidimetry-Alkalimetry titration: Estimation of carbonate-bicarbonate mixture; Redox titration: Estimation of Fe^{2+} , Fe^{3+} and total iron; Complexometric titration: Estimation of Pb, Hg by EDTA titration; determination of hardness of water; Estimation of alkali content in Antacid

Second Year-Second Semester:

FTBE/T/221 CHEMISTRY OF FOOD

Definition of food, proximate composition of foods.

Water in foods - definition of water in foods, interaction of water with solutes; sorption phenomenon; types of water; water activity.

Carbohydrates- definition, & structure of starch, glycogen, cellulose, hemi-cellulose, lignins, crude fiber , pectins, gums and mucilages; chemical reactions of carbohydrates; effect of processing and storage on carbohydrates.

Fats and Oils : Effect of processing and storage on fats and oils (oxidative and hydrolytic rancidity), fat micelles, soap and detergency , essential fatty acids, saponification number, acid number, iodine value, acetyl value, Reichert-Meissl number and Polenski value.Smoke, fire, flash point of oils, cis-trans isomerism and enzymatic conversions of fatty acids.

Amino-acids and proteins –physical and chemical properties of proteins; nutritive value of proteins- amino-acid chemical score, BV, PER; important food proteins; changes of proteins on processing and storage with special emphasis on enzymatic and non-enzymatic browning such as Maillard reactions and Strecker degradation. Functional properties of proteins (hydration, solubility, ionic charges, viscosity and diffusivity in solutions.

Vitamins and minerals- loss during storage, transport and food processing of provitamins A & D and vitamins A, D, E, K, C, B, H niacin, pyridoxin, cyanocobalamine, folic acids, p-aminobenzoic acid, biotin and choline; occurrence and functions of minerals.

Natural pigments and Flavors- chlorophyll, carotenoids, anthocyanins, anthoxanthins, flavonoids, tannins; natural flavor constituents; Food flavors- types of flavors, flavors generated during processing – reaction flavors, flavor composites, stability of flavors during food processing, analysis of flavors, extraction techniques of flavor, flavor emulsions, encapsulation of flavors, authentication of flavors.

Recommended Books.
1   Food Chemistry: L.H. Meyer, C.B.S. Publishers, Delhi, 1987.
2   Food chemistry: Fenamma
3   Food Chemistry: De Man

FTBE/T/222 HEAT TRANSFER

*Conduction: G*eneral conduction equation, Steady state conduction in one dimensional system, effect of variable thermal conductivity, steady state conduction involving internal heat generation, lagging on pipes, the critical thickness of insulation on pipes, extended surfaces of uniform thickness and E-section fin effectiveness, fin efficiency.

Convection: Free and forced convection, concept of heat ransfer co-efficient, dimensionless numbers in free and forced convection, Dimensionless analysis, Detremination of Heat transfer coefficient using heat and momentum transfer analogies, experimental determination of heat transfer coefficient and common working correlations.

Condensation and Boiling: Condensation heat transfer phenomenon, film condensation on vertical plates and cylinders as well as on horizontal cylinders. Effects of noncondensable gases and vapour velocity on condensation, pool boiling, working correlation's for pool boiling.

Evaporation: Types of Evaporators, single and multiple effects, single and multiple effects calculations, evaporator capacity, economy, effect of liquid head and boiling – point elevation, methods of feeding.

Heat Exchangers : Various types of heat exchangers, overall heat transfer coefficients, heat exchanger mean temperature differences, heat exchanger effectiveness and the number of transfer units.

Radiation Heat Transfer : Black Body radiation, and grey body radiation, physical mechanism, radiation properties and shape factor, heat exchange between non-black bodies, radiation shields pyrometry and effect of radiation on temperature measurement.

Books Recommended.

1	Mc Cabe, W.L., Smith, J.C.	:	Unit Operations of Chemical Engineering Mc Graw Hill .
2	Holman, J.P.	:	Heat Transfer, Mc Graw Hill Book Co.
3	Mc Adams, W.H.	:	Heat Transmission, Mc Graw Hill Book Co.
4	Chapmann, A.J.	:	Heat Transfer, Mc Millan Publishing Co.
5	Kern, D.Q.	:	Process heat Transfer, Mc Graw Hill Book Co.
6	Kreith, F.	:	Principles of Heat Transfer, Harper & Row Pub., London.

FTBE/T/223 MICROBIOLOGY II

Development of microorganisms in food. Taxonomy, differentiation and classification of bacteria. Role and significance of microorganisms in foods. Intrinsic and extrinsic parameters of foods that affect microbial growth. Microorganisms important in food microbiology. General principles underlying spoilage and chemical changes of foods caused by microorganisms. Contamination and preservations of food. Microbiology of air water, milk and milk products. Food borne infection and intoxication. Food sanitation and hygiene. control and inspection. Fermented foods, Determination of the presence of microorganisms in foods and food products by different techniques(Contamination, preservation and spoilage of different kinds of foods viz. fruits and vegetables, fish, meat, egg and their products.)

Books Recommended:

1	Prescott, Herley, Klein (2nd ed.)	:	Microbiology
2	Stain	:	General Microbiology
3	Salley	:	Bacteriology
4	Prescott & Dunn	:	Industrial Microbiology
5	Casida	:	Industrial Microbiology
6	Pelczar et al	:	Microbiology
7	Frazier	:	Food Microbiology
8.	J Jay	:	Food Microbiology

FTBE/Math/T/224 MATHEMATICS III

Integration by resolution into partial fractions. Definite integral as limit of sum. Volumes and surfaces of solids of revolution. Mean values, root mean square values, multiple integral in calculation of volume and areas.Numerical methods: graphical solution of non-linear equation, Newton's method of approximation of real roots, Simpson's rule , Trapezoidal rule. Statistical Methods: frequency distribution , mean variance, SD, symmetrical and non-symmetrical distribution, skewness, Least square principle, B'alembert's principle.Determinant and matrices. Addition and substraction of vectors. Componenets of vectors. Scalar and vesctor products. Scalar triple product and vector triple products.

