SYLLABUS
M. Tech in Food Processing Technology (3 Year)

3 Year Programme:
B. Sc. with Chemistry as one of the subjects/ B. Sc (Agriculture)/ B. Sc (Home Science) with elective in Food & Nutrition/ B. Sc(Fishery)/ B.V. Sc with a minimum 50% marks in major subjects or equivalent Grade Point Average. Candidates must have passed Mathematics at 10+2. level. Candidates from university/institutes which do not offer major/honours must have minimum 50 % mark in aggregate as applicable in case of major/honours stated above.

Lateral entry in the 3rd semester : B.E./B. Tech degree in Food Processing Technology/ Food Technology/ Food Technology & Biochemical Engineering/ Food Process Engineering/ M.Sc. degree in Food Processing Technology/ Food Technology with at least 50% marks in aggregate or equivalent CGPA. GATE qualified candidates will get preference.

(a) Minimum credit to be completed for award of degree:
   for candidates with B.Sc. degree                                          : 108
   for lateral entry with B.Tech./ M.Sc. (Food Tech.) degree     : 68

CORE COURSES

<table>
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<tr>
<th>Code</th>
<th>Course Name</th>
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<td>FP 401</td>
<td>Principles of Food Processing</td>
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**ELECTIVE COURSES**

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<td>FP 407</td>
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Any 500 level and above courses offered by the University and recommended by the Department can be opted as an elective course

(L = Lecture, T = Tutorial, P = Practical, CH = Contact Hours, CR = Total Credit)

**Semester Wise Course Structure**

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<tr>
<th>Semester</th>
<th>Courses</th>
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<tr>
<td>1st Semester</td>
<td>Microbiology, Principles of Food Processing, Food Chemistry, Food Analysis, Applied Mathematics &amp; Statistics, Basic Electrical Engineering and Electronics</td>
</tr>
<tr>
<td>2nd Semester</td>
<td>Food Microbiology, Biochemistry &amp; Nutrition, Unit Operations in Food Engineering - I, Business Management, Computer Fundamentals and Programming, Instrumentation and Control in Food Processing</td>
</tr>
<tr>
<td>3rd Semester</td>
<td>Quality Control in Food Processing Industries, Unit Operations in Food Engineering – II, Packaging and Storage Technologies, Food Plant Design and Product Development, Elective-I</td>
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<tr>
<td>4th Semester</td>
<td>Emerging Technologies in Food Processing, Design of Food Processing Equipment, Elective-II, Elective-III, Elective IV</td>
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<tr>
<td>5th Semester</td>
<td>Simulation and Modeling, Elective V, Elective VI, Mini Project, Seminar</td>
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<tr>
<td>6th Semester</td>
<td>Major Project</td>
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Detail syllabus

CORE COURSES

FP 401 Principles of Food Processing 2-0-1

Introduction to food processing: scope and importance; basic concepts about properties of foods: liquid, solid and gases; Unit operations; Water activity; Processing at ambient temperatures: theory and equipment for raw material processing, size reduction, mixing and forming, separation and concentration of food components, irradiation; Processing at high temperatures: theory and equipments for blanching, pasteurization, heat sterilization, evaporation, distillation, extrusion, dehydration, baking, roasting, frying, dielectric heating, ohmic and infrared heating; Processing by removal of heat: theory and equipments for chilling, controlled and modified–atmosphere storage, freezing, freeze drying and freeze concentration; Basic concepts about hurdle technology and membrane technology.

Practicals:
Size reduction by dry and wet grinding; osmotic dehydration of foods; blanching and canning of fruits and vegetables; preparation of fruit juice concentrates; preparation of intermediate moisture food; extrusion cooking; modified atmosphere packaging; preparation of baked foods; visit to food processing units.

