SECOND YEAR-FIRST SEMESTER

Subject Code	Name of the Subject	Category	Type	Contact L-T-P	Credit	Marks
FTBE/ BS/ B/T/ 211	Biochemistry & Nutrition - I	BS	B	3-0-0	3	100
FTBE/ BS/ B/T/ 212	Basics of Microbiology	BS	B	3-0-0	3	100
FTBE/ PC/ B/T/ 213	Food Chemistry	PC	B	3-0-0	3	100
FTBE/ PC/ B/T/ 214	Chemical Engineering Fundamentals	PC	B	3-0-0	3	100
FTBE/ PC/ B/T/ 215	Fluid Flow	PC	B	3-0-0	3	100
FTBE/ PC/ B/T/ 216	Chemical Engineering Thermodynamics	PC	B	3-0-0	3	100
FTBE/ PC/ B/T/ 217	Heat Transfer	PC	B	3-0-0	3	100
FTBE/ BS/ B/S/ 211	Basics of Microbiology Laboratory	BS	B	0-0-4	2	100
				Total	23	800

FTBE/ BS/ B/T/ 211: BIOCHEMISTRY & NUTRITION I

Content:

Module I: Introduction to biochemistry: definition, objectives and scope; acids, bases and buffers; overview of chemistry of carbohydrates, proteins and lipids; overview of dietary metabolism; bioenergetics, electron transport chain; oxidative and substrate level phosphorylations; oxidative stress and antioxidants.

Module II: Carbohydrates: metabolism and regulations: definition and classification of carbohydrates in the human body; metabolic pathways for breakdown of carbohydrates – glycolysis and Kreb's cycle; metabolism of hexoses other than glucose by feeder pathways; pentose phosphate pathway, Cori cycle, gluconeogenesis; glycogen metabolism; regulation of blood glucose and energy balances.

Module III: Proteins: metabolism and regulations: definitions and classification of proteins in the human body; essential and conditionally 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; amino-acids as biosynthetic precursors and protein biosynthesis.

Module IV: Lipids: metabolism and regulations: definitions, classification, structures, physical and chemical properties of lipids in the human body; pathways for breakdown (oxidation pathways of even; odd chains and unsaturated fatty acids); biosynthesis of fatty acids and lipids,; ketone bodies; lipoproteins; digestion and absorption of lipids; fatty liver; lipotropic agents and energy balances.

Module V: Introduction to human nutrition: concepts of nutrition and health and interrelationship between them; functions of food in the human body; nutritional aspects of carbohydrates (including glycemic index and load), proteins and fats.

Recommended Books:

1. Biochemistry by Debajyoti Das, Academic Publishers, 14 ed., 2015.
2. Fundamentals of Biochemistry by J.L. Jain, S. Jain and N. Jain, S. Chand, 7th ed., 2016.
3. Lehninger Principles of Biochemistry by D.L. Nelson and M. M. Cox, W.H. Freeman & Co., 7th ed., USA, 2017.

Couse Outcome:

The students of the course should be able to

CO1: Comprehend basic concepts of human biochemistry and nutrition
CO2: Describe structures, classification and functions of carbohydrates, proteins and lipids
CO3: Describe dietary metabolism and regulatory pathways for breakdown and synthesis of carbohydrates, proteins and lipids
CO4: Describe energy balances involving carbohydrates, proteins and lipids
CO5: Describe nutritional aspects of carbohydrates, proteins and lipids

FTBE/ BS/ B/T/ 212: BASICS OF MICROBIOLOGY

Content:
*Module I: Introduction to Microbiology***:** Landmark discoveries relevant to the field of microbiology, The importance of microbes in food and fermentation industries. Microscopes. Dyes and staining techniques.

Module II: Morphological features and growth of microbes: Taxonomical classification of bacteria, Morphology, growth condition and reproduction of bacteria, yeasts and moulds. Bacterial growth and its estimation. Techniques of pure culture .Preservation of microbial culture. Bacterial genetics. Phage virus.

Module III: Microbial Metabolism: Nutrition of bacteria. Microbial respiration. Energy metabolism of microbes. Nitrogen fixation.

Module IV: Control of Microbes: Thermal death point, Antimicrobial agents: Disinfection and disinfectants. Pasteurization, sterilization and arnoldization.

Recommended Books:

1 Prescott, Herley, Klein (2nded): Microbiology
2 Salley: Bacteriology
3 K. S. Bilgrami: Essentials of Microbiology
4 Bennett, Chapman and Hall: Basic Food Microbiology
5 M. R. Adam: Food Microbiology
6 Pelczar, Chan and Krieg: Microbiology
7 Frazier: Food Microbiology
8. J Jay: Modern Food Microbiology

Course Outcome:
The students of the course should be able to
CO1: Explain the role of microorganism in food and fermentation industries
CO2: Describe the morphological features of microorganisms
CO3: Explain growth requirements and preservation techniques of microorganism
CO4: Discuss the metabolism of bacteria.
CO5: Explain the methods of controlling microbial load

FTBE/ PC/ B/T/ 213: FOOD CHEMISTRY

Content:
Module I: Introduction to food chemistry: definition of food; proximate composition of foods; concepts of nutraceuticals, antioxidants, enrichment, fortification and restoration.

Module II: Water in foods: definition of water in foods, interaction of water with solutes; sorption phenomenon; types of water and water activity.

Module III: Carbohydrates: definition, classification, structure and functions of carbohydrates: mono-, oligo- and polysaccharides including starch, glycogen, cellulose, hemi-cellulose, lignins, crude fibre, pectins, gums and mucilages; occurrence in foods: carbohydrate contents and composition of selected foods; physicochemical and biochemical properties of carbohydrates including gelatinization and retrogradation; nutritional properties of carbohydrates; chemical reactions of carbohydrates; evaluation of carbohydrate quality; effects of processing and storage on carbohydrates.

Module IV: Fats and Oils: definition, classification, structure and functions of fats and oils: triglycerides, fatty acids, phospholipids, sterols and derived lipids, occurrence in foods: fat content and major fatty acid composition of selected foods; physicochemical and biochemical properties of fats and oils including polymerization and polymorphism; nutritional properties of fats and oils; chemical reactions of fats and oils; evaluation of fat and oil quality; effects of processing and storage on fats and oils; fat spoilage (rancidity) mechanisms and prevention.

Module V: Proteins: definition, classification, structure and functions of amino acids and proteins, occurrence in foods: protein content and composition of selected foods; physicochemical and biochemical properties of proteins including post-mortem changes, tenderization, denaturation and renaturation; functional and nutritional properties of amino acids and proteins; chemical reactions of proteins; evaluation of protein quality; effects of processing and storage on proteins; protein spoilage (putrefaction) mechanisms and prevention.

Module VI: Vitamins and Minerals: definition, classification, structure and functions of water and fat soluble vitamins and minerals; occurrence in foods: vitamin and mineral contents of selected foods; physicochemical, biochemical and nutritional properties of vitamins and minerals; effects of processing and storage on vitamins and minerals.

Module VII: Natural pigments and Flavors: definition, classification, structure and functions of natural pigments: carotenoids, chlorophyll, anthocyanins, tannins and myoglobin; structure and functions of food flavors: terpenes, esters, aldehydes, ketones and quinines; occurrence in foods: pigment and flavor contents of selected foods; physicochemical, biochemical, sensory and nutritional properties of pigments and flavors; effects of processing and storage on pigments and flavors.

Recommended Books:

1. Food Chemistry by L.H. Meyer, C.B.S. Publishers, Delhi, 198.7
2. Principles of Food Science by O. R. Fennema, Vol 1-4, Dekker, 1975.
3. Principles of Food Chemistry by J.M. deMan, Aspen Publishers, 1999.
4. Food Chemistry by H.D. Belitz, W. Grosch and P. Schieberle, Springer, 2009.

Course Outcome:

The students of the course should be able to

CO1: Understand and describe the proximate composition of foods; structures and functions of water, carbohydrates, and vitamins and minerals in foods
CO2: Explain and analyze changes in the above during processing and storage of foods
CO3: Understand and describe nutraceuticals; structures and functions of lipids, proteins, natural pigments and natural flavors in foods
CO4: Explain and analyze changes in the above during processing and storage of foods

FTBE/ PC/ B/T/ 214: CHEMICAL ENGINEERING FUNDAMENTALS

Content:

Module I: Units and Dimensions: Introductory concepts of units, physical quantities in chemical engineering, dimensionless groups, "basis" of calculations, Semi-log and log-log plot

Module II: Material Balances for non-reacting systems: Introduction: degree of freedom analysis for simple unit, multiple units with recycle, bypass and purge. Solving material balance problems without chemical reaction

Module III: Material Balances for reacting systems: Concept of stoichiometry and mole balances, examples, including combustion. Degree of freedom analysis with single chemical reactions, multiple chemical reactions.

Module IV: Gases, Vapours and Liquids: Equations of state, Vapour pressure, Clausius-Clapeyron equation,

Module V: Introduction to energy balance: Open and closed system, heat capacity, thermo Chemistry laws: Law of Hess, Standard Heat of Reaction, and Combustion & Formation. Numerical problems.

Module VI: Energy Balance for non-reacting processes and reacting processes: Theoretical flame temperature. Adiabatic reactions temperature, flame temperature, Calculations on Heat of reaction, Heat of combustion. Enthalpy changes associated with unit operations.

Recommended Books:

1. Himmelblau, D. M., Riggs, J. B. "Basic Principles and Calculations in Chemical Engineering", Eighth Ed., Pearson India Education Services
2. Bhatt, B. I., Vora, S. M., "Stoichiometry", Fourth Edition, Tata McGraw Hill Publishing, Company Ltd,
3. Folder, R.m., Roussenu R.W., Elementary Principles of Chemical Process, Third Edition, John Wiley & Sons,
4. Hougen, O. A., Watson, K. M., Ragatz, R. A., "Chemical Process Principles, Part-I Material & Energy Balances", Second Edition, CBS Publishers & Distributors,
5. Venkataramani, V., Anantharaman, N., Begum, K. M. Meera Sheriffa, "Process Calculations" , Second Edition, Prentice Hall of India.
4. Sikdar, D. C., "Chemical Process Calculations", Prentice Hall of India.