FTBE/ET/T/225 ELEMETERY ELECTRONICS

Energy band structure of metals, semi-conductors and insulators; Electron conduction in intrinsic and extrinsic semiconductors; P-Type and N-Type semiconductors; P-N junction; Metal-conductor junction
Junction diode, zenner and avalanche breakdown, rectifiers, filters and voltage regulators, BJT and its characteristics in CB and CE configurations; Bias stability, Low frequency, small signal analysis of BJT using simplified hybrid models; basic concepts of feedback amplifiers.
FET and MOSFET - Characteristics and applications
Digital System; Elements of Digital Circuits - AND, OR, NOT, NOR, NAND gates. Flip-flops (R-S, J-K, Master-Slave), ExOR, Half Adder & Full Adder.

FTBE/CSE/T/226 NUMERICAL METHODS & COMPUTER PROGRAMMING

Introduction to computer system. C Programming.
Numerical Methods : Approximations and errors. Solution of transcendental equations. Solution of linear system of equations. Interpolation. Curve fitting. Integration. Numerical solution of ordinary differential equations.

FTBE/S/221 CHEMISTRY OF FOOD LABORATORY

Determination of moisture and ash. Determination of fat and protein in food sample: Reducing and non reducing sugar in samples of foods. Estimation of iodine value, saponification value, acid value, peroxide number in food, sample. Estimation of phosphorous. Estimation of vitamins. Detection and estimation of metals in food sample. Detection of some adulterants in food. Crude fibre in food sample.

FTBE/ME/S/222 MACHINE DESIGN & DRAWING

Basic idea of design, factor of safety, modes of failure, theories of failure, design under static and fatigue loading. Design of Cotter/knuckle Joint, threaded and riveted joint, eccentric loading. Shaft coupling (rigid / flexible). Belt-pulley drive. Pressure vessel.

FTBE/CSE/S/223 COMPUTER APPLICATION & PROGRAMMING PRAC. LABORATORY

To supplement the theoretical course on "Numerical Methods & Computer Programming".

Third Year-First Semester:

FTBE/ T/311 CHEMICAL ENGINEERING THERMODYNAMICS

Basic Concepts: Concept of continuum, microscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilirium; state of a system, state diagram, path and process; different modes of work, laws of thermodynamics; concept of temperature; heat. Entropy concept, Entropy and lost work calculations. Microscopic interpretation of entropy.
Therodynamic Relations: Tds relations, Maxwell's equations, Clapeyron equation, Joule-Thomson coefficient, calculation of properties of simple compressible substances, compressibilities and expansion coefficient.
Phase equilibria: chemical potential, Gibbs free energy, Fugacity, activity and activity coefficient. Gibbs-Duham equation and its application to vapor-liquid equilibria.

Chemical equilibria: Adiabatic reactions, Gibbs phase rule. Estimation of thermodynamic properties from molecular structure.

Introduction toEngines : internal combustion engines, air standard cycles, Otto, Diesel and Joule cycle, power output and efficiency, principles of two and four - strokes spark ignition and expression ignition engines.

Compressed air and vacuum: Reciprocating air compressors. Vacuum Pumps. Air Receivers, Piping systems.

Steam: Boiles, Steam Handling and distribution Steam nozzles.
Refrigeration: Air refrigeration cycle. Vapour compression cycle, Liquification processes.

Power Generation: Internal Combustion engines. Gas turbines, steam power polants.

Books Recommended:

1.	Rogers, P. H. and Mawhew, H.	:	Engineering Thermodynamics, Work and Heat Transfer, Dongmons ELBS
2.	Nag, P.K.	:	Engineering Thermodynamics, Tata Mc-Graw Hill (1987).
3.	Eastop, T.D. and McConkey, A.	:	Applied Thermodynamics, III ed., Longmans.
4.	Wark, Kennith	:	Thermodynamics, McGraw Hill (1971).
5	Jouganson, R.	:	Fan Engineering, Buffalo Rorge Co., 1970.
6	Wangham, D.A.	:	Theory and Practice of Heat Engines, ELBS Cambridge University Press, 1960.
7	Lyle, O.	:	Efficient use of Steam, HMSO, 1963.
8	Stoccker, W.F.	:	Refrigeration and Air Conditioning, Mc-Graw Hill, 1950.

FTBE/T/312 FOOD PACKAGING TECHNOLOGY

Introduction to packaging components: types of packaging materials, manufacturing processes, and properties such as mechanical, optical and barrier properties like WVTR, GTR; test procedures for packaging materials; packaging requirements for different types of foods such as fruits, vegetables, meat, fish, edible oils, spices, bakery foods, confectionaries, snack foods, alcoholic and non-alcoholic carbonated beverages.
Primary packaging materials- paper, paper-based, plastic, aluminium foil, tin plate and TFS, glass;
Secondary packaging materials- folding carton, corrugated fibre board boxes, wooden boxes; *Ancillary packaging materials* - printing inks, varnishes, lacquers and varnishes.
Process of packaging : Bottling, canning, capping, labeling, form-fill-seal and cartonning machineries; vacuum and gas packaging, retort packaging, CAP, MAP, active packaging, shrink packaging, lined cartonning system.PET, Preform, tetrapack. Flash 18 process. Biocomposite and alternative packaging, TTI, active and intelligent packaging.
Packaging standards and regulations- laws, specifications and quality control; collection, separation, disposal and recycling of packaging materials.