Text/ References:

<table>
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<tr>
<th>FP 402</th>
<th>Food Chemistry</th>
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Food chemistry: definition and importance; Water: functions, physical properties, types of water, water activity and shelf life of food; Carbohydrates: definition, nomenclature, classification, physical and chemical properties of sugar, functional properties of polysaccharides, modified starch, starch hydrolysates, polyols, glycogen, fibre, gum; Proteins; physical and chemical properties of amino acids, proteins, classification and structure, function and properties of protein, animal and plant proteins, effect of processing; Lipids: classification, estimation of fatty acids, physical properties, Fat constant: saponification number, acid number, iodine value, acetyl value,
Reichert Meissel number, effect of freezing, flavour reversion, oxidative and hydrolytic rancidity, 
hydrogenation, interesterification, different types of fats, uses in food processing, food emulsions, 
fat replacers, Minerals: classification, minerals in meat, milk, plants and their interaction with 
other components, losses of minerals during processing, metal uptake in canned foods; Vitamins: 
fat soluble and water soluble vitamins, their food sources, effect of food processing, Enzymes: 
nature and functions, enzymes in food processing, immobilized enzymes; Natural pigments and 
flavouring agents; chlorophyll, carotenoids, anthocyanins, anthoxanthins, flavonoids, tannins, 
natural flavour constituents; Additives and contaminants: intentional additives, incidental 
additives, antinutritional factors.

Practicals:
Determination of moisture, proteins, total sugars, nonreducing sugars and reducing sugars, 
starches, crude fiber, crude fat and total minerals in foods; detection and estimation of amino 
acids by chromatographic techniques; determination of minerals: calcium, phosphorous and iron;
estimation of vitamins: ascorbic acid, carotene and thiamine; estimation of iodine value, 
saponification value, acid value, nonsaponifiable matter, Reichert value, Krschner value in fats 
and oils, analysis of fats and oils for free fatty acids and peroxide value; study of enzymatic and 
onenzymatic browning in food, estimation of enzymatic activity.

Text/ References:
foods, Dietetics, Food Scientists. CRC Press, 1996

FP 403 Food Analysis 1 - 0 - 2
Techniques of analysis: gravimetric, titrimetric, colorimetric, spectrophotometric, fluorimetric, 
chromatographic; Acceptance sampling: operational characteristics, risks, attribute sampling 
plans, administration of attribute sampling plans, sampling error; Physical, chemical and 
rheological properties of food; Principles of analysis of various food constituents and subsequent 
changes on packaging; sensory attributes of foods: mechanisms of sensation and perception of 
colour, taste, odour, and flavour; importance and use of sensory evaluation methods; facilities 
required for sensory evaluation; selection of trained panelists; affective and analytical methods: 
discrimination methods, preference and ranking; rating with use of scales, magnitude 
determination, sensory profiling, flavour profile; descriptive analysis: Quantitative Descriptive 
Analysis and Spectrum techniques; texture profile; selection of trained panelists: type of panelists
suitable for different tasks and methods; conditions for sensory analysis: room, serving and preparation of samples; application of consumer tests; control of factors affecting accuracy and precision of sensory data; analysis of sensory data; statistical testing; correlating instrumental and sensory measurements.

Practicals:
Sample preparation; study of emulsion stability, determination of specific gravity of oils, hydration capacity of dehydrated foods, acidity of milk, egg foam stability; study of effect of meat tenderizers, effect of processing on colour of meat, vegetables; determination of available lysine in processed meat; changes in ascorbic acid and thiamin in canned vegetables during thermal treatment; estimation of additives in foods; effect of cooking on ascorbic acid content in vegetables; determination of lactose content in yoghurt; determination of starch and pectins; estimation of sugars using HPLC; protein identification through electrophoresis; determination of free fatty acid by GLC; estimation of pesticide residue in foods; estimation of anti nutritional factors like gossypol, trypsin inhibitor; screening tests and sensory acuity; comparison of discrimination test methods; forced choice thresholds measured by ascending methods of limits; exploration of time-intensity relationship; flavour profile; Quantitative Descriptive Analysis, acceptance and preference testing.