5. Toledo, R.T., Elements of Food Engineering, CBS Publishers & Distributors Pvt Ltd
6. Ghosal Dutta Sanyal., Introductionn to chemical Engineering; Mcgraw Hill Higher Education

Course Outcome
The students of the course should be able to

CO1: Develop expertise over process calculations relevant to chemical / bio-chemical / food engineering processes
CO2: Handle elementary flow-sheeting, material balance calculations without and with chemical reactions, and involving concepts like recycle, bypass and purge
CO3: Be familiar with equations of state and properties of gases and liquids.
CO4: Calculate the enthalpy changes associated with non-reacting operations
CO5: Analyze and solve energy balance problems involving reacting systems

FTBE/ PC/ B/T/ 215 : FLUID FLOW

Content:
Module I: Basic concepts of fluid mechanics: Fundamental terms. Physical values. Fluids and their properties. Forces inside fluid

Module II: Fluid Statics: Pascal's law. Euler's equation of fluid statics. Measurement of pressure. Relative statics of fluid – constant acceleration, rotation. Forces of hydrostatic pressure. Buoyancy. Flotation. Stability.

Module III: Fluid Kinematics: Euler and Lagrangian specification of fluid flow. Streamlines. Pathlines. Stream surface. Stream tube. Mass/volume flow. Control volume.

*Module IV: Fluid Dynamics***:** Continuity equation. Basic laws of fluid dynamics – conservation of mass, conservation of lnear momentum, conservation of energy. Ideal fluid flow. Application of Bernoulli's equation. Real fluid flow. Viscosity. Reynolds experiment. Laminar and turbulent flow. Boundary layer. Velocity profile. Losses in pipes. Frictional losses. Flow through Packed bad and Fluidization: Principles and application

Module V: Flow of compressible fluids: Compressible Flow and Flow through nozzles.

Module VI: Flow Measurements: Manometer, Pitot tube, Orifice, Venturi, Rotameter and Notches, wet gas meter etc. Fluid Machinery: Classification and Performance of Pumps, Compressors, Fan and Blowers, Selection and Specification,

Recommended Books:

1 McCabe, Warren L., Smith, Juluam C.: Unit Operations of Chemical Engineering, McGraw 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, McGraw – Hill Kogakusha Ltd., New Delhi
5 Fox, R.W. and mc Donald A.T.: Introduction to Fluid Mechanics (SI Version) 4 th Ed. John Wiley and Sons.
6 Chattopadhyay, P.: Unit Operations of Chemical Engineering, Vol.I, Khanna Publishers, New Delhi.

Course Outcome:
The students of the course should be able to

CO 1: Understand basic laws, principles and phenomena in the area of fluid mechanics
CO2: Learn to perform integral analyses and overall balances for flow systems from conservation laws and differential equations analyses for fields.
CO 3: To apply the acquired knowledge in analyzing and solving different flow problems
CO 4: Understand the usage of fittings and accessories in a flow line
CO 5: Explain the working principles of flow measuring devices and equipment

FTBE/ PC/ B/T/ 216: CHEMICAL ENGINEERING THERMODYNAMICS

Content:

Module I: Basic concepts: Concept of continuum, microscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work, concept of temperature.

Module II: Laws of thermodynamics: Concept of energy and various forms of energy; internal energy, enthalpy; specific heats; first law applied to elementary processes, closed systems and control volumes. Heat, Entropy concept, Entropy and lost work calculations. Microscopic interpretation of entropy. Thermodynamic Relations: Tds relations, Maxwell's equations, Clapeyron equation, Joule-Thomson coefficient, calculation of properties of simple compressible substances, compressibility and expansion coefficient.

Module III: Properties of pure substances: 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.

Module IV: Thermodynamic cycles: Carnot vapor cycle, Ideal Rankine cycle, Rankine reheat cycle, air-standard Otto cycle, air standard Diesel cycle, air-standard Brayton cycle, vapor-compression refrigeration cycle. Dalton's and Amagat's laws, properties of ideal gas mixtures, air-water vapor mixtures and simple thermodynamic processes involving them

Recommended Books:

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
3. Eastop, T.D. and McConkey, A.: Applied Thermodynamics, III ed., Longmans.
4. Wark, Kennith: Thermodynamics, McGraw Hill
5 Jouganson, R: Fan Engineering, Buffalo Rorge Co.,
6 Wangham, D.A: Theory and Practice of Heat Engines, ELBS Cambridge University Press,
7 Lyle, O.: Efficient use of Steam, HMSO,
8 Stoccker, W.F.: Refrigeration and Air Conditioning, Mc-Graw Hill,

Course Outcome:

The students of the course should be able to
CO1: Explain different thermodynamic properties and laws of thermodynamics
CO2: Solve different problems related to thermodynamic principles
CO3: Describe the concept of thermodynamic equilibrium
CO4: Describe the properties of pure substances
CO5: Design different components of refrigeration system

FTBE/ PC/ B/T/ 217: HEAT TRANSFER

Content:

Module I: Conduction: Basic concept of 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.

Module II: Convection: Basic concept of convection. Free and forced convection, concept of heat transfer co-efficient, dimensionless numbers in free and forced convection, Dimensional analysis, Determination of Heat transfer coefficient using heat and momentum transfer analogies, experimental determination of heat transfer coefficient and common working correlations.

Module III: Radiation heat transfer: Basic concept of radiation. Black Body radiation, and grey body radiation, physical mechanism, radiation properties and shape factor, heat exchange between non-black bodies, radiation shields pyrometer and effect of radiation on temperature measurement

Module IV: Design of heat transfer equipment: Double pipe heat exchanger, concept of LMTD, DPHE sizing; shell and tube heat exchanger, effectiveness-NTU method, construction aspects in brief, Bell Delaware Method. Design aspects of finned tube and other compact heat exchangers

*Module V: Basics of Heat transfer with phase change***:** Introduction to boiling, Introduction to condensation

Design aspects of Condensers and Evaporators; Unsteady state heat transfer

Recommended Books:

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.

Course Outcome:

Students will be able to

CO1: Describe different heat transfer phenomena.
CO2: Identify and analyze different modes of heat transfer
CO3: Design double pipe heat exchanger, shell and tube heat exchanger, finned tube and other compact heat exchangers
CO4: Analyze the issues regarding heat transfer during phase change
CO5: Design condenser and evaporator

FTBE/ BS/ B/S/ 211: BASICS OF MICROBIOLOGY LABORATORY

Content:

- Study of a compound microscope.
- Preparation of media for bacteria, yeasts and molds
- Morphology of bacteria, yeasts and molds
- Gram staining of bacteria
- Observation of shape, size of bacteria
- Spore staining of bacteria (observation of spore in bacteria)
- Techniques of pure culture (pour plate and streak plate method)
- Methylene blue reduction time test for milk
- Determination of thermal death point of bacteria
- Bacteriological examination of water and milk
- Growth curve of bacteria.

Course Outcome:
The students of the course should be able to
CO1: Operate a compound microscope
CO2: Describe morphological features of microorganism
CO3: Prepare media for growth of microorganism
CO4: Apply the techniques to detect, count and characterize microorganism present in different food samples

SECOND YEAR-SECOND SEMESTER

Subject Code	Name of the Subject	Category	Type	Contact L-T-P	Credit	Marks
FTBE/ BS/ B/T/ 221	Biochemistry & Nutrition - II	BS	B	3-0-0	3	100
FTBE/ PC/ B/T/ 222	Food Microbiology	PC	B	3-0-0	3	100
FTBE/ PC/ B/T/ 223	Principles of Food Preservation - I	PC	B	3-0-0	3	100
FTBE/ PC/ B/T/ 224	Food Process Technology- I	PC	B	3-0-0	3	100
FTBE/ PC/ B/T/ 225	Chemical Engineering Kinetics	PC	B	3-0-0	3	100
FTBE/ PC/ B/T/ 226	Mechanical Operation	PC	B	3-0-0	3	100
FTBE/ ES/ B/ME/T/ 227	Thermal Engineering	ES	B	3-0-0	3	100
FTBE/ PC/ B/S/ 221	Chemistry of Food Laboratory	PC	B	0-0-4	2	100
				Total	23	800

FTBE/ BS/ B/T/ 221:BIOCHEMISTRY & NUTRITION – II

Content:

Module I: Enzymes: Introduction, classification, nomenclature, structures and functions of enzymes in the human body; 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.

Module II: Vitamins and Minerals: occurrence, structures, functions, of vitamins and minerals in the human body; deficiency diseases; daily requirements and roles in metabolism of vitamin A, D, E, K, C, B1, B2, niacin, pyridoxine, cyanacobalamin, folic acid, choline, *p*-aminobenzoic acid; specific roles of iron, calcium, phosphorus, iodine, sodium, chlorine, potassium, copper and magnesium.

Module III: Nucleic acids: definitions and structures of nucleic acids- DNA and RNA, replication, transcription and translation.

Module IV: Human nutrition: concept of a balanced diet and principles of meal planning; overview of human dietary requirements (RDA); factors affecting bioavailability of nutrients; dietary supplements; nutritional status of Indian populations; problems of under and over nutrition; pediatric and geriatric foods; common degenerative disorders related to nutrition.

Recommended Books:

1. Lehninger Principles of Biochemistry by D.L. Nelson and M. M. Cox, W.H. Freeman & Co., USA
2. Fundamentals of Biochemistry by J.L. Jain, S. Jain and N. Jain, S. Chand, New Delhi, India
3. Biochemistry by Debajyoti Das, Academic Publishers, New Delhi, India

Course Outcome:

The students of the course should be able to

CO1: Describe classification, structures, functions and mechanisms of action of enzymes in the human body
CO2: Describe classification, structures and functions of vitamins in the human body
CO3: Describe classification, structures and functions of minerals in the human body
CO4: Describe classification, structures and functions of nucleic acids in the human body
CO5: Describe bioavailability of nutrients and nutrient-related disorders of the human body

FTBE/ PC/ B/T/ 222 : FOOD MICROBIOLOGY

Content:

Module I: Classification of bacteria: Taxonomy, differentiation and classification of bacteria.

Module II: Factors required for the growth of microorganism in food: Role and significance of microorganisms in foods. Intrinsic and extrinsic parameters of foods that affect microbial growth. Microorganisms important in food microbiology. Food sanitation, hygiene, control and inspection.

Module III: Food spoilage caused by microorganism: General principles underlying spoilage and chemical changes of foods caused by microorganisms. Microbiology of air water, milk and milk products. Mycotoxin.

Module IV: Growth of microorganism in food: Fermented foods, Food borne infection and intoxication.

Module V: Detection of microorganism in food: Contamination and preservations of food. 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.)