Recommended Books

1.	F.A. Paine	:	Fundamentals of packaging
2.	F.T.Day	:	Packaging of Food Beverages
3.	Sacharow & Griffin	:	Food Packaging
4.	A.L. Brody	:	Flexible Packaging of Foods

5.   R. Heiss   :   Principle of food packaging.

FTBE/T/313 FOOD PROCESS TECHNOLOGY – I

Fish and Fish processing: Methods of catching, handling & transport of fish, biochemistry of fish spoilage, assessment of quality of fish, fish preservation methods – canning, retorting, freezing and packaging, manufacture of important commercial fish products . General idea of Common machineries required for fish processing plants : working principles and Specifications.

Meat processing : Slaughtering techniques of animal and slaughtering practices, meat cuts and portions of meat, meat quality, inspection and grading of meat, physicochemical composition of muscle, connective tissue, intramuscular fat, post-mortem changes in muscle, conversion of muscle to meat. Chemical , nutritional and Physico-chemical quality aspects of meat including toxins, spoilage characteristics of meat, endogenous and exogenous infections, preventive (prophylaxis) measures for avoiding meat spoilage. Processing methodologies of meat , commercially important meat products, meat analogs, meat storage and preservation techniques in brief. General idea of Common machineries required for fish processing plants : working principles and Specifications.

Poultry products: Poultry slaughter, factors affecting quality of poultry; classification of poultry meat, composition and nutritional value of poultry meat, processing of poultry meat, spoilage and control, by-product utilization; structure, composition and functions of eggs, inspection and grading for egg quality, preservation and safe handling of eggs, important commercial poultry and egg products . General idea of Common machineries required for poultry processing plants : working principles and Specifications.

Recommended Books
1.   R. L. Henricksons   :   Meat, Poultry and Sea Food Technolgy
2.   Albert Levie   :   Meat Hand Book
3.   G. J. Mountney   :   Polutry Products Technology
4.   George Borgstrom   :   Fish as Food (Vol. i, ii, iii, iv)
5.   R. J. Roberts   :   Fish Technology

FTBE/T/314 FOOD PROCESS TECHNOLOGY – II

Cereals : Storage of cereals, infestation control and use of pesticides; drying of grains; wheat processing - classification of wheat; milling of wheat, functionality of wheat flour components and bakery ingredients, dough mixing, types of dough and its rheology testing, production of wheat products such as bread, including multigrain bread and gluten-free bread, biscuits and cakes;Quality testings and machineries required for biscuit , cake and crackers. Lay out of bakery plant. rice processing - classification, paddy processing and milling, manufacture of instant rice and puffed products, by-product utilization such as bran; milling of corn, barley, oat, sorghum, ragi and millets; nutritional and antinutritional factors in cereals.

*Pulses and Legumes :*Milling of pulses, processing of soybean for value added products such as soya protein isolate, tofu and soya milk; nutritional and anti-nutritional factors in pulses and legumes.

Oil seeds , processing and products : Status of fat and oil industries; extraction, physical and chemical refining of oils from oilseeds such as groundnut, mustard, soybean, sunflower and sesame including winterization, bleaching and deodorization; animal fats; rancidity of fats and antioxidants. Hydrogenation and catalysis. Plasticity in fats; preparation of confectionary fats, shortenings, margarine, salad dressing, mayonnaise, imitation dairy products and low calorie spreads; fat replacants, analytical techniques for fat and oil analysis. Technology of oilseed protein isolate. Utilization of byproducts from the oil-milling industry. Design of oil milling equipments and plant layout.

Recommended Books

1. N. L. Kent : Technology of Cereals
2. Y. Pomeranz : Wheat Chemistry and Technology
3. Tanley A Watson, Paul E. Ramstad : Corn Chemistry and Technology
4. B.O. Julliano : Rice Chemistry and Technology
6. P.H. Pandey : Post Harvest technology
7. Bailey : Fats and oil
8. P.N. Wlilliars & J. Devine : The Chemistry & technology of edible oils & fats
9. J Matz : Cereal chemistry
10. A sultan : Bakery technology and macineries

FTBE/T/315 MECHANICAL OPERATION

Material handling- handling of solids, fluids and slurries; material handling equipments- gravity and powered conveyers, bucket and screw type elevators and pumps.

Sorting and grading: cleaning- dry, wet and combination methods: dry methods – screening, aspiration and magnetic cleaning and abrasive cleaning; wet cleaning- soaking, spray washing, floatation washing and ultrasonic washing.

Size reduction: granulation and particle separation; crushing and grinding; equipment selection for grinding; open circuit and closed circuit grinding, power requirement; granulation and size enlargement operations; particle separation; sampling and screening; particle size measurement; cyclone separator, bag filter, magnetic and electrostatic separators.

Hydraulic separation and expression- mechanics of settling, hydraulic pressing, heavy media separation, froth-floatation, elutriation, tabling.

Sedimentation and flocculation- free and hindered setting, thickening, counter-current decantation, flow through packed bed and pressure drop calculations; flocculation and flocculating agents.

Filtration and centrifugation- theory of filtration, filtration equipments (pressure filtration, vacuum filtration and centrifugal filtration), filter medium and filter aid; 'S' concept in centrifugation, types of centrifuges and their design, application to biological suspensions.

Mixing of solids, liquids and slurries – agitating, kneading, blending and homogenizing;

Books Recommended

1. Mc Cabe, Warren L., Smith, Juluam C. and Harriot, Peter : Unit Operations of Chemical Engineering, 5th edition, Mc Graw Hill int. ed. (Chemical Engineering Series)Mc Graw Hill Book Compan, New York, 1993.

2. Foust, Alan S., Wenseli, Leonard A., Clump, Curtis W., mans, Louis and Anersen, L. Bryce : Principles of Unit Operations, Wiley International Edition, John iley & Sons Inc., New York.

3. Coulson, J.M. and Richardson, J.F. : Unit Operations (Volume 2 of Chemical Engineering) New York : Mc Graw –Hill Book Co., Inc.