Text/References:

FP 405 Biochemistry and Nutrition 3 - 0 - 1

Biochemistry: Introduction to biochemistry; usefulness of cells and organisms in biochemical studies; Water: its effect on dissolved biomolecules; Enzymes: properties, classification, coenzymes and cofactors, enzyme kinetics, regulatory enzymes, isoenzymes, enzyme inhibition and kinetics of enzyme inhibition, enzyme purification; elements of bioenergetics; Metabolism of carbohydrates, glycolysis, TCA cycle, oxidative phosphorylation, biosynthesis of starch; Lipid metabolism, fatty acid oxidation, biosynthesis of fatty acids, phospholipids, cholesterol; Amino
acid oxidation, protein biosynthesis; Nucleic acids; Hormones; Elements of immunology.

**Nutrition**: Introduction to the study of nutrition, characteristics, functions, digestion and assimilation of food, metabolism, food sources of different nutrients, e.g., proteins and amino acids, carbohydrates, lipids, minerals, fat-soluble vitamins, water-soluble vitamins-ascorbic acid and vitamin B complex; energy metabolism, special nutrition needs during pregnancy, lactation, infancy, for children, adolescents, and aged; nutrition and public health; introduction to therapeutic nutrition, diet in disease conditions: jaundice, coronary heart disease, obesity, anaemia, renal problems, GI tract problems; inborn errors of metabolism, diabetes: nutraceuticals.

**Practicals:**

Assay of enzymes; kinetics of any one enzyme and determination of Michaelis–Menten constant; polyacrylamide gel electrophoresis; determination of amino acid and protein by spectrophotometric method, biuret and Lowry method; amino acid analysis by amino acid analyzer; determination of vitamins A, C, and beta carotene; chromatographic experiments; analysis of blood for haemoglobin, protein, sugar and cholesterol; analysis of urine for urea, creatinine; body mass index; determination of protein efficiency ratio.

**Text/References:**


**FP 411**  
**Unit Operations in Food Engineering - I**  
2 - 0 - 1

Basic principles of food engineering: mass and energy, food composition, physical properties, introduction to food processing; Units and dimensions: SI, CGS, English system, conversion factor, dimensional consistency; Basic understanding about material transfer, fluid flow, heat transfer; Thermodynamics – thermo dynamic properties, laws of thermodynamics, Ideal gas law, sensible latent heat, enthalpy energy balances; Material balances- law of conservation of mass, batch and continuous process, General mass balance equation, algebraic unknowns, basis for calculations; Fluid flow in food processing: liquid transport system, properties of liquids, measurement of viscosity, handling system for Newtonian liquids, mechanical energy balance,
pump selection and performance evaluation, flow measurement, pressure drop, friction, Reynolds number; Energy for food processing: generation of steam, fuel utilization, electric power utilization; Heat transfer in food processing: systems for heating and cooking food products, thermal properties of foods, modes of heat transfer, heat balance, Fouriers law, application of steady state heat transfer. Food freezing: freezing systems, effect of freezing on foods, freezing time, frozen food storage, responses of foods to industrial freezing; Psychrometrics: properties of dry air, water vapour, vapour mixture, psychrometric chart; mass transfer in food processing: Fick’s law of diffusion, diffusion processes.

Practicals:
Measurement of physical dimensions; application of psychrometric charts in food engineering; generation of steam and its applications; measurement of pressure, and flow of fluids; measurement of viscosity; study of pumps and heat exchangers, visit to food processing plants.

Text/References:
1. Y.H.Hui, *Handbook of Food Science, Technology and Engineering (vol.1-4)*, Marcel Dekker, 2005

**FP 513 Business Management 2 - 0 - 1**

Human Resource Management: Maslow’s hierarchy of needs, Theory X and Theory Y, Staffing process;
Introduction to Entrepreneurship- Project Work.

Texts/References:
binomial & poisson distributions. Control chart concept, mean chart and range chart for variables, runs tests, p chart and c chart for attributes, cusum control charts, discussion of time weighted charts. Identify the importance of measurement, relationship between standards and measurement in a quality process, Identification of quality characteristics of a product or service, effect of instrument characteristics on measurement results, GR&R studies.