Recommended Books:

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

Course Outcome:
The students of the course should be able to
CO1: Explain the differentiation and classification of bacteria.
CO2: Describe the factors required for the growth of microorganism in food
CO3: Identify the causes of food spoilage.
CO4: Describe the growth of microorganism in food.
CO5: Explain the detection techniques of microorganism in food.

FTBE/ PC/ B/T/ 223:PRINCIPLES OF FOOD PRESERVATION – I
Content:

Module I: Introduction to food preservation: Concept of food preservation, causes of food spoilage-microbiological, enzymatic and biochemical changes in food, concepts of senescence or aging, biotic, abiotic and oxidative stress in foods; water activity scale

*Module II: 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.

Module III: Preservation by removal of heat: Freezing process, rate of freezing, effects of freezing on proximate composition of foods, thawing, preliminary introduction to freezers and cold storage, dehydrofreezing, freeze drying, cryoprotectants and antifreeze proteins, frozen storage and thawing of foods.

Recommended Books:

1. The Technology of Food Preservation by J.N. Desrosier and N. W. Desrosier, AVI Publishing company Inc., USA,
2. Food Science by N.N. Potter and J.H. Hotchkiss, AVI Publishing company Inc., USA,
3. Food Preservation Techniques by P. Zeuthen and L.B. Sorensen, Woodhead Publishing Ltd., UK,

Course Outcome:
The students of the course should be able to

CO1: Understand and describe causes of food spoilage and concepts of food preservation, principally related to the microbiological aspects.
CO2: Explain and analyze food preservation by removal of water.
CO3: Understand and describe causes of food spoilage and concepts of food preservation, principally related to enzymatic and biochemical changes in foods.

CO4: Explain and analyze food preservation by removal of heat.

FTBE/ PC/ B/T/ 224 : FOOD PROCESS TECHNOLOGY- I

Content:

Module I: Methods of Fish catching, handling and preservation of fish: Methods of catching, handling & transport of fish, biochemistry of fish spoilage, Average composition of fish; assessment of quality of fish, Methods of Preservation of fish: Canning, Freezing, Drying, Salting, Smoking and Curing. Packaging of commercial fish and fish products.

Module II: Production methods of different fish products: Fish products - production of fish meal, fish protein concentrate, fish liver oil and fish sauce and other important byproducts; Quality control of processed fish. General idea of Common machineries required for fish processing plants: working principles and Specifications.

Module III: Characteristics and preservation of meat and meat products: Meat cuts and portions of meat, physicochemical composition of muscle, protein including connective tissue, fat. Preservation techniques of meat by curing and smoking and equipment involved. Commercially important meat products-sausage, ham, bacon.

Module IV: Characteristics and preservation of poultry, egg and egg products: Poultry- structure and composition of egg. Nutritive value of egg. Physical and chemical spoilage of egg. Preservation of eggs by different methods, egg quality assessment.

Recommended Books:

1. R. L. Henricksons: Meat, Poultry and Sea Food Technology
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

Course Outcome:
The students of the course should be able to –

CO1: Describe different methods of fish catching, transportation and detection of fish quality and methods of fish preservation
CO2: Explain the methods of producing different fish products and working principal of machineries required for that.
CO3: Explain the physicochemical composition of meat, their preservation methods along with equipment involved.
CO4: Describe the structure and composition of egg along with its nutritive value, reasons for spoilage of egg, methods of preservation and its quality assessment.

FTBE/ PC/ B/T/ 225 : CHEMICAL ENGINEERING KINETICS
Contents:

Module I: Reactions and reaction rates: Stoichiometry, extent of reactions, conversion, Selectivity
Reaction rate fundamentals - elementary reaction sequences, steady state approximation and rate limiting step theory.

Module II: Ideal reactors: Generalized material balance, design equations, graphical interpretation.

*Module III: Sizing and analysis of ideal batch, mixed (CSTR), plug flow and recycle reactors***:** Solving design equations for constant and variable density systems, reactors in series and parallel. Arrhenius equation.

Module IV: Analysis and correlation of experimental kinetic data: Data collection & plotting, linearization of rate equations, differential and integral method of analysis.

Module V: Introduction to Catalysis, homogeneous and heterogeneous catalysis: Preparation and Characterization of catalysts, catalyst poisoning.

Module VI: Physical and chemical adsorption: Adsorption isotherms, Determination of BET surface area and pore volume of the Catalyst.

Recommended Books:

1. Elements of Chemical Reaction Engineering by H. Scott Fogler, 2nd Edition, Prentice Hall
2. Chemical Reaction Engineering by Octave Levenspiel, 3rd Edition, John Wiley & Sons,
3. Chemical and Catalytic Reaction Engineering, Carberry, J. J., Dover Books on Chemistry

Course Outcome:

Students will be able to

CO1: Design chemical reactors involving heat effects optimally using minimum amount of data
CO2: Fix some problems related to operability and productivity
CO3: Operate reactors in a safe manner for single reactions
CO4: Understand the concept of homogeneous catalytic reaction
CO5: Understand the concept of heterogeneous catalytic reaction

FTBE/ PC/ B/T/ 226: MECHANICAL OPERATION

Content:
Module I: Solids and Its Flow Properties: Characterization of solid particles, Mixed particles sizes and analysis, Screen analysis, properties of particulate masses, Screening equipment, Comparison of ideal and actual screens, Screen effectiveness. Mixing of solids, Mixer for cohesive solids, Mixer for free flowing solids.

Module II: Size Reduction, Enlargement, Screening: Principles of comminution, Rittinger's and Kick's laws, Bond's crushing law and work index, Size reduction equipment's, crushers, grinders, Ultra fine grinders, Cutting machines, Open circuit and closed circuit operation. Different size enlargement processes.

Module III: Fluidization and Conveying: Conditions for Fluidization, Types and application of fluidization, Slurry and pneumatic transport, Conveyers.

Module IV: Filtration and Sedimentation: Introduction, different types of filters, Gravity classifiers, Sink and float method, Differential settling methods, Clarifiers and thickeners, Batch sedimentation, Rate of sedimentation, Thickeners, sedimentation zones in continuous thickeners, Cyclones, Hydrocyclones, Cenrifuge.

Mixing-Agitation and fluid:
Different types of agitators and their selection criteria, Calculation of power required for agitation, Scale up of agitated vessel.

Recommended Books:

1. McCabe W.L. and Smith J.C., Unit operation in chemical engineering, 5 Ed., McGraw Hill New York 1993.
2. Foust A. S. & Associates, "Principles of Unit Operations" John Wiley and Sons , 1980
3. Perry R.H. & Chilton C.H., "Chemical Engineers Hand Book", 7th ed. McGraw hill
4. Badger and Bencharo, "Introduction to Chemical Engineering". Tata McGraw hill, 1997
5. S. K. Gupta, "Momentum Transfer Operation". Tata McGraw Hill,1979
6. Coulson and Richardson: Chemical Engineering, Vol. 2.Butterworth Heinemann Pub
7. Welty, Wicks, Wilson & Rorrer, Fundamentals of Momentum, Heat and Mass Transfer, 4th ed. Wiley
8. Narayanan C.M.& Bhattacharya B.C. "Mechanical Operations for Chemical engineers", Khanna Publishers. 3rd Ed.1999

Course Outcome:
After completion of the course the students should be able to:
CO1: To acquire basic knowledge of various mechanical operations.
CO2: To build up knowledge, practical importance and relevance of unit operations used for comminuting in chemical industry.
CO3: To utilize the technological methods related to unit operations in different plants.
CO4: To study a detailed overview of equipment used to perform various mechanical operations and problems associated during the implementation and applications.
CO5: To build a bridge between theoretical and practical concept used in industry

FTBE/ ES/ B/ME/T/ 227 : THERMAL ENGINEERING

Content:
Introduction to engineering thermodynamics.
Study of properties of steam. Study of different types of boilers.
Different types of heat engines (with descriptive study). Different heat transfer equipment.
Descriptive study of small power plant and water treatment plants.

Course Outcome:
After completion of the course the students should be able to:
CO1 : Acquire basic knowledge of steam properties.
CO2 : Understand operations and applications of boilers
CO3 : Comprehend the principles of action of heat engines
CO4 : Explain the composition and mode of action of small power plant.

Recommended Books:

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.
3. Wangham, D.A.: Theory and Practice of Heat Engines, ELBS Cambridge University Press.
4. Lyle, O.: Efficient use of Steam, HMSO.
5. Stoccker, W.F.: Refrigeration and Air Conditioning, Mc-Graw Hill.
6. Hegde R K, Power Plant Engineering, Pearson.

FTBE/ PC/ B/S/ 221: CHEMISTRY OF FOOD LABORATORY

Content:
- Determination of proximate composition of foods: moisture, ash, protein, crude fat, crude fiber, total carbohydrates
- Titrimetric determinations of- reducing and non-reducing sugars in foods
- Saponification value, acid value, peroxide value of fats and oils
- Estimation of phosphorus content of a food sample
- Identification of water and oil soluble dyes

Course Outcome:
The students of the course should be able to
CO1: Determine the proximate composition of a food sample.
CO2: Estimate the sugar content of a food sample.
CO3: Explain the quality of a fat/oil sample.
CO4: Estimate the Phosphorus content of a food sample
CO5: Identify different dyes present in food sample.

THIRD YEAR-FIRST SEMESTER

Subject Code	Name of the Subject	Category	Type	Contact L-T-P	Credit	Marks
FTBE/ PC/ B/T/ 311	Biochemical Engineering-I	PC	B	3-0-0	3	100
FTBE/ PC/ B/T/ 312	Principles of Food Preservation - II	PC	B	3-0-0	3	100
FTBE/ PC/ B/T/ 313	Food Process Technology - II	PC	B	3-0-0	3	100
FTBE/ PC/ B/T/ 314	Food Process Technology - III	PC	B	3-0-0	3	100
FTBE/ PC/ B/T/ 315	Mass Transfer Operation I	PC	B	3-0-0	3	100
FTBE/ PC/ B/T/ 316	Microbial Technology	PC	B	3-0-0	3	100
FTBE/ ES/ H/T/ 317	Mechanics of Solid	ES	H	3-0-0	3	100
FTBE/ PC/ B/S/ 311	Microbial Technology Laboratory-I	PC	B	0-0-4	2	100
FTBE/ PC/ B/S/ 312	Biochemical Engineering Laboratory - I	PC	B	0-0-4	2	100
FTBE/ PC/H /S / 313	Assignment / Mini Project	PC	H	0-2-3	3.5	100
				Total	28.5	1000

FTBE/ PC/ B/T/ 311: BIOCHEMICAL ENGINEERING-I

Content:

Module I: Dynamics of microbial growth: growth pattern and kinetics, different growth models, microbial growth in batch and continuous system. Submerged fermentation, solid state fermentation.