4. Badger, Walter L. and Banchero, Julius T. : Introduction to Chemical Engineering, Mc Graw – Hill Kogakusha Ltd., New Delhi

| 5 | Brown, C.G. | : | Unit Operations, John wiley & Sons, Inc., New York. |
| 6 | Chattopadhyay, P. | : | Unit Opeations of Chemical engineering, Vol.I, Khanna Publishers, New Delhi. |

FTBE/T/316 MICROBIAL TECHNOLOGY

Economic activities of microorganisms . backers yeast. Production of alcohol, glycerol and beer. Mechanism of alcohol and glycerol fermentation. Production of wine and other alcoholic beverages (Whicskey, rum etc.) Activities of lactic acid bacteria and industrial production of lactic acid. Production of acetic acid, vinegar, production of dextrans. Amino acid fermentation. Microbial production of organic acids (viz. citric acid, gluconic, fumeric, itaconic, gibberellic and Kojic acid).
Microbial production vit B_2 and B_{12} . Production, isolation and purification of microbial enzymes. Immobilized enzymes and their applications. Production of glucose and fructose from starch by enzymatic methods. Production of mushroom.Production of algal protein and recent advances. Microbiological transformation of steroids. Production and isolation of antibacterial and antifungal antibiotics.

FTBE/S/311 MICROBIAL TECHNOLOGY LABORATORY I

Qualitative & quantitative studies on the microbial production of alpha-amylase, fungal amyloglucocidase, glutamic acid, citric acid, vitamins.

FTBE/EE/S/312 ELECTRICAL ENGINEERING LABORATORY

Experiments to supplement the theoretical course on "Fundamentals of Electrical Engineering".

FTBE/Chem/S/313 PHYSICAL CHEMISTRY LABORATORY

Viscosity measurement, surface tension measurement, study of phase equlibria, gas thermometer, reaction equilibrium constant, kinetics of some reaction, distribution coefficient. Heat effects (heat of reaction, activation energy) , T-X-Y diagram.

Third Year-Second Semester:

FTBE/T/321 FOOD PROCESS ENGINEERING

Rheological properties of fluid and solid foods- rheological classification of foods, rheological models for viscous and viscoelastic foods. Food gels, colloids and food emulsions. measurement of flow properties of fluid foods, (fundamental methods, empirical methods and imitative methods), quasistatic and dynamic tests for solid foods; Thermal and thermodynamic properties of foods- introduction to thermal properties, importance of thermal properties, thermodynamic properties of foods in dehydration- introduction, food-water system, dehydration principles, engineering aspects of various types of dryers used in the food industry, including tray dryer, fluidized bed dryer, spray dryer and freeze dryer; modeling of drying process.

Electrical conductivity of food- introduction to liquid food, theory of electrolytic activity, effect of temperature, electric field strength and ingredients on electrical conductivity of liquid and solid foods; Dielectric properties of food- basic principle, effect of processing on dielectric properties of food, assessment of food quality using dielectric properties;

Surface properties- introduction, fundamental consideration, Gibbs and Fraundlich adsorption equation and contact angle measurement techniques; Colorimetric properties of food- physiological basis of color, measurement of color.

Engineering aspects of different equipments : sterilizers and bioreactors (batch and continuous). Design of primary settling tank. Design of digestor.Seaming machines and other accessories used in caning industries, evaluation of process time in canning by different methods; Engineering aspects of pasteurizers, homogenizers, evaporators, concentrators and crystallizers used in the food industry. Engineering aspects of different types of freezers used in the food industry including plate freezers, air blast freezers and cryogenic freezers, construction of refrigerated vans, wagons and cold storage; Engineering aspects of extruders in designing of foods.

Books Recommended:

1	Levenspial, D.	:	Chemical Reaction Engineering, John Wiley.
2	Smith, J.M.	:	Chemical Engineering, Kinetics, McGraw Hill.
3	Wales, S.M.	:	Reaction Kinetics for Chemical Engineers, McGraw Hill Book Co., Inc.
4	Denbigh, K., Turner, K.G.	:	Chemical Reactor Theory-An Introduction, Cambridge Univ. Press.
5	Scott Fogler, H.	:	Elements of Chemical Reaction Engineering, Prentice Hall.
6	Toledo, RT	:	Elements of Food Engineering, CBS

FTBE/T/322 FOOD PROCESS TECHNOLOGY – III

Fruits and Vegetables : Storage and handling of fresh fruits and vegetables, biochemical composition, pre and post harvest changes, role of plant growth regulators in post harvest storage, physiology of ripening, physical and chemical treatments to increase post harvest life of fruits and vegetables; thermal and osmotic dehydration of fruits and vegetables, canning and bottling, UHT processing, aseptic processing and packaging, CAP and MAP storage, juice extraction and preparation of soft drinks, syrups, squashes, cordials, nectars, jam, jelly, marmalade, preserves, candies, ketchup, pickles, chutneys, sauces, vinegar, tomato products, fruits juice concentrates and powders, fruit toffees, fortified soft drinks, extraction of fruit flavors and essences, minimally processed fruits and vegetables, fermented fruit and vegetable products, coconut and its derivatives, by-products of fruits and vegetable industry wastes.

Spices and Herbs : Types of spices, spice quality and specifications, active constituents in Indian spices antioxidant, antimicrobial and medicinal properties of black pepper, cinnamon, nutmeg, cardamom, turmeric, ginger, cloves; preparation of spice blends, spice powder, extractives - essential oil and oleoresins, encapsulated oils, salad dressings and seasonings; spice processing machineries. Introduction to different types of herbs of nutritional and medicinal importance .

Confectioneries : Manufacture of chocolate,Types of confectionery goods,Characteristics and processing of raw materials,Technology of manufacture of toffee, chocolate, fruit drops, hard-boiled candies, bars, chewing gums, bubble gums, lozenges, candy bars food gels and special confectionery goods.Color, flavor and texture of confectionery. Standards and regulations.Economics and marketing of confectionery goodsDesign of equipments used in confectionary. Plant layout.