Practicals:
Conducting and HACCP study; determination of composition of different food materials using different techniques. Quality assessment of foods; vegetables, cereals, milk, dairy products, meat, poultry; qualitative and quantitative measurement of adulterants in milk, vegetable oils, spices etc.; quantitative measurement of additives in foods.

Text/ References:

**FP 515 Unit Operations in Food Engineering - II 4 - 0 - 1**

Thermal processing: decimal reduction time D, thermal resistance constant, thermal death time, spoilage probability, relationships between chemical kinetics and thermal processing parameters; Refrigeration: selection of a refrigerant, components of refrigeration system, pressure enthalpy charts, analysis of vapour – compression refrigeration; Evaporation: boiling point elevation, types of evaporators, single-effect evaporator, multiple-effect evaporator, vapour recompression systems; Food dehydration: drying theory, basic drying process, dehydration systems, dehydration system design, quality and stability of dried food; Mechanical separation: filtration, sieving, centrifugation sedimentation; Mechanical handling: conveying and elevation; Size reduction and classification: mixing, kneading, blending; Membrane separation systems: electrodialysis, reverse osmosis, ultrafiltration. Distillation: Vapour liquid equilibria, boiling
point diagram, relative volatility, enthalpy concentration diagram, flash vapourization, differential distillation, steam distillation, azeotropic distillation and extractive distillation. Super critical fluid state, properties of super critical fluids. SCFE systems and components, Applications; extraction of fatty acids, Hops, Essential oils and bio chemicals.

Practicals:
Study of dryers; elevating and conveying equipments, and sieve analysis; study of membrane separation system; study of mechanical separators; kinetics of food dehydration; study of distillation equipments, visit to food processing plants.

Text/ References:

**FP 516 Packaging and Storage Technologies 2 - 0 - 1**

Introduction to packaging: definition, importance and scope of packaging of foods; protective role of packaging; Packaging materials: origin, types, chemistry, morphology and physical characteristics, advantages, defects and risks; Forms of packaging: wooden boxes, crates, plywood, wire bound boxes, corrugated and fiber board boxes, bottle, tetra, retortable, flexible and laminated pouches, shrink, vacuum, gas, CAP, MAP, wrappers, textile bags, aseptic etc; Introduction to WVTR, GTR, bursting strength, tensile strength, tearing strength, drop test, puncture test, impact test, etc; Characteristics of food stuffs that influence packaging selection: physical chemical and biological; Active packaging: migration and sorption; Packaging requirements and their selection for raw and processed foods; meat, fish, poultry and egg, milk and dairy products, fruits and vegetables, cereal grains and cereal products, baked products, beverages, ready to eat snacks; Packaging machinery: bottling, canned former, form fill and sealed machine, bags- their manufacturing and closing, vacuum pack units, shrink pack units,
tetra pack units, temper evident and child resistant packaging and box coding; Packaging and temperature changes: intelligent packaging; Packaging for microwave heating; Printing techniques; Package labeling: functions and regulations; Environmental aspect of food packaging, ecobalances.

Cold Storage design and construction: Small and large commercial storages, cold room temperatures, insulation, properties of insulating materials, air diffusion equipment, doors and other openings. Refrigeration cycles, vapour compression and vapor absorption cycles, refrigerants, characteristics of different refrigerants. Ton of refrigeration, components of refrigeration system. Cold load estimation; prefabricated systems, walk-in coolers, and refrigerated container trucks; Freezer storages, freezer room temperatures, insulation of freezer rooms. Pre cooling and pre freezing. Stacking and handling of material in and around cold rooms. Storage of grains - biochemical changes during storage - production, distribution and storage capacity estimate models, storage entomology - storage capacity models - ecology, storage factors affecting losses, storage requirements, bag and bulk storage - method of stacking - preventive method, bio-engineering properties of stored products - function, structural and thermal design of structures.

Controlled and modified atmospheric storages: Principles and basics of their construction, operation and maintenance, cleanliness, defrosting practices, preventive and safety measures. Optimum temperatures of storage for different food materials: meat and poultry products, marine products, fruits and vegetables, spices and food grains.