Module II: Sterilization process: Kinetics of thermal death of microorganisms. Mechanisms of thermal sterilization and sterilization by filtration. Design criteria and design equations for process design of air.

Module III: Down stream processing: Recovery of cell and solid particles, filtration, centrifugation, membrane separation, sedimentation, reverse osmosis, ultrafiltration, fixed bed adsorption, chromatography, electrophoresis and other emerging technologies.

Module IV: Recombination of DNA: Recombinant DNA Technology and genetically modified foods.

Couse Outcome:
The students of the course should be able to
CO1: Students will able to understand microbial growth kinetics in different fermentation systems.
CO2: Comprehend media and air sterilization mechanisms.
CO3: Apply knowledge on downstream processing in fermentation processes.
CO4: Explain Recombinant DNA Technology.

FTBE/ PC/ B/T/ 312: PRINCIPLES OF FOOD PRESERVATION-II

Content:

Module I: Preservation by addition of heat: pasteurization, sterilization, blanching, cooking, frying, roasting, baking, canning and extrusion

Module II: Preservation by food additives: detailed mechanism of action of acidulants, preservatives, emulsifiers, coloring agents, flavoring agents, hydrocolloids and sweeteners (nutritive and non-nutritive) and their applications in various food products

Module III: Other methods of preservation: curing, pickling, smoking, fermentation, hurdle technology

Recommended Books:

1. The Technology of Food Preservation by J.N. Desrosier and N. W. Desrosier, AVI Publishing company Inc., USA, 1970.
2. Food Science by N.N. Potter and J.H. Hotchkiss, AVI Publishing company Inc., USA, 1986.
3. Food Additives, by A.L. Branen, P.M. Davidson, S. Salminen and J.H. Thorngate III, Marcel Dekker Inc., New York, 2001.
4. Food Preservation Techniques by P. Zeuthen and L.B. Sorensen, Woodhead Publishing Ltd., CRC Press, London, 2003.

Couse Outcome:
The students of the course should be able to

CO1: Understand and describe food preservation by addition of heat
CO2: Explain and analyze methods of food preservation by addition of heat
CO3: Understand and describe food preservation by food additives and other miscellaneous methods of food preservation CO4: Explain and analyze food preservation by addition of food additives and by other miscellaneous methods of food preservation

FTBE/ PC/ B/T/ 313: FOOD PROCESS TECHNOLOGY- II

Content:

Module I: 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 testing and machineries required for biscuit, cake and crackers; 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 anti-nutritional factors in cereals.

Module II: 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.

Module III: Oil seeds, processing and products: extraction of vegetable oils from oilseeds: rendering, pressing, solvent extraction, accelerated solvent extraction, design of extractors, factors contributing to cost reduction and oil improvement in oil quality during vegetable oil extraction; membrane technology in vegetable oil industry.

Module IV: Refining of extracted oils: physical and chemical refining including degumming, neutralization, bleaching, deodorization, oil conditioning, dewaxing, fractionation, winterization, hydrogenation, molecular distillation, interesterification, lecithin recovery; alternate solvents for oil extraction; pervaporative dehydration of oil, new neutralization processes.

Module V: Product development using fats and oils: Application development, analytical development and triglyceride replication; liquid oil formulations: cooking oils, salad oils and high stability oils; blending of oils; Plastic fats: concept of plasticity in fats: manufacture, physicochemical properties and applications of plastic shortenings and margarine?
Oilseed protein: technology of production of oilseed proteins isolates

Recommended Books:

1. Food Oils and Fats: Technology, Utilization and Nutrition, by H.W. Lawson, Springer, Berlin, 1995.
2. Fats and Oils: Formulating and Processing for Applications, by R. D. O'Brien, CRC Press, Boca Raton, USA, 2003
3. Bailey's Industrial Oil and Fat Products, 6 volume set, by JF. Shahidi (Ed.), Wiley-Blackwell, New Jersey, USA, 2005.
4. .Oilseeds: Properties, Processing, Products and Procedure, by G. Nagraj, New India Publishing Agency, New Delhi, 2009.

Couse Outcome:

The students of the course should be able to

CO1: Understand and describe processing of different cereals, pulses and legumes
CO2: Explain and analyze processing of cereals, pulses and legumes

CO3: Understand and describe processes of extraction-cum-refining of edible oils from oilseed; and fat/oil-based product development
CO4: Explain and analyze processes of extraction-cum-refining of edible oils from oilseed; and fat/oil-based product development

FTBE/ PC/ B/T/ 314: FOOD PROCESS TECHNOLOGY – III

Content:

Module I: Fruits and Vegetables: storage and handling of fresh fruits and vegetables; physical and chemical treatments to increase post-harvest life of fruits and vegetables; different methods of preservation of fruits and vegetables such as osmotic dehydration, canning and aseptic processing; fruit juice extraction and preparation of soft drinks, syrups, squashes, cordials, nectars, jam, jelly, marmalade, candies, ketchup, pickles, tomato products, fruit juice concentrates and powders, minimally processed fruits and vegetables and coconut products.

Module II: Spices and Herbs: definition and classification; introduction to different types of spices and herbs of nutritional and medicinal importance; active principles, flavor profiles and nutraceutical properties of spices and herbs; authenticity of spices; quality parameters/indices of spices and spice products such as essential oils, oleoresins, extracts, isolates and absolutes; common adulterants in spices and spice products, namely essential oils and their detection techniques; extraction technologies for flavor and bioactives of spices and herbs, preservation of spice extracts as encapsulates and liposomes.

Module III: Confectioneries and fat replacers: technology of manufacture of chocolate and cocoa products; specialty confectionary fats and special confection products- caramel, butterscotch, fudge, candy and toffee; fat replacers- mayonnaise, salad dressings (pourable and spoanable) and spreads.

Recommended Books:

1. Handbook of Herbs and Spices, by K.V. Peter (Ed.), Woodhead Publishing Ltd., CRC Press, London, 2001.
2. Fats and Oils: Formulating and Processing for Applications, by R. D. O'Brien, CRC Press, Boca Raton, USA, 2003.
3. Bailey's Industrial Oil and Fat Products, 6 volume set, by JF. Shahidi (Ed.), Wiley-Blackwell, New Jersey, USA, 2005.
4. Industrial Chocolate Manufacture and Use, by S.T. Beckett, Wiley-Blackwell, New Jersey, USA, 2008.
5. Preservation of Fruits and Vegetables, by G,L. Tandon, G.S. Siddappa and Girdhari Lal (Eds.), Indian Council of Agricultural Research, New Delhi, 2009.
6. Handbook of Vegetables and Vegetable Processing, by N.K. Sinha (Eds.), Wiley-Blackwell, New Jersey, USA, 2010.
7. Chocolate Science and Technology, by Emmanuel Afoakwa, Wiley-Blackwell, New Jersey, USA, 2010.
8. Handbook of Fruits and Fruit Processing, by N.K. Sinha (Eds.), Wiley-Blackwell, New Jersey, USA, 2012.
9. Chocolate, Cocoa and Confectionary: Science and Technology, by B.W. Minifie, Springer, USA, 2012.
10. Handbook of Analysis and Quality Control for Fruit and Vegetable Products, by S. Ranganna, McGraw Hill Education, New York, 2017.

Couse Outcome:

The students of the course should be able to

CO1: Understand and describe processing of different fruits and vegetables
CO2: Explain and analyze processing of fruits and vegetables
CO3: Understand and describe processing of spices-herbs; and confectionaries-cum-fat replacers
CO4: Explain and analyze processing of spices-herbs; and confectionaries-cum-fat replacers

FTBE/ PC/ B/T/ 315: MASS TRANSFER OPERATION-I

Content:

Module I: Introduction to mass transfer, molecular diffusion in gas, liquid and solid, diffusivity, interphase mass transfer, mass transfer coefficients.

Module II: Gas absorption, countercurrent multistage operations, packed towers, plate towers

Module III: Introduction to liquid – liquid extraction, selectivity and choice of solvent, material balances in single and multistage operations, graphical methods in determination of number of stages.

Module IV: Fundamental principles of leaching operations, applications, material balance in single and multistage operations, equipment used in leaching operations.

Recommended Books:

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.

Couse Outcome:

The students of the course should be able to
CO1: Describe the mechanisms of molecular diffusion through solid/ liquid / gaseous materials
CO2: Describe the mechanisms of mass transfer across different phases
CO3: Analyze the mass transfer process of liquid-liquid extraction for single and multi-stage operation and solve numerical problems.
CO4: Describe the process of leaching, industrial equipment used and solve problems.

FTBE/ PC/ B/T/ 316: MICROBIAL TECHNOLOGY

Content:
Module I: Economic activities of microorganisms, Classification of Microbial Products, Media for Fermentation, Importance of media components for production of industrial products by fermentation. Importance of pH, temperature, aeration in fermentation. Fermentative production of alcoholic beverages: Backers yeast. Production of alcohol, glycerol and beer. Mechanism of alcohol and glycerol fermentation. Production of wine and other alcoholic beverages (Whiskey, rum etc.)

Module II: Fermentative production of metabolites: 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. Activities of lactic acid bacteria and industrial production of lactic acid. Production and isolation of antibacterial and antifungal antibiotics.

Module III: Microbial production of enzymes and their applications: Production, isolation and purification of microbial enzymes. Immobilized enzymes and their applications. Production of glucose and fructose from starch by enzymatic methods. Microbiological transformation of steroids.

Module IV: Microbial biomass production and its application: Production of mushroom. Production of algal protein and recent advances. Production of Single cell protein.

Recommended Books:

1. Food Microbiology; Frazier WC; 4th ed, Tata-McGrowhill Pub.
2. Modern Food Microbiology; Jay JM; 4th ed, CBS Publishers.
3. Microbiology; Pelczar, Chan & Krieg; Tata-McGrawHill Pub.
4. Food Microbiology; Adams MR & Moss MD; New Age International (P) Ltd Pub.
5. Fundamental Principles of Bacteriology; Salle AJ; 7th ed, 1985, Tata-McGraw-Hill
6. Industrial Microbiology; Prescott & Dunn, CBS Publisher

Course Outcomes:

The students of the course should be able to
CO1: Understand the basic requirements for fermentative production of metabolites.
CO2: Explain the fermentative production of alcoholic beverages.
CO3: Describe fermentative production of different metabolites.
CO4: Discuss the processes of microbial production of enzymes, biomass and their application.