Books Recommended:

1.	Giridhari Lal	:	Preservation of Fruits & Vegetables
2.	Ranganna	:	Analysis of Fruits and Vegetables
3.	Luh & Woodroof	:	Commercial Vegetable Processing

4.	Woodroof & Luh	:	Commercial fruit processing
5.	Beckette	:	Industrial Chocolate Manufacture: 3rd ed, 2000; CBS Publication, New Delhi.
6.	Marie	:	Handbook of Sweeteners: 2000; CBS Publication, New Delhi.

FTBE/T/323 PROJECT PLANNING , LAYOUT & ECONOMICS

Introduction to plant design and project engineering. Process selection and evaluation. Pilot and semi-commercial plants scale-up techniques. Selection of materials of construction and specification of process equipments with special considerations for equipments and accessories of Food and Biochemical projects. Plant layout. Location of plant, raw materials and utilities. Objectives and business organization rules and procedures of process plant costing to man power, material, equipment and utilities. Analysis of production and productivity in joint products and by-products. Cost reduction techniques, optimization techniques and assessment of alternatives. Conceptual frame work on marginal costing and profitability. Application of PERT & CPM in project planning and monitoring. Techno-economic case studies in Food and Biochemical projects. Introduction of computer applications in project engineering and process plant costing.

FTBE/T/324 BIOCHEMICAL ENGINEERING I

Characteristic properties of biological fluids. Dynamics of microbial growth – different growth models for microbial processes – Dynamics of continuous culture. Kinetics of thermal death of micro organisms-Mechanisms of thermal sterilization and sterilization by filtration Design criteria and design equations for sterilization process design for air. Production of microbial crude enzyme – their isolation & purification – kinetics of enzymatic reactions. Modulation and regulation of enzymatic activity. Immobilized enzymes and their industrial uses. Biochemical reactors. Different techniques of immobilization. kinetics of enzymes. Different types of enzyme reactors and their applications. Material of construction for fermentation process equipment. Different types of bo-reactors in use and their operation. Design and analysis of biological reactors. Aeration and agitation-Oxygen supply and demand in microbial processes- single and multiple bubble aeration. Oxygen transfer in fermentation- Design o f spargers, aeration equipment and agitators. Scale-up of biological reactors. Introduction to molecular genetics and control system. Principle of recombinant – DNA technology – Cultivation of recombinant cells in biological reactors- Application of recombinant microorganisms. Animal and plant-cell reactor technology- Requirements for animal cell cultivation-nutritional and environmental conditions. Reactors for large-scale production employing animal cell cultivation. Instrumentation and control operation, bio-reactors. Microprocessor controlled fermentation.

FTBE/T/325 MASS TRANSFER OPERATION I

Basic concept of mass transfer: theory of interphase mass transfer and mass transfer coefficients; analogy between heat mass and momentum transfer, mass transfer during condensation and evaporation.
Theory of diffusional processes- molecular and eddy diffusion in fluids, measurement of diffusivity; theory of absorption of a single component from gas mixtures in a wetted wall column; theory of adsorption and desorption operations.

Fundamental principles of liquid-liquid extraction:, selectivity and choice of solvent; material balances in stage operations and principles of graphical methods in determination of number of equilibrium stages;
Fundamental principles of leaching operation and material balance calculations.

Books Recommended:

1	Treybal, Robert E.	:	Mass Transfer Operations, McGraw-Hill.
2	Sherwood, Thomas K., Pifford, Robert L. and Wilke, Charles R.	:	Mass Transfer, McGraw –Hill.
3	Skelland, A.H.P.	:	Diffusional Mass Transfer, John Wiley & Sons, New York.
4	McCabe, Warren L., Smith Julian C. and Harrlott, Peter.	:	Unit Operations of Chemical Engg., McGraw-Hill.
5	Coulson & Richardson	:	Chemical Engineering Vol. I & II.

FTBE/ T/326 CHEMICAL ENGINEERING KINETICS

Introduction and a brief review of the Kinetics of Homogeneous Reactions.

Interpretation of Rate Data from Constant Volume and constant pressure systems.

Single Ideal Reactors

Design for Single Reactions

Design for Multiple Reactions

Thermal Characteristics of Reactors Temperature and Pressure Effects.

Non-ideality in reactors and its effects on chemical conversion. One parameter models to represent the behaviour of chemical reactors.

Degradation of nutrients, colour pigments and microorganisms during thermal processing and storage of foods.

Books Recommended:

1	Levenspial, D.	:	Chemical Reaction Engineering, John Wiley.
2	Smith, J.M.	:	Chemical Engineering, Kinetics, McGraw Hill.
3	Wales, S.M.	:	Reaction Kinetics for Chemical Engineers, McGraw Hill Book Co., Inc.
4	Denbigh, K., Turner, K.G.	:	Chemical Reactor Theory-An Introduction, Cambridge Univ. Press.
5	Scott Fogler, H.	:	Elements of Chemical Reaction Engineering, Prentice Hall.
6	Toledo, RT	:	Elements of Food Engineering, CBS

FTBE/S/321 MICROBIAL TECHNOLOGY LABORATORY II

Qualitative & quantitative studies on the microbial production of antibiotics, alcohol, Baker's yeast biomass. Study on MIC and Phenol Coefficient. Detection and accounting of coli form bacteria and salmonella. Microbial quality evaluation of food items like milk, canned food, mineral water, fruit juice, bread , biscuit etc.

FTBE/S/322 BIOCHEMICAL ENGG. & INSTRUMENTATION LABORATORY I

BOD analysis of industrial wastes,COD analysis of industrial wastes ,Study on the enzyme reaction kinetics and comparison with theoretical L-B model,K_La determination of a liquid medium by sulphite oxidation method,Kinetics study on Agar drying,Rheological study on CMC solution with the help of Brook Field Viscometer.