Practicals:
Identification of different types of packaging and packaging materials; determination of tensile strength of given material; performing destructive and nondestructive test on glass container: determination of wax weights, tensile strength of papers, bursting strength and WVTR of packaging materials; measurement of thickness of packaging materials; testing of chemical resistance of packaging materials; determination of shelf life of packaged foods; determination of ERH of foods; determination of drop test of food packages; introduction of students with the latest trends in packaging consulting the websites and magazines. Determination of cooling load for cold storages. Problems on Design of cold storages. Visit to cold storages.

Text/ References:

**FP 517 Food Plant Design and Product Development 3-0-1**

Plant design concepts and general design considerations; plant location - location factors and their interaction with plant location, location theory models, feasibility analysis and preparation of feasibility report; plant size - factors affecting plant size and their interactions, estimation of break-even and economic plant size; process selection; process flow charts, computer aided development of flow charts; equipment selection including economic analysis of equipment alternatives; plant layout, layout symbols; planning and design of service facilities, human resource, product packaging and marketing system; hygienic design aspects and workers' safety; functional design of plant building and selection of building materials; estimation of capital investment, analysis of plant costs and profitabilities; management techniques in plant design including applications of network analysis; preparation of project report and its appraisal.

History of product development; why new products; ‘New products’ from different cultures; product concept, concept testing approaches: sampling methods, role of sensory evaluation, preparation of concept testing documentation; Development of product specification; prototype development, role of ingredients and processing in defining attributes; process flow sheet development, factors to consider process development, process optimization, HACCP; PARS; factors to consider beyond formulation and processing: shelf life requirement, product performance testing, market positioning; developing test market strategies, process trial, final product.

**Practical:**

In practical a group of 3 to 4 students will be assigned to develop a new food product and they will be asked to solve plant design problem based on the new product. The students should carry out the Planning the preliminary stages of the product, product idea generation, market and literature, search on product and processing methods; screening of product ideas and selection of ideas for concept testing; determination of product attributes for selected products; product
designing; specification and formulation; cost analysis; evaluation of sensory data and product modification, development of processing procedure, processing flow chart, processing trial, second sensory evaluation, sensory data analysis and further product modification; quality control methods for the new product- quality criteria, test methods; statistical quality control- sampling plans, control chart, conceptual design of the food plant, flow sheeting, material and energy balance calculations, and cost and profitability analysis of the Food Plant.

Text/ References:
2. G.W.Fuller, New Food Product Development: from to Marketplace, 2nd ed, 2004
7. Z. B. Maroulis and G. D. Saravacos, Food Process Design, Marcel Dekker 2003

**FP 518  Emerging Technologies in Food Processing  2 - 0 - 0**

High Pressure Processing: Principles of high pressure processing, use of high pressure to improve food safety and stability. Effects of high pressure on food quality: Pressure effects on microorganisms, enzyme, texture and nutrients of food. Modelling HP processes. Other applications of high pressure processing.

Pulsed electric fields processing: Historical background, PEF treatment systems, main processing parameters. Mechanisms of action: mechanisms of microbial and enzyme inactivation. PEF for processing of liquid foods and beverages, PEF Processing for solid foods. Food safety aspects of pulsed electric fields. Pulsed electric field and high pressure processing.

Osmotic dehydration: mechanism of osmotic dehydration, effect of process parameters on mass transfer, determination of moisture and solid diffusion coefficient, application of osmotic dehydration.

Athermal membrane concentration of liquid foods and colours: osmotic membrane distillation, direct osmosis, membrane modules, Applications of membrane concentration.

Processing by radio frequency electric fields: radio frequency electric fields equipments, RFEF non-thermal inactivation of yeasts, bacteria and spores, electrical costs.