FTBE/ ES/ H/T/ 317 : MECHANICS OF SOLID

Content:

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/ PC/ B/S/ 311: MICROBIAL TECHNOLOGY LABORATORY I

Content:

Qualitative & quantitative studies on the microbial production of
1. Alpha-amylase
2. Fungal amyloglucocidase,
3. Glutamic acid
4. Citric acid
5. Vitamins

Course Outcome:
The students of the course should be able to
CO1: Describe the methods of microbial production of different metabolites
CO2: Estimate qualitatively and quantitatively the target metabolites produced by microorganisms
CO3: Understand the role of different parameters for microbial production of different metabolites

FTBE/ PC/ B/S/ 312: BIOCHEMICAL ENGINEERING LABORATORY – I

Content:
1. BOD analysis of industrial waste
2. COD analysis of industrial waste
3. Kinetics study on agar drying
4. Study on the enzyme reaction kinetics and comparison with theoretical L-B model
5. K_La determination of a liquid medium by sulphite oxidation method
6. Rheological study on CMC solution with the help of Brook Field Viscometer

Couse Outcome:
The students of the course should be able to
CO1: Determine BOD of a sample of waste water
CO2: Determine COD of a sample of waste water
CO3: Describe drying characteristics of commercial agar gels
CO4: Explain enzyme reaction kinetics
CO5: Determine K_La of a liquid medium
CO6: Describe the rheological characteristics of CMC solution

FTBE/ PC/H /S / 313 ASSIGNMENT / MINI PROJECT

Students will be assigned a major problem on selected designs of plant and equipment related to food and biochemical processing industries under the guidance of departmental teachers.
Alternatively, the students will be assigned a major research project work and generate new experimental data under the guidance of departmental teachers.

CO1: Apply domain knowledge in- designing plant equipment of food processing and biochemical industries/research projects

CO2: Create new knowledge for industries and academia

THIRD YEAR-SECOND SEMESTER

Subject Code	Name of the Subject	Category	Type	Contact L-T-P	Credit	Marks
FTBE/ PC/ B/T/ 321	Food Process Engineering	PC	B	3-0-0	3	100
FTBE/ PC/ B/T/ 322	Food Packaging Technology	PC	B	3-0-0	3	100
FTBE/ PC/ B/T/ 323	Biochemical Engineering - II	PC	B	3-0-0	3	100
FTBE/ PC/ B/T/ 324	Mass Transfer Operation II	PC	B	3-0-0	3	100
FTBE/ PC/ B/T/ 325	Food Process Technology-IV	PC	B	3-0-0	3	100
FTBE/ ES/ H /ME /T/ 326	Machine Design and Drawing	ES	H	3-0-0	3	100
FTBE/ PC/ B/S/ 321	Biochemical Engineering Laboratory II	PC	B	0-0-4	2	100
FTBE/ PC/ B/S/ 322	Microbial Technology Laboratory-II	PC	B	0-0-4	2	100
FTBE/ ES/H / ME/S/ 323	Machine Design and Drawing Laboratory	ES	H	0-0-3	1.5	100
FTBE/ PS/ B/S/ 324	Internship / Training	PS	B	0-0-0	0	0
				Total	23.5	900

FTBE/ PC/ B/T/ 321: FOOD PROCESS ENGINEERING

Content:

Module I: Engineering properties of foods: rheological and flow properties, thermal and thermodynamic properties, aerodynamic and hydrodynamic properties and surface properties of solid and liquid foods

Module II: Engineering aspects of dehydration processes: 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

Module III: Engineering aspects of freezing processes: engineering aspects of different types of freezers used in the food industry including plate freezers, air blast freezers (straight belt and spiral belt), fluidized bed freezer, immersion freezer, freezer for liquid food and cryogenic freezers (liquid carbon dioxide and liquid nitrogen based); newer developments in conventional freezers; transportation of frozen foods by refrigerated vans and wagons; cold storage design; determination of freezing time by different approaches- Plank, Nagaoka, Cleland & Earle, Tao and Mott.

Module IV: Engineering aspects of sterilization processes: rate of microbial inactivation and different types of microbial inactivation curves; sterilizing value or lethality of a process and acceptable sterilizing values for food processing operations; determination of D values using partial sterilization technique; design of continuous flow sterilizer (aseptic cold fill) based on concept of integrated lethality; methods of determination of process time for canned foods and retorts-Bigelow method, Ball method and Stumbo method considering simple heating curve.

Module V: Storage properties of grains and seeds: evaluation of true and bulk density, porosity, equivalent diameter, sphericity, angle of repose, terminal velocity, static co-efficient of friction of grains and seeds

Recommended Books:

1. Fundamentals of Food Engineering, by S.E. Charm, AVI Publishing company Inc., USA, 1971.
2. A Complete Course in Canning and Related Processes: Packaging, aseptic processing, ingredients, by A. Lopez, Canning Trade, USA, 1987.
3. Food Process Engineering: Theory and Laboratory Experiments, by K. Sharma, S.J. Mulvaney and S.S.H. Rizvi, Wiley-Blackwell, New Jersey, USA, 1999.
4. Fundamentals of Food Process Engineering, by R. T. Toledo, CBS Publishers & Distributors, New Delhi, 2000.
5. Introduction to Food Engineering, by R.P. Singh and D. R. Heldman, 5th ed., Academic Press, USA, 2013.

Couse Outcome:

The students of the course should be able to

CO1: Understand and describe engineering properties of different food products; and engineering aspects of dehydration processes
CO2: Explain and analyze engineering properties of food products; and engineering aspects of dehydration processes
CO3: Understand and describe engineering aspects of freezing and sterilization processes; and storage properties of grains and seeds
CO4: Explain and analyze engineering aspects of freezing and sterilization processes; and storage properties of grains and seeds

FTBE/ PC/ B/T/ 322: FOOD PACKAGING TECHNOLOGY

Content:

Module I: Introduction to food packaging: Definition and objectives of packaging

Module II: Different types of packaging materials: rigid, semi-rigid and flexible packaging materials, their manufacturing processes and physicochemical properties such as mechanical, optical and barrier properties (WVTR, GTR)
Packaging requirements for different food products: design of rigid and flexible composites/laminates for various food products: dehydrated foods, frozen foods, dairy products, fruits and vegetables, meat, poultry and sea foods

Module III: Operations in food packaging technology: bottling, canning, vacuum and gas packaging, retort packaging; shrink packaging, aseptic packaging- complete aseptic packaging (UHT), semi-aseptic packaging; aseptic packaging; machinery for consumer packs with special emphasis on form-fill-seal machines, Tetra Brik, Pure Pak, direct and indirect heat sterilizers

Module IV: Modern developments in packaging technology: active and intelligent packaging- oxygen scavengers, ethylene scavengers, carbon dioxide scavenger-cum-emitter, moisture regulator, antioxidant releaser, ethanol generators, packaging for release or absorption of flavors or aromas, TTI packaging and antimicrobial packaging; modified atmospheric packaging- gas packaging and vacuum packaging; *sous-vide* packaging technology; edible films and biodegradable films

Module V: Packaging standards and regulations: laws, specifications and quality control, testing procedures for packaging materials

Recommended Books:

1. Flexible Packaging of Foods, by A. Brody, CRC Press, London, 1970.
2. Principles of Food Packaging, by S. Sacharow and R.C. Griffin, AVI Publishing company Inc., USA, 1980.
3. Food Packaging Science and Technology, by D.S. Lee, K.L. Yam and L. Piergiovanni, CRC Press, London, 2008.
4. Food Packaging: Principles and Practice, by G.L. Robertson, CRC Press, London, 2012.

Couse Outcome:
The students of the course should be able to

CO1: Understand and describe objectives of food packaging, packaging laws and regulations; different types of rigid packaging materials; and packaging requirements for different food products
CO2: Explain and analyze various operations of rigid packaging of food products
CO3: Understand and describe objectives of food packaging, packaging laws and regulations; different types of flexible packaging materials; and packaging requirements for different food products
CO4: Explain and analyze the modern developments in flexible packaging of food products

FTBE/ PC/ B/T/ 323: BIOCHEMICAL ENGINEERING-II

Content:

Biochemical reactors: Different types of bioreactors in use and their operation.
Material of construction for fermentation process equipment's. Design and analysis of biological reactors. Design of spargers, aeration equipment's and agitators.
Aeration and agitation-oxygen supply and demand in microbial processes: single and multiple bubble aeration.
Scale up of biological reactor.

Couse Outcome:

The students of the course should be able to
CO1: Comprehend the operation of different bioreactors
CO2: Apply the knowledge to design different bioreactor systems
CO3: Understand the aeration process in bioreactors
CO4: Apply the knowledge to scale up fermenter
CO5: Comprehend different analytical instruments used in fermenters

FTBE/ PC/ B/T/ 324: MASS TRANSFER OPERATION- II

Content:

Module I: *Distillation:* Vapor-liquid Equilibrium, relative volatility, batch and equilibrium distillation, theory of rectification; design of distillation column.

Module II: Dehumidification: Principles of dehumidification operations, use of psychrometric chart, numerical problems on psychometry.

Module III: *Drying:* Theory of drying of solids, water activity, drying curves, factors affecting rate of drying, introduction to type of dryers, theory of freeze drying, drying time calculations.

Module IV: *Crystallization:* Theory of crystallization, material and energy balance calculations and introduction to crystallizer design.

Recommended Books:

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.

Couse Outcome:

The students of the course should be able to

CO1: Describe the mechanisms of distillation processes
CO2: Understand the principle of dehumidification process and how to refer psychrometric chart.
CO3: Analyze drying operation processes at industrial scale, equipment required and also solve numerical problems on drying time calculations.
CO4: Acquire knowledge on the design aspects regarding a crystallizer.

FTBE/ PC/ B/T/ 325: FOOD PROCESS TECHNOLOGY IV:

Content:

Module I: Dairy products: composition and nutritive value of milk, microbiology of milk, pasteurization, standardization, toning and homogenization; technology of production of dried whole milk, condensed milk, cream, butter, ghee, margarine, fermented milk products, cheese and ice cream.

Module II: Non-alcoholic b*everages:* Classification of beverages, technology of manufacture of mineral water, technology of manufacture of non-alcoholic beverages: fruit & vegetable juices, carbonated soft drinks and dairy beverages; chemistry and technology of tea, processing and production, varieties of tea, flavor of tea, byproducts of tea, tea substitutes and adulterants in tea; chemistry and technology of coffee, processing and production, varieties of coffee, flavor of coffee, instant coffee, coffee substitutes, chicory production and cocoa powder production.