FTBE/CHE-ME/S/323 CHEMICAL & MECHANICAL ENGG LABORATORY

Flow of fluids through flow meters such as venturimeters, Orifice meters, rotameters, weirs, etc. Calibration of flow meters. Friction through bends, fittings, etc. Efficiency of pump. Measurement approximate critical velocity of liquid. Rate of filtration under different pressures. Drying rate under constant drying conditions. Running of vacuum drum drier water distillation plant. Concentration by forth floatation. Screen analysis of crushed products. Packed tower operations. Rectification of binary moisture. Also experiments in the mechanical laboratory.

Fourth Year-First Semester:

FTBE/T/411 FOOD PROCESS TECHNOLOGY – IV

 D*airy Products :* Definition, composition and nutritive value of milk, milk industry scenario and practices related to procurement and transportation of milk; testing of authenticity of milk products, detection of adulteration of milk including foreign fats; microbiology of milk, sources of contamination and hygienic practices; pasteurization, standardization, toning, homogenization and cream separation.

Technology of dried whole milk, SMP, cream, butter, ghee, margarine, condensed milk, fermented milk products, probiotic milk based products, synthetic and imitation milk, sterilized flavored milk, UHT milk, whey drinks, aseptic packaged milk, ice-cream, cheese (cheddar, cottage and gouda), lactose free milk and milk by-products (casein and lactose).

Beverages: Status of the beverage industry in India. Its future prospects. Classification of beverages.Technology of manufacture of mineral water.Technology of manufacture of non-alcoholic beverages: fruit & vegetavle juices, soft drinks, dairy beverages, etc. Introduction to machineries, analytical instruments and control devices used for continuous beverage line Technology of manufacture of alcohalic beverages: beer, wine, whiskey, rum etc. Various types of tea and coffee; chemistry of tea, coffee and chicory; processing of tea, coffee and cocoa; drying, fermentation, roasting and browning processes and their importance; analysis of quality components, standards and specifications of tea, coffee and cocoa products. Technology of manufacture of tea and coffee drinks.Design of equipments used in manufacturing of beverages. Water quality control, byproduct utilization .Plant layout.

*Books Recommended***:**

1	De, S	:	Outlines of DairyTechnology
2	Ahmed, T	:	Dairy Industry Plant Layout
3	Eckles	:	Chemstry & Technology of Milk
4	Woodroof & Phillips	:	Beverages, AVI Publication, USA
5	Wangham, D.A.	:	Coffee & Tea, Interscoience publication, USA
6.	Ranganna	:	Handbook of Analysis of Fruit and Vegetable Products
7.	Prescott & Dunn	:	Industrial Microbiology

8.   Casida   :   Industrial Microbiology

FTBE/T/412 INSTRUMENTATION & PROCESS CONTROL

General Principles of measurements.

Static and dynamic characteristics of instruments.

Temperature measurement: Thermocouples, resistance thermometers, thermistors, optical and radiation pyrometers.

Pressure measurement: Use of mano-meters, Bourdon gauge, bellows type gauge, Measurement of vacuum and pressure Transducers.

Liquid level measurement, Direct and differential method, Measurement in open and pressure vessels. Measurement of liquid.

Measurement of viscosity, conductivity, humidity and pH.

Measurement of nuclear radiation.

Instrument for gas analysis, gas chromatography mass spectroscoping.

Industrial weighing and feeding system.

Process instrumentation, Recording instruments, indicating and signalling instruments, Transmission of instrument reading, central control, Instrumentation diagram, Instrumentation in modern plant.

Incentives for Process Control, Design Aspects of a process control system. Hardware Elements of a control system.

Laplace transform and transfer functions. Block diagram. Difference between lumped and distributed parameter systems, Dynamic behaviour of first and higher order systems, interacting and Non-interacting systems, dead time. `

Different modes of control actions and their basic characteristics, Controllers and their characteristics, control valve.

Closeed-loop transfer functions, Trnasient response of simple control systems, Routh stability criterion, Root Locus.

Introduction to Frequency Response, control system Design by Frequency Response.

Introduction to advanced control techniques such as cascade control, ratio control, feedforward-feedback control, inferential control, adaptive control and digital computer control.

Books Recommended:

1   Eckman, D.P.   :   Industrial Instrumentation, Wiley Eastern Ltd., 1975.

2   Kerk, F.W. Rimboi, W.R., :   Instrumentation., Wiley & Sons, 1973.
     and Tarapore, D.B.

3   Considine, D.N.   :   Process Instruments and Controls Handbook, McGraw-
                                              Hill.

4   Andrew, W.G.   :   Applied Instrumentation in the Process Industries Vols.
                                              I, II, III Gulf Publishing Company.

5   Instrument   Society   of :   Instrumentation in the Chemical and Petrochemical
     America   Industries,

6.	D Patranabish	:	Process instrumentation and control
7.	Coughanowr. D.R. and Koppel, L.B.	:	Process Systems Analysis and Control, 2nd Ed. Mc Graw Hill(1991).
8.	Stephanopolous	:	Chemical Process Control-An Introduction to Theory and Practice, Prentice Hall of India (1990).
9.	Harriott, P.	:	Process Control, TMH Edition, Tata MCGraw Hill, Publishing Co. Ltd., New Delhi (1972).

FTBE/T/413 MASS TRANSFER OPERATION II

Distillation- vapor-liquid equilibrium, relative volatility, batch and equilibrium distillation, steam distillation, molecular distillation, azeotropic and extractive distillation, enthalpy-concentration diagram; theory of rectification; design of distillation column.

Theory of drying of solids: sorption isotherms and their use, drying curves, factors affecting rate of drying, introduction to types of dryers and dryer designs. Theory of sublimation;

Principles of humidification and dehumidification operations: principles of construction and use of psychometric chart; application of mass and heat transfer in design of cooling towers and humidifiers.