Ultrasound processing: fundamentals of ultrasound, ultrasound as a food preservation and processing aid, effects of ultrasound on food properties.
Alternate thermal processing: Microwave heating: dielectric properties of foods, heat and mass transfer in microwave processing, application of microwave processing for foods;
Radiofrequency processing: dielectric heating, material properties, radio-frequency heating and drying applications; Ohmic heating: Fundamentals of ohmic heating, electrical conductivity, modeling, treatment of products.
Hybrid drying technologies: combined microwave vacuum drying, combining microwave vacuum drying with other processes, equipment for microwave vacuum drying, product quality degradation during dehydration.

Text/References:
1. Sun, Da-Wen, Emerging Technologies for Food Processing, Academic Press, 2005
2. Barbosa-Canovas, Tapia and Cano, Novel Food Processing Technologies; CRC Press, 2004
3. Ohlsson, Minimal Processing technologies in the food industry, Woodhead Publishing Limited, 2002

FP 519 Design of Food Processing Equipment 2 - 0 - 1

Introduction to various mechanical properties of materials to be used as material of construction, resistance of metals to corrosion under varying conditions of temperature and pressure etc. Application and use of various codes and standards in design.
Design of non-pressure storage vessel, tall vertical vessels, unfired pressure vessels with internal pressure: storage vessels and process vessels.
Design of unfired pressure vessels with external pressures, end closures, flat plates, domed ends, torispherical, ellipsoidal, hemispherical and conical ends. Design of nozzles, openings and reinforcements
Bolted flanges, pipe-line design and process design of a few equipments like heat exchangers, evaporators, distillation column, absorbers, reactors and dryers.
Design of belt and chain drives; toothed gearing; shaft and bearing; specification of handling equipment.
Mechanical design of selected process equipments such as heat exchangers, evaporators, distillation column, absorbers, reactors and dryers, crystallizers.

Practicals:
Mechanical design and drawing of process equipments: Storage vessels, pressure vessels, heat exchangers, evaporators, distillation and fractionation columns, agitators, nozzles etc.

Text/References:
FP 600 Simulation and Modeling 3-0-1


Review of heat, mass and momentum transfer operations, Modelling of exchangers, Evaporators, Absorption columns, Extractors, Distillation columns, Membrane processes. Rate equations, linear and non-linear regression analysis, Design of experiments, Factorial, Central, fractional design, Evolutionary operation techniques, Case studies.

Practicals:
Modelling of heat exchangers, evaporators, absorption column and other food processing equipments, experimental design.

Text/References:

Practicals:

Experiments on network theorem, RC circuit, operation/starting of motor/generator, wiring practice, diode characteristics, rectifier, CB-CE amplifier, oscilloscope.

Text/References:
2. V. Del Toro, “Electrical Engineering Fundamentals”, PHI, 1994
5. R. L. Boylestad and L. Nashelsky : Electronic Devices and Circuit Theory; PHI, 6e, 2001
Temperature controller in dryer, ration control in food pickling, atmospheric controller in food preservation, timers and indicators.

**Practicals**

Experiments on transducers such as Load Cell, Thermocouple, RPM Sensors, IC Sensor, LVDT, Optical sensor, E-Nose etc.

**Text/References:**


**CS 451 Computer Fundamentals and Programming 2 - 0 - 1**

Introduction to Computer Hardware and Software:

Hardware: Components of a computer system – Motherboard, Processor, RAM, Cache, Interface cards, I/O Ports.

Software: OS, Translators, Utilities and Service programs, Communication s/w, DBMS, Multimedia s/w, Application s/w

Classification of Computers: Notebook, PC, Workstation, Mainframe system, supercomputer, client-server.

Computer Organization:

Processor: Central Processing Unit (CPU), Control Unit, Arithmetic Logic Unit, Instruction set, Registers, CISC and RISC processors.

Memory: Primary memory, secondary memory, main memory organization, fixed and variable word length memory, main memory- static/ dynamic RAM, ROM, cache memory, flash memory, main memory capacity, memory bus (Unibus and Dual bus architecture), Secondary memory- H/D, CD, DVD, Magnetic tape, Pen-drive

I/O Devices: Various I/O Devices, I/O Bus (data, address, control bus)


Programming and Problem Solving Aspect:

The Problem Solving aspect, top-down step wise refinement, algorithms, flow charts, program, Basic Programming Concepts- variables, exchange of values, branching, loops, iterative
constructs, Basic algorithms: Exchange of two variables, Summation of set numbers, Factorial computation, Sine/Cosine function computation, Generation of Fibonacci Sequence, Reversing of Digits of an integer, Finding Square root, Factoring GCD, Generating prime numbers.