Module III: Enzymes in food processing: sources of industrial enzymes, technical enzyme preparations, use of enzymes in food processing such as in baking, brewing, oil processing and product development, dairy processing, fruit & vegetable processing, tea & coffee processing, starch & sugar processing and in animal feed with examples of specific enzymes.

Module IV: Health foods: nutraceuticals and functional foods: definition of nutraceuticals and functional foods; processing of heath and functional foods; types of specialty functional foods - anti-carcinogenic, hypocholesterolemic, hypoglycemic, dietetic, anti-ageing, prebiotic and probiotic foods.

Recommended Books:

1. Coffee Technology, by M. Sivetz and N.W. Desrosier, AVI Publishing company Inc., USA, 1979.
2. Coffee, Volume 1: Chemistry and Volume 2: Technology, by R.J. Clarke (Ed.), Springer, Netherlands, 1987.
3. Enzymes in Food Processing, by G.A. Tucker and L.F.J. Woods, Springer, USA, 1995.
4. Dairy Technology: Principles of Milk Properties and Processes, by P. Walstra et al., CRC Press, London, 1999.
5. Dairy Science and Technology, by P. Walstra, J.T.M. Wouters and T.J. Geurts, CRC Press, Boca Raton, USA, 1999.
6. Outlines of Dairy Technology by S. De, Oxford, 2001.
7. Handbook of Nutraceutical and Functional Foods, by R.E.C. Wildman, CRC Press, Boca Raton, USA, 2001.
8. Handbook of Vegetables and Vegetable Processing, by N.K. Sinha (Eds.), Wiley-Blackwell, New Jersey, USA, 2010.
9. Handbook of Fruits and Fruit Processing, by N.K. Sinha (Eds.), Wiley-Blackwell, New Jersey, USA, 2012.
10. Enzymes in Food Processing, by T. Nagodawithana and G. Reed, Academic Press, USA, 2013.
11. A Text Book on the Chemistry and Agriculture of Tea: Including the Growth and manufacture, Forgotten Books, London, 2017.
12. Nutraceutical and Functional Food Components: Effects of Innovative Processing Techniques, by C. Galanakis, Academic Press, USA, 2017.

Couse Outcome:
The students of the course should be able to

CO1: Understand and describe processes of manufacture of dairy and dairy products; and non-alcoholic beverages such as fruit & vegetable juices; and dairy beverages
CO2: Explain and analyze processes of manufacture of dairy and dairy products; and non-alcoholic beverages such as fruit & vegetable juices; and dairy beverages
CO3: Understand and describe processes of manufacture of non-alcoholic beverages such as soft drinks; and tea and coffee; technical applications of enzymes in manufacture of food products; manufacturing processes of various nutraceutical/functional foods/health foods
CO4: Explain and analyze processes of manufacture of non-alcoholic beverages such as soft drinks; and tea and coffee; technical applications of enzymes in manufacture of food products; manufacturing processes of various nutraceutical/functional foods/health foods

FTBE/ ES/ H /ME /T/ 326 & FTBE/ ES/H / ME/S/ 323 : MACHINE DESIGN AND DRAWING (THEORY AND LABORATORY)

Content:

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/ PC/ B/S/ 321 BIOCHEMICAL ENGINEERING LABORATORY – II

Content:

1. Determination of efficiency of an air sterilizing unit
2. Study of Reaction kinetics of Immobilized enzymes
3. Determination of Specific Death Rate constant of microorganism
4. Determination of size and Density of Yeast cells
5. Study on the settling characteristics of biological suspensions.

Couse Outcome:
The students of the course should be able to

CO1: Complete set up of an air sterilization unit and evaluate its efficiency
CO2: Explain the reaction kinetics of immobilized enzymes
CO3: Determine the Specific Death Rate constant of microorganism
CO4: Determine the size and density of yeast cells
CO5: Explain the settling characteristics of biological suspensions.

FTBE/PC/B/S/322: MICROBIAL TECHNOLOGY LABORATORY II

Content:

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.

Couse Outcome:
The students of the course should be able to

CO1: Describe the method of microbial production of different metabolites
CO2: Estimate qualitatively and quantitatively the target metabolites produced by microorganism
CO3: Estimate microbial quality of food items

FTBE/ PS/B/S/324: INTERNSHIP / TRAINING

Students will undertake industrial training /internship for 2-3 months in selected food processing and/or biochemical industries. The design problem should be worked out by students under the guidance of teachers. A complete report should be submitted by the students within prescribed date.

CO1: Analyze industrial scale processes based on domain knowledge
CO2: Evaluate industrial scale processes based on domain knowledge

FOURTH YEAR-FIRST SEMESTER

Subject Code	Name of the Subject	Category	Type	Contact L-T-P	Credit	Marks
FTBE/ PC/ B/T/ 411	Quality Control & Food Safety	PC	B	3-0-0	3	100
FTBE/ HS/ B/T/ 412	Project Planning , Layout and Economics	HS	B	3-0-0	3	100
	Elective – I					
FTBE/ PE/ B/T/ 413A	Waste Valorization of Food & Biochemical Processes	PE	B	3-0-0	3	100
FTBE/ PE/ B/T/ 413B	Analytical Instruments in Food Analysis: Principles and Practices					
FTBE/ PC/ B/S/ 411	Food Analysis and Quality Control Laboratory	PC	B	0-0-4	2	100
FTBE/ PC/ B/S/ 412	Food Engineering and Food Preservation Laboratory- I	PC	B	0-0-4	2	100
FTBE/ PS/ B/S/ 413	Seminar and Group Discussion- I	PS	B	0-1-3	2.5	100
FTBE/ PC/ H /S/ 414	Design of Food and Biochemical Process Equipment	PC	H	0-1-4	3	100
	Open Elective	OE	B	3-0-0	3	100
				Total	21.5	800

FTBE/ PC/ B/T/ 411: QUALITY CONTROL AND FOOD SAFETY

Content:

Module I: Food quality indices and evaluation procedures: Definition of food quality, quality specifications and attributes of different food products according to food laws especially Codex and FSSAI, classifications, functions and safety limits of food additives such as colors, flavors, antioxidants, emulsifiers, sequesterants, humectants, hydrocolloids, sweeteners, acidulants, anticaking agents and buffering salts; safety and quality evaluation of additives and contaminants, acute and chronic studies, $LD_{50,}$ ADI and NOAEL; role of sampling in food quality analysis; concept of application of fractals in food quality control; anti-nutritional factors, food allergens and food toxins and impact of processing.

Module II: Sensory principles and evaluation methodologies: Methodologies for sensory evaluation - discriminating tests (paired comparison, Duo-trio, triangle), ranking tests, sensitivity test, descriptive tests (category scaling, ratio scaling, flavor profile analysis, texture profile analysis), effective tests (paired performance test, ranking test, hedonic rating scale) and ranking test using fuzzy logic approach

Module III: Statistical quality control methods: Hypothesis testing, F and T test, Chi-square test, one-way and two-way ANOVA

Module IV: Introduction to food safety: definition, types of hazards- biological, physical and chemical; management of hazards

Module V: Food laws and standards: Indian food regulatory regime and global scenario- 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

Module VI: Food safety management tools: GHPs, GMPs, HACCP, ISO series, Environmental Protection Agencies (EPA) and their role in food safety system; TQM, Kaizen, risk analysis, accreditation and auditing

Module VII: Recent concerns in food safety: new and emerging pathogens, genetically modified foods, transgenic foods, organic foods

Recommended Books:

1. Quality Control in the Food Industry, Volume 1, by S.M. Herschdoerfer, Academic Press, London, 1967.
2. The Technology of Food Preservation by J.N. Desrosier and N. W. Desrosier, AVI Publishing company Inc., USA, 1970.
3. Food Science by N.N. Potter and J.H. Hotchkiss, AVI Publishing company Inc., USA, 1986.
4. Sensory Evaluation of Foods: Statistical Methods and Procedures, by M. O'Mahony, CRC Press, Boca Raton, USA, 2002.
5. Food Preservation Techniques by P. Zeuthen and L.B. Sorensen, Woodhead Publishing Ltd., UK, 2003.
6. Statistical Quality Control for the Food Industry, by M. R. Hubbard, Springer, USA, 2003.
7. Food and Nutritional Toxicology, by S.T. Oamye, CRC Press, Boca Raton, USA, 2004.
8. Sensory Evaluation Practices, by H. Stone and J. Sidel, Academic Press, London, 2004.
9. Food Toxicology, by D. Bagchi and A. Swaroop, CRC Press, Boca Raton, USA, 2017.

Couse Outcome:
The students of the course should be able to

CO1: Understand and describe food quality indices and assessment procedures; sensory principles and evaluation methodologies; and statistical quality methods
CO2: Explain and analyze food quality indices and assessment procedures; sensory principles and evaluation methodologies; and statistical quality methods
CO3: Understand and describe principles of food safety; food laws and standards; food safety management tools; and state-of-the-art procedures in handling food safety issues
CO4: Explain and analyze principles of food safety; food laws and standards; food safety management tools; and state-of-the-art procedures in handling food safety issues

FTBE/ HS/ B/T/ 412: Project Planning, Layout and Economics

Content:

Module I: Introduction: Introduction to plant design and project Engineering, Food plant design process, Introduction to feasibility study and analysis, location and site selection of food plant.

Module II: Pilot and semi pilot scale up techniques, Food plant size and utilities, Illumination and Ventilation

Module III: Food plant layout- introduction and planning, Layout Design Procedure, Symbols used for Food and Biochemical plant design and layout, Food processing enterprise.

Module IV: Procedures of process plant costing to man power, material, equipment and utilities, Engineering economics, analysis of production and productivity in joint products and by-products, cost reduction techniques. Optimization techniques and assessment of alternatives.

Module V: Process scheduling and Plant operation, Selection of materials of construction and specification of process equipments with special considerations for equipments and accessories of Food and Biochemical projects.