Theory of crystallization: material and energy balance calculations and introduction to crystallizer design.

Books Recommended:

1	Treybal, Robert E.	:	Mass Transfer Operations, McGraw-Hill.
2	Sherwood, Thomas K. Charles R. Pigford, Robert L. and Wilke	:	Mass Transfer, McGraw-Hill.
3	Ghosal, Dutta , Sanyal	:	Introduction to Chemical Engineering
4	McCabe, Warren L., Smith, Julian C. and Harriot H.P.	:	Unit-Operations of Chemical Engg. McGraw-Hill.
5	King, C.J.	:	Separation Processes, Tata McGraw Hill Publishing Co.Ltd. New Delhi.
6	Holland, Charles D.	:	Fundamentals and Modelling of Separation Processes, Prentice-Hall, Inc. New Jersey.
7	Geankoplis, C.J.	:	Transport Process and Unit Operations, Prentice Hall, Inc. New Delhi, 1997.

FTBE/T/414 BIOCHEMICAL ENGINEERING II

Improvement in processed food by the application of various biotechnological processes. Technology of conventional and non conventional fermentation based food products from cereals, legumes, fruits, vegetables, milk, fish, meat etc. Biotechnological process for manufacture of food staff and food etc. Fermentation production of modified carbohydrates, lipids and proteins and their purification techniques. Studies on changes in clour , flavour and organoleptic test during processing and storage of the fermented food and chances of spoilage of the products due to process defects. Evaluation and standardization of quality and safety of the fermented food products by the application of modern techniques.

FTBE/S/411 SEMINAR

Students will be required to carryout under the supervision of the staff members, a literature search and will prepare review papers on selected topics. Every student will do critical review of assigned subjects in Food Technology or Bio-chemical Engineering. Review of assigned subjects in food technology or Biochemical Engineering will be followed by discussions.

FTBE/S/412 BIOCHEMICAL ENGG. & INSTRUMENTATION LABORATORY II

Immobilized enzyme reaction kinetics study, Determination of Specific Death Rate constant of microorganism, Determination of efficiency of an air sterilizing unit, Determination of size and Density of Yeast cells, Study on the settling characteristics of biological suspensions.

FTBE/S/413 FOOD ENGG. & QUALITY CONTROL LABORATORY I

Evaluation of F & T values of two types of microorganisms encountered in spoilage of canned food. Determination of process time by graphical & formula method. Drying rate characteristics of different food materials. Studies on dehydration in spray drier. Spray drier, fluidized bed drier, freeze drier etc. Parboiling of paddy, wheat & other cereals & determination of their milling characteristics. Extraction and refining of oil from various oil seeds. Production of rice bran oil. Milling of spices & determination of oil & oleoresein. Evaluation of properties of different packaging material. Extrusion process.

Fourth Year-Second Semester:

FTBE/T/421 QUALITY CONTROL & FOOD SAFETY

Food laws and standards – concept of food laws, safety and standards; Indian food regulatory regime- PFA Act, Food Safety and Quality Requirements, Additives, Contaminants and Pesticide Residue, Food Safety and Standards Act, 2006, Essential Commodities Act, 1955, BIS, AGMARK, Export Quality Control and Inspection Act, 1963, Customs Act and Import Control Regulations; Global scenario - Codex Alimentarius, WHO/FAO bodies (JECFA/JEMRA/JMPR), OIE and IPPC; European Commission, USFDA; Voluntary quality standards and certification - GMP, HACCP, GAP, ISO 9000, ISO 14000, ISO 22000, Good Animal Husbandry Practices, Environmental Protection Agencies (EPA) and their role in food safety system; Food safety Inspection Services (FSIS) and their utilization.

Quality and definitions : Quality definition of different food products according to food laws especially PFA. Classifications and functions and safety limits of food additives such as preservatives, antioxidants, colors, flavors, emulsifiers, sequesterants, humectants, hydrocolloids, sweeteners, acidulants, anticaking agents, buffering salts; Enzymes in food processing. Misbranding. Adulteration in oil, dairy items and spices and analytical procedures for identification.carry over principles in food. Heavy metals and pesticide residue in foods. Exports and legislations.

Overview of sensory principles and practice: methodology for sensory evaluation - discriminative tests (paired comparison, Duo-trio, triangle, ranking), sensitivity test, descriptive tests (category scaling, ratio scaling, flavor profile analysis, texture profile analysis), effective tests (paired performance test, ranking test, hedonic rating scale).

Risk assessment studies- safety and quality evaluation of additives and contaminants, acute and chronic studies, NOAEL, ADI, LD_{50}.

Statistical quality control methods - hypothesis testing, F and T test, Chi-square test, one-way and two-way ANOVA.

Recommended Books

1. PFA volume
2. AOAC Book
3. J Rangana   : Food analysis
4. CPomeranz   : Quality control and food analysis
5. Jacobs   : Food analysis

FTBE/T/422 ELECTIVE

1. COMPUTER APPLICATION FOR FERMENTATION PROCESS
2. PLANT OPERATION, MAINTENANCE AND SAFETY
3. NON-CONVETIONAL ENERGY & POLLUTION CONTROL

FTBE/T/422A COMPUTER APPLICATION FOR FERMENTATION PROCESS

A. Computer : (1) Hardware (2) Software B. Instrumentation : i) Physical measurements, temperature, vessel pressure, volume/level weight, density, power input, agitation speed gas flow rate, liquid media feed rae, viscosity forming. ii) Chemical measurement : pH, biomass, gas oxygen and carbon dioxide concern dissolved oxygen, dissolved carbon dioxide, nitrogen source, ionic strength, redox potential, enzyme coupled sensors, microbe-coupled sensors, calorimeters, automatic sampling and inoculation, other methods. iii) Bio-chemical measurement : ATP/ADP, NAD/.NADH, Cytophotometry and cytofluorometry. iv) Biological measurement.
B. Sole estimation and parameter identification : Indirect measurement, microscope material/energy balances. On line estimation.
C. Modelling : Types of growth models, consideration in modelling and the use of models in computer control.