Introduction to Database Management:
Introduction to database, Different types of databases, definition and advance of using DBMS, some DBMS terminologies- table, attribute, value, tuples, record, relationship, keys of relation.

Practicals:
Concepts of windows, working knowledge of PC software (MS-word, MS-Excel, MS-PowerPoint, Web page designing using html tags, simple c programs or database creation and maintenance using MS-ACCESS, Hardware and Network.

Text/References:
2. R.G. Dromey “How to Solve it by Computer”, Prentice Hall of India, 2004

MS 400 Applied Mathematics and Statistics 4 - 0 - 0

Limit, continuity, differentiability of functions of single and several variables; Rolle’s Theorem, Cauchy’s Theorem, Taylor’s Theorem, Fundamental Theorems of Integral and differential Calculus.
First order ordinary differential equations, second order ODE with constant coefficients, application of ODE.
Statistical methods: frequency distribution, measures of location, dispersion, skewness and curtosis principle of least square, correlation, ANOVA and linear OLS regression.

Text/ References:

BT 404 Microbiology 3 - 0 - 1
Introduction to microbiology: history, scope and relevance; microbial diversity—broad classification of microorganisms; ultra structure of prokaryote and eukaryote microorganisms—representative samples of viruses, bacteria, mycoplasma, rickettsia, archebacteria, actinomycetes, algae, fungi (mould, yeast); isolation; cultivation and identification of bacteria; microbial growth and screening of microbe for the production of secondary metabolites, their isolation and purification, microbial nutrition with specific reference to aerobic, chemolithotrophic bacteria, phototrophic bacteria, and methane bacteria; microbial metabolism: basic mechanism of metabolism and energy conversion; microbial conversion of carbon, nitrogen, sulphur; genetic mechanism in prokaryotes and introduction to phage genetics including genetic exchange among microorganism in the environment; microbial pathogenicity: antibiotic resistance in microorganisms; role of microorganism in degradation of xenobiotics in the environment; principles of microbial culture, assessment of microbial diversity with the analysis 16S rRNA; concept of prions, viroids, interferons.

Practicals:
Culture media preparation and sterilization; activities of microorganism; determination of microbial growth curves based on absorbance; isolation, plating and characterization of microbes, population, colony count; Gram staining; antibiotic sensitivity and determination of minimum inhibitory concentration.

Text/References:
3. Tortora, Funk, Case Benjamin Cummings, *Microbiology*, 1999

BT 422 Food Microbiology 2 - 0 - 1

The evolution of food microbiology: early developments, traditional and modern food processing, emerging food borne pathogens, food associated microbes, classification and their enumeration; food borne pathogens, indicator microbe sampling plans; Modern legislation and development of pasteurization; food analytical methods; genetics and molecular biology of food associated microbes; Microbial growth, survival and death in foods: food ecosystems, intrinsic, extrinsic and other factors influencing microbes, homeostasis and hurdle concept, growth and death kinetics, microbial physiology and metabolism, bioenergetics and biofilms; Microbial spoilage of meat, fish and seafoods: ecology of spoilage micro flora and muscle foods, origin of micro flora in meat and fish, microbial progression during storage, spoilage of meat, cooked and processed products,
raw products, and control of spoilage of foods; Microbial spoilage of milk and dairy products: growth of microbes in milk and their effects; Microbes associated with milk products and their preservation. Microbial spoilage of fruits, vegetable and grains: pathogen, spoilage and their types, mechanism of spoilage, biochemical changes and spoilage micro flora; Food borne pathogenic bacteria: different species of *Salmonella, Campylobacter, Yersinta, Shigella, Vibrio, Clostridium, Bacillus, Listeria, Staphylococcus* and *E. coli*; Mycotoxigenic moulds: toxigenic *Aspergillus* spp. *Fusaria* and other toxigenic moulds; Food borne viruses: hepatitis virus and other food and water borne viruses; Food and water borne parasites: helminths and protozoan; Preservatives and preservation methods: physical, chemical and biological preservation methods and their mode of actions; Food fermentation: fermented dairy products, vegetables, fermented meat, poultry and fish; traditional fermented foods, alcoholic beverages-wine and beer; Advanced technologies in food microbiology: rapid method for the detection of food borne pathogens; Probiotics and prebiotics; predictive modeling and risk assessment hazard analysis and critical control point system (HACCP);Molecular genetic aspects of food associated microorganisms.