Module VI: Application of PERT and 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

Text Book:
1. Food Plant Economics by Z.B. Maroulis and G.D. Sarvacos. Published by CRC press
2. Chemical Project Economics, Mahajani V. V. and Mokashi S M., MacMillan India Ltd. 2005
3. Plant Design and Economics for Chemical Engineers, Max Peters, Klaus Timmerhaus, Ronald West, McGraw Hill International Edition, 2013

Reference books
1. Project Feasibility Analysis by Clifton D.S. and D.E. Fyfee. Published by John Willey and Sons, New York
2. Process Plant Design by Backhusrt J.R. and J.H. Barker. Published by Heimann Educational Books, London
3. Plant Design and Economics for Chemical Engineers by Peters M.S. and K.D.Timmerhaus. Published by McGraw-Hill
4. Computer Aided Process Plant Design by Leesley M.E. Published by Gulf Publishing company, Houston
5. Project Management for Engineers by M.D. Rosenau Published by Van Nostrand Reinhold Co., New York

6. Engineering Economic Analysis by W.T. Morris. Published by Reston Publishing Company, Inc., New York .

Course Outcomes
Students will be able to

CO1.Analyze food plant design process
CO2.Understand the scale up technique and layout procedure
CO3.Solve different problem related to Engineering economics and process plant costing
CO4:Select the appropriate materials for food and biochemical process equipment
CO5.Apply different methods to plan and monitor the project

FTBE/PE/B/T/413A: WASTE VALORIZATION OF FOOD & BIOCHEMICAL PROCESSES

Content:

Module I: Fruit and vegetable waste uses: non-fermented food products such as pectin, citrus oils, citric acid, ethanol, vitamins, proteins, pigments, flavors, antioxidants, starch, dietary fibers and fermented food products such as antibiotics, mushroom culture media, fermentable sugars, animal feed, bioenergy and compost.

Module II: Fish, meat & poultry waste uses: fish meal and protein concentrates, hemoglobin and myoglobin from waste blood, chitin, glue and other shell products, cattle feed such as ensilage and poultry feed.

Module III: Cereal waste uses: oils and waxes from bran, puffed cereals, silica from husk, proteins, modified starches and industrial alcohol, feed for livestock and biodegradable packaging materials.

Module IV: Dairy and plantation product waste uses: fermentation products, lactose and protein from whey; natural colors, flavors, antioxidants, fertilizers and feed for livestock and poultry from tea and coffee waste. *Biochemical industry waste uses*: utilization of biomass for production of SCP, animal feed, compost and bio-gas.

Recommended Books:
1. Managing Food Industry Waste, by R. R. Zall, Blackwell Publishing Ltd., Iowa, USA, 2004.
2. Handbook of Waste Management and Co-Product Recovery in Food Processing, by K. Waldron (Ed.), CRC Press, Boca Raton, USA, 2007.
3. Food Processing Waste Management: Treatment and Utilization Technology, by V.K. Joshi and S.K. Sharma, New India Publishing Agency, New Delhi, 2011.
4. Valorization of Food Processing By-products, by M. Chandrasekaran, CRC Press, Boca Raton, USA, 2016.
5. Waste Management and Valorization: Alternative Technologies, by E.C. Rada, Apple Academic Press (CRC Press), Boca Raton, USA, 2016.

Couse Outcome:
The students of the course should be able to

CO1: Assess byproducts and wastes of various food and biochemical process industries
CO2: Describe technological processes for utilization of pre- and post processed fruit and vegetable wastes
CO3: Describe technological processes for utilization of pre- and post processed cereal and plantation product wastes
CO4: Describe technological processes for utilization of pre- and post processed dairy product wastes
CO5: Describe technological processes for utilization of biochemical industries

FTBE/ PE/ B/T/ 413B: ANALYTICAL INSTRUMENTS IN FOOD ANALYSIS: PRINCIPLES AND PRACTICES

Content:

Module I: Chromatography: working principles and food applications of column chromatography, gas chromatography (GC), high pressure liquid chromatography (HPLC), various injectors, detectors and columns used; paper chromatography, thin layer chromatography (TLC), high performance thin layer chromatography (HPTLC), gas chromatography-mass spectrometry (GC-MS) and liquid chromatography-mass spectrometry (LC-MS).

Module II: Spectroscopy: working principles and food applications of UV-Vis, Fourier transform infrared (FT-IR) and ^{13}C and ^{1}H NMR spectroscopy.

Module III: Colorimetry: working principles and food applications of Hunter lab colorimeter, CIE meter, and Lovibond Tinctometer.

Module IV: Viscosity and Rheology: working principles and food applications of viscometer and rheometer

*Module V: Kinesthetic*s: working principles and food applications of texture analyzer including all parameters of food texture and electronic tongue based on polymer sensors

Module VI: Olfaction: working principles and food applications of various types of electronic noses based on metal oxide, semi-conductor and polymer sensors

Module VII: Extraction and Concentration: working principles and food applications of Clevenger extraction assembly, supercritical CO_2 extraction assembly, Vigreux concentrator and rotary vacuum evaporators

Module VIII: Non-invasive equipments and instruments: working principles and food applications of near-infrared (NIR) spectrometers, pH meter, conductivity meter; ultrasonic equipment, lyophilizer and gamma irradiation unit

Recommended Books:

1. Instrumental Methods in Food Analysis, Volume 18, by J.R.J. Paré J.M.R. Bélanger, Elsevier, 1997.
2. Chromatography in Food Science and Technology, by T. Cserhati and E. Forgacs, CRC Press, Boca Raton, USA, 1999.
3. Handbook of Food Analysis: Methods and Instruments in Applied Food Analysis, Volume 3, by L.M. L. Nollet (Ed.), CRC Press, Boca Raton, USA, 2004.
4. Flavor Chemistry and Technology, by G. Reineccius, CRC Press, Boca Raton, USA, 2005.
5. Electronic Noses and Tongues in Food Science, by M.R. Mendez (Ed.), Academic Press, USA, 2016.
6. Spectroscopic Methods in Food Analysis, by A.S. Franca and L.M. L. Nollet, CRC Press, Boca Raton, USA, 2017.
7. Food Analysis, by S. Suzanne Nielsen, Springer, USA, 2017.

Couse Outcome:

The students of the course should be able to

CO1: Understand and describe various types of chromatographic methods of analyses of food products; analytical techniques related to texture, viscosity and rheology analyses of food products; working principles and food applications of various types of electronic noses, various types of extractors and concentrators

CO2: Explain and analyze various types of chromatographic, spectroscopic and colorimetric methods of analyses of food products; analytical techniques related to texture, viscosity and rheology analyses of food products; working principles and food applications of various types of electronic noses, various types of extractors and concentrators

CO3: Understand and describe various types of spectroscopic and colorimetric methods of analyses of food products; and various types of non-invasive equipments and instruments used in food analyses

CO4: Explain and analyze various types of spectroscopic and colorimetric methods of analyses of food products; and various types of non-invasive equipments and instruments used in food analyses

FTBE/PC/B/S/ 411: FOOD ANALYSIS AND QUALITY CONTROL LABORATORY

Content:

- Analysis of important quality control indices of the following food products with reference to their legal quality standards: milk, jam or jelly, squash, bread or biscuit, a baby food, a ready-to-eat cereal, tea, coffee and soft drink
- Changes in ascorbic acid content during fruit juice processing
- Detection and estimation of harmful additives in processed food products such as sulphite and benzoate

Couse Outcome:

The students of the course should be able to

CO1: Analysis of important quality control indices of several food products

CO2: Evaluate changes in vitamin C content during juice preparation from citrus fruits

CO3: Determine content of benzoate and sulphite in processed foods

FTBE/PC/B/S/412: FOOD ENGINEERING AND FOOD PRESERVATION LABORATORY- I

Content:

- Determination of process time by graphical and formula methods
- Drying rate characteristics of different food products in tray dryer and fluidized bed dryer
- Production of ice cream
- Production of candy and chocolate
- Production of milk powder by spray drying
- Production of fermented vegetables and vegetable sauces
- Production of fruit juice concentrate

Couse Outcome:

The students of the course should be able to

CO1: Determine process time during thermal processing of food products
CO2: Determine drying characteristics of food products using tray and fluidized bed dryers
CO3: Demonstrate production processes for fruit and vegetable based products, fermented vegetable product, frozen desserts and chocolate confectionaries using laboratory scale food processing equipments
CO4: Demonstrate production process of milk powder using spray dryer
CO5: Demonstrate process of production of fruit juice

FTBE/ PS/ B/S/ 413: SEMINAR AND GROUP DISCUSSION- I

Students will be assigned a seminar topic not directly part of syllabus to deliberate on using power point presentations, video etc., and submit a detailed report on the same.
Students in groups will participate in group discussions on topics of industrial significance.

Couse Outcome:

The students of the course should be able to
CO1: Apply domain knowledge in preparing seminar and in group discussions.
CO2: Create new soft skills for industrial-cum-academic competence.

FTBE/PC/H/S/414: DESIGN OF FOOD AND BIOCHEMICAL PROCESS EQUIPMENTS

Content:

1. Thermal processing. Canning and retort processing – process design and equipment. Design aspects of pasteurizer, homogenizer, sterilizers, evaporators and concentrators. Dryers and their design parameters – tray dryer, spray dryer, fluidized bed dryer and solar dryer.
2. Design of material handling equipments like belt conveyor, screw conveyor, bucket elevator and pneumatic conveyors.
3. Construction of cold storages and refrigerated vans; Types of freezers and their design parameters – plate contact freezer, air blast freezer, cryogenic freezer.
4. Bakery machines and equipment; Sheeting, mixing and blending, Extrusion and other non-thermal processing – process design and equipment

Couse Outcome:

The students of the course should be able to
CO1. Understand different design operating parameters of food processing equipment.
CO2. Solve the problem related to the design and operating parameter of different food processing equipment.
CO3. Design the different types of Food processing equipments.

FOURTH YEAR-SECOND SEMESTER

Subject Code	Name of the Subject	Category	Type	Contact L-T-P	Credit	Marks
FTBE/ PC/ B/T/ 421	Waste Treatment Engineering	PC	B	3-0-0	3	100
	Elective-II	PE	B	3-0-0	3	100
FTBE/ PE/ B/T/ 422A	Food Biotechnology					
FTBE/ PE/ B/T/ 422B	Plant Operation, Maintenance and Safety					
FTBE/ HS/ B/ME/T/ 423	Industrial Management	HS	B	3-0-0	3	100
FTBE/ PC/ H /T/ 424	Non Thermal Food Processing Technologies	PC	H	3-0-0	3	100
FTBE/ PC/ H /T/ 425	Separation and Purification Processes	PC	H	3-0-0	3	100
FTBE/ PS/ B/S/ 421	Seminar and Group Discussion- II	PS	B	3-0-0	3	100
FTBE/ ES/ B/CHE-ME/S/ 422	Chemical and Mechanical Engineering Laboratory	ES	B	0-0-3	1.5	100
FTBE/ PC/ B/S/ 423	Food Engineering and Food Preservation Laboratory- II	PC	B	0-0-4	2	100
FTBE/ PC/ B/S/ 424	Design / Project	PS	B	0-0-8	4	100
				Total	25.5	900

FTBE/ PC/ B/T/ 421 WASTE TREATMENT ENGINEERING

Content:
Module I: Introduction: Environment and energy of nature, Pollutant types, Characterization and classification of solid and liquid waste from food and biochemical industries. Stream pollution and measurement. Factors affecting the waste treatment process.