FTBE/T/422B PLANT OPERATION, MAINTENANCE AND SAFETY

Introduction to the structure of systems of plant operation, maintenance and safety. System interactions and degree of freedom with man, material and equipment. Factory rules and procedures with Indian and International specifications in operation, maintenance and safety. Effects of economic design criteria in optimum plant operation. Trouble shooting operation and maintenance in presence of uncertainty. Simulation for interpretation in difficult plant operation. Introduction to microprocessor based operations. Inspection, testing and analysis of tolerance limit and types of failure. Hazards and operative (HAZOP) analysis. Accidents and emergency preventive procedures. Insurance claim and loss analysis. Case studies on Food and Biochemical plants.

FTBE/T/422C NON-CONVETIONAL ENERGY & POLLUTION CONTROL

Fundamental concept of environmental system. Climatic aspects of pollution causes of Air pollution. Control of air pollution caused by industries and agriculture, viz. Sulfur dioxide removal from waste gases. Water quality, system for treating water and wastes, by physical, chemical and biological treatment processes. Processing of sludge Reuse of Water. Sensing, Instrumentation and measurement of air and water quality.

Environmental education for creating awareness of pollution among people. Legal consideration. Energy forms and basic laws. Different types of solid gaseous fuels. World Energy Resources and consumption. The nature of Solar energy, Biological and chemical conversion of solar energy. Energy conservation in industries. Wind and tides and other forms of energy like geothermal energy etc. Renewable energy system for application in agriculture. Development of equipments based on the use of energy obtainable from non conventional sources.

FTBE/T/423 WASTE TREATMENT ENGINEERING

Environment and energy of nature. Water for food and biochemical industries. Stream pollution and measurement. Physical treatment,Chemical treatment, Drying and incineration.
Industrial waste treatment : Vacuum treatment Sludge lagooning. Drying and incineration. Treatment and disposal of sludge solids Vacuum treatment. Sludge lagooning Drying and incineration.Microbial flocculation and sedimentation, Design of biofilters and bioclarifiers. Ion exchange in biological fluids. Biogas.

FTBE/ME/T/424 INDUSTRIAL MANAGEMENT & ENERGY

Growth of Industries, Management thoughts and scientific management, Taylorism; Factory system of production, Introduction to management problems, Types of manufacture, Planning analysis and control aspects in industries. Types of business ownership, means of finance and business combinations, organization structures, committee organization, authority and responsibility, duty and span of control. Plant location, factory buildings and physical facilities, plant layout, tools and techniques of plant layout, materials - handling arrangements. Product development, standardization, simplification and diversification. Functions of production, planning and control, production forecasting, production scheduling and network techniques, Gantt chart, CPM, PERT etc. Work study, job evaluation and merit rating; purchase system and inventory control. Inspection and quality control of systems, statistical quality control, maintenance and replacement policies for machine and equipments; decision making theories, breakeven analysis cost benefit analysis, evaluation of financial and managerial efficiencies. Introduction to operational research techniques. Application of fuzzy logic in modern management concepts. Human relations in industry and labour compensation. Personnel management, provision of industrial legislations in India. Wage and salary administrations. Welfare and safety provisions, trade union acts. Study of environmental impacts and environmental laws. Current management approach like six sigma, five S concept, quality and energy audit.

Recommended Books:
1. Production and operations management: S.N.Chari
2. Industrial Management: Basu & Majmundar (Birla Pub., Newdelhi)
3. Quantitative techniques in management: N.D.Vohra (Tata Mcgraw Hill)
4. Production systems analysis and control: Riggs
5. Works organization and management : Basu, Sahoo & Dutt
6. Fuzzy logic with Engineering applications: Timothy J. Ross (Mcgraw Hill)

FTBE/E/421 GENERAL VIVA-VOCE

Based on all the theoretical and sessional subjects of all the semesters.

FTBE/S/422 HOME DESIGN/PROJECT

Students will be assigned Home design problem on selected designs of plant and equipment, related to Food Technological and Biochemical or similar industries. The design problem should be worked out by students under the guidance of teachers. Complete design with drawings should be submitted by the students within

prescribed date. Alternatively, the students will be assigned one project work to carry out a particularly experiment and to find out experimental data under the guidance of departmental teachers. The Home design/project report along with vive will be considered as an examination paper, carrying 100 marks for the final examination.

FTBE/S/423 FOOD ANALYSIS LABORATORY

Extraction, separation and identification, water and oil soluble dyes. Detection and estimation of additives in food materials net as, boric acid, benzoates, sulphites, formaldehyde, formic acid, lactic acid, saccharine cyclamate, dulcin etc. Analysis of following food stuffs : with reference to the standards of quality fixed for these : milk, jam, jelly, squash, vinegar, cider, biscuit, baby food, ready-to-eat cereals, tea, coffee, soft drink, milk and milk products, rice and wheat. Changes in the vitamins ascorbic acid and thiamin in canned vegetabless during thermal treatment. Available lysine content in fish-meal.

FTBE/S/424 FOOD ENGG. & QUALITY CONTROL LABORATORY II

Preparation of squash, jam, jellies, marmalade, preserved and candied fruit. Preparation of alcoholic beverages. Preparation of pickles, chutneys, sauces, fermented vegetables & tomato products. Fruit juice concentrate & powder. Preservation of fruits & vegetables, fish meat etc. by canning freezing, drying and quality assessment of the processed products. Testing of can preparation of ice cream & other frozen products. Preparation of confectionery products including bread, biscuits, cake etc. Preservation of milk by heat treatment. Preparation of various milk based products. Enumeration of faecal indicator organisms, salmonella & pathogenic organism in processed food. Detection and identification of food spoilage organisms. Quality assessment of processed food.