Module II: Waste treatment processes: Different physical, chemical and biological waste treatment processes. Design of primary and secondary waste treatment chambers.

Module III: Design of waste treatment processes: Processes and design criteria for tertiary and special treatment methods for industrial waste.

Module IV: Anaerobic digestion: Principle and design criteria. Biogas.

Recommended Books:
1. Environmental Biotechnology: Principles and Applications; Rittmann BE & McCarty PL; 2001, McGrow-Hill International editions.
2. Water & Wastewater Engineering; Fair GM, Geyer JC &Okun DA; 1986, John Wiley & Sons, Inc.
3. Wastewater Treatment; Bartlett RE; Applied Science Pub Ltd.
4. Food Industry Wastes: Disposal and Recovery; Herzka A & Booth RG; 1981, Applied Science Pub Ltd.
5. Environmental Biotechnology; Bhattacharyya B C & Banerjee R; Oxford University Press.

Couse Outcome:

The students of the course should be able to
CO1: Explain basic concepts of nature of industrial waste
CO2: Design treatment plants for industrial waste
CO3: Describe tertiary and special treatment of waste
CO4: Analyze anaerobic digestion methods of waste

FTBE/ PE/ B/T/ 422A FOOD BIOTECHNOLOGY

Content:
Module I: Introduction: 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.

Module II: Fermentative modification: Biotechnological process for manufacture of food staff and food etc. Fermentation production of modified carbohydrates, lipids and proteins and their purification techniques.

Module III: Changes during fermentation: Studies on changes in color, flavor 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.

Module IV: Application of biotechnology in food: Production of microbial biomass and its economic aspects. Regulatory and social aspects of Biotechnology modified foods. Genetically modified foods.

Recommended Books:

1. Microbiology by Pelczar, Chan, and Krieg, TMH
2. Industrial Microbiology Prescott & Dunn, CBS Publishers
3. Modern Food Microbiology by Jay JM, CBS Publishers
4. Food Microbiology; Frazier WC; 4th ed, Tata-McGrowhill Pub.
5. Fermentation Biotechnology, Principles, Processed Products by Ward OP, Open University Press.

Couse Outcome:

The students of the course should be able to
CO1: Explain the application of various biotechnological processes
CO2: Describe the biotechnological process for modification of biomolecules in food
CO3: Identify the changes occurred to fermented food during storage
CO4: Enumerate the regulatory aspects of biotechnologically modified food

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

Content:

Module I: Introduction to plant operation: 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.

Module II: Optimization of plant operation: 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.

Module III: Hazard analysis: Inspection, testing and analysis of tolerance limit and types of failure; hazards and operative (HAZOP) analysis;

Module IV: Preventative procedures in plant: Accidents and emergency preventive procedures; insurance claim and loss analysis; case studies on food and biochemical plants.

Couse Outcome:

The students of the course should be able to
CO1: Explain the system of plant operation, maintenance and safety
CO2: Understand the factory rules and procedure at national and international level
CO3: Understand economic design criteria troubleshooting, simulation related to plant operation
CO4: Analyze types of failure, hazards and preventive procedure related to operation of food and biochemical plants

FTBE/ PC/ H /T/ 424: NON-THERMAL FOOD PROCESSING TECHNOLOGIES

Content:

Module I: Food irradiation: sources of gamma radiations and their specifications, units and doses, safe dose limits, principles and theory of gamma irradiation, energy requirements in food irradiation, packaging and labeling requirements of irradiated foods, changes in food properties consequent to irradiation, essentials of an irradiation facility; introduction to electron bean irradiation, combination treatment with other food preservation methods

Module II: Membrane technology, sub-critical and supercritical carbon dioxide processing, microwave and radio frequency processing, high pressure processing, ultrasonic processing: principles and mechanism; processing parameters, various applications in food and biochemical processes.

Module III: Newer techniques in food processing: applications of technologies of high intensity, light, pulse, electric field, Ohmic heating, infrared heating, inductive heating, dielectric heating, pulsed X-rays in food processing and preservation

Module IV: Nanotechnology: principles and applications in food processing

Recommended Books:

1. Non-thermal Processing Technologies for Food, by H.Q. Zhang et al., (Eds.), Wiley, New Jersey, USA, 2011.
2. Non-thermal Food Engineering Operations, by E. Ortega-Rivas, Springer, USA, 2012.
3. Food Nanoscience and Nanotechnology, by H.H-Sánchez and G. F. G-Lopez, Springer, USA, 2015.
4. Minimally Processed Foods: Technologies for Safety, Quality, and Convenience, by M.W. Siddiqui and M.S. Rahman, Springer, USA, 2016.
5. Novel Approaches of Nanotechnology in Food: Nanotechnology in the Agri-Food Industry, Volume 1, by A. M. Grumezescu, Academic Press, USA, 2016.
6. Nanotechnology Applications in Food: Flavor, Stability, Nutrition and Safety, by A. M. Grumezescu and A. Opera, Academic Press, USA, 2017.
7. Non-thermal Processing of Foods, by O.P. Chauhan (Ed.), CRC Press, Boca Raton, USA, 2019.

Couse Outcome:

The students of the course should be able to

CO1: Understand and describe principles, mechanism and applications of various non-thermal processing operations such as gamma irradiation, electron beam irradiation, sub-critical and supercritical carbon dioxide processing, high pressure processing, ultrasonic processing and pulse electric field processing of foods

CO2: Explain and analyze describe principles, mechanism and applications of various non-thermal processing operations such as gamma irradiation, electron beam irradiation, sub-critical and supercritical carbon dioxide processing, high pressure processing, ultrasonic processing and pulse electric field processing of foods

CO3: Understand and describe principles, mechanism and applications of newer non-thermal processing techniques such as radio frequency processing, high intensity light pulse and pulsed X-rays in food processing and preservation

CO4: Explain and analyze principles, mechanism and applications of newer non-thermal processing techniques such as radio frequency processing, high intensity light pulse and pulsed X-rays in food processing and preservation

FTBE/ PC/ H /T/ 425 SEPARATION AND PURIFICATION PROCESSES

Content:

Fixed bed processes: ion exchange, molecular sieve; membrane techniques: reverse osmosis, ultra-filtration, electrodialysis; types of system design (a) continuous process (b) batch process (c) feed and bleed process (d) internally staged process; i) process based on chromatography: partition chromatography adsorption chromatography–ion exchange chromatography, affinity chromatography; ii) diffusional process: gaseous diffusion, thermal diffusion; iii) electrophoresis, isoelectric focusing gel filtration; iv) alternative processes for alcohol recovery and purification; a) solvent extraction, b) A.D. little CO_2 extraction process, c) vapor recompression system, d) low temperature blending with gasoline, e) dehydration, f) molecular sieve adsorption, g) membrane technology.

Recommended Books:

1. Separation Processes, McGraw-Hili Chemical Engineering Series, ed 2, by C. Judgson King (Ed.), McGraw-Hili Book Company, New York, USA, 1980.
2. Separation Process Principles: Chemical and Biochemical Operations, ed 3, by J.D. Seader et al. (Eds.), John Wiley & Sons Inc., Springer, USA, 2011.
3. Chromatography and Separation Science, by S. Ahuja, Academic Press, California, USA, 2003.
4. Separation and Purification of Materials: Physical Processes in the Chemical Industry, VI, R. Hammond (Ed.), LLC, USA, 2013.
5. Principles of mass transfer and separation processes, by B. K. Dutta (Ed.), PHI learning Pvt. Ltd., New Delhi, India, 2009.

6. Separation Processes in the Food and Biotechnology Industries: Principles and Applications: Principles and Practices, A.S. Grandison and M.J. Lewis (Eds.), Woodhead Publishing Ltd., UK, 1996.

Couse Outcome:

The students of the course should be able to
CO1: Understand various types of separation and purification processes used for Food & Biochemical Industries
CO2: Explain the mechanism of action of different downstream operations
CO3: Identify and select effective mode of separation and purification process(s) to be adopted for a particular set of conditions
CO4: To address different problems related to various separation and purification processes

FTBE/ PS/ B/S/421 SEMINAR AND GROUP DISCUSSION- II

Content:

Students will be assigned a seminar topic not directly part of syllabus to deliberate on using power point presentations, video etc., and submit a detailed report on the same.

Students in groups will participate in group discussions on topics of industrial significance.

Couse Outcome:

The students of the course should be able to

CO1: Apply domain knowledge in preparing seminar and in group discussions.
CO2: Create new soft skills for industrial-cum-academic competence.

FTBE/PC/B/S/423: FOOD ENGINEERING AND FOOD PRESERVATION LABORATORY- II
Content:

- Production of jam, jelly and marmalade
- Production of red and white wine
- Retort packaging of vegetables, fish and meat
- Production of fat replacers – mayonnaise and salad dressings
- Production of bread, cakes, biscuits and cookies
- Production of essential oils, oleoresins and absolute from spices and herbs

Couse Outcome:

The students of the course should be able to
CO1: Produce jam, jelly and marmalade using laboratory scale food processing equipment
CO2: Produce wine using laboratory scale food processing equipment
CO3: Produce confectionary products using laboratory scale food processing equipment
CO4: Demonstrate retort packaging operation for vegetable and flesh foods
CO5: Produce fat replacers using laboratory scale food processing equipment
CO6: Demonstrate production processes for spice-based products using laboratory scale food processing equipment

FTBE/ PS/ B/S/ 424: DESIGN / PROJECT

Students will be assigned a major problem on selected designs of plant and equipment related to food and biochemical processing industries under the guidance of departmental teachers.
Alternatively, the students will be assigned a major research project work and generate new experimental data under the guidance of departmental teachers.

Couse Outcome:

The students of the course should be able to
CO1: Apply domain knowledge in- designing plant equipment of food processing and biochemical industries/research projects
CO2: Create new knowledge for industries and academia