**Practicals:**

Isolation and characterization from normal and decayed food items; effect of environmental factor on growth and development of microbes; study on food fermentation processes: isolation and identification of coliforms and vibrio species

**Text/References:**

4. L.M.C. Landsborough, *Food Microbiology Laboratory*, CRC, 2003

**Elective Courses**

**FP 407 Technology of Cereals and Legumes** 2 - 0 - 1

**Rice:** Historical perspectives, world production and consumption pattern, rice cultivation using genetic modification; physical properties of paddy and rice and their relation to handling and processing; drying of paddy: dryer used; milling of rice: degree of milling, factors affecting milling, rice milling equipment, effect on head rice yield, milling cost, by products of milling and their utilization, modern rice milling; new processing methods and equipments; types of rice: high-, intermediate-, low- amylose and scented rice; rice grain quality indicators; parboiled rice:
types of parboiled rice, methods, advantages and disadvantages of parboiling, changes during parboiling; rice product: flaked rice, popped rice, puffed rice, traditional rice products of Assam, fermented rice products, instant rice, baby foods, quick cooking rice, rice snack foods, rice noodles, canned and frozen rice, drum dried and extruded products; effect of ageing of rice; effect of processing on nutritive value; enrichment and fortification, future trends; factors affecting bran quality and stabilization, industrial uses of bran; rice bran oil: composition, processing and stabilization.

Wheat: Wheat production and consumption pattern, structure, composition, effect of structure on milling; wheat milling, cleaning, conditioning, equipments used, milling fractions and their composition, extraction rates; criteria of wheat quality; starch damage, functional properties of flour components; protein-lipid-carbohydrate interaction; rheology and chemistry of dough; bread manufacturing process: functions of ingredients, methods, changes in dough characteristics, bread faults and remedies; biscuits, cookies, cakes manufacturing process, functions of ingredients, methods, factors affecting quality faults and remedy, additives used in baking; wheat based extruded food: macaroni, spaghetti, vermicelli; effect of processing on nutritive value.

Maize: structure, composition, cultivation, form of consumption, milling, milling equipments, processed products, processing methods; effect of processing on nutritive value.

Cereal malts: basic malting process, malting plant, malt storage, malt characteristics, malt extract, uses.

Starch: source, granule size and shape, processing effect, modified starches, corn syrup, uses

Legumes: Legume production, types, chemical composition, toxic factors, milling of legumes, milling equipments, factors affecting legume quality, secondary processing of legumes, processed products, fermented products, traditional products, by products utilization; effect of processing on nutritive value.

Practicals:
Milling of paddy, wheat, dhal; study of rice quality; processing of rice into products: flaked rice, puffed rice; parboiling of paddy by normal – pressure-, dry heat parboiling methods; preparation of green gram malt and study of the physicochemical properties, rheological properties: test for wheat flour quality; test baking; preparation of extruded foods; processing of legumes into secondary products; visit to rice mill, dhal mill, roller flour mill and extruded food units, etc.

Text/ References:

FP 408 Technology of Milk and Milk Products 2 - 0 - 1

Milk: Introduction to dairy production and processing industry; consumption, chemistry, nutritive value and properties of milk and milk products; factors affecting composition and yield of milk; milk carbohydrates; lactose crystal forms, properties and determination; milk proteins; nonprotein nitrogen compounds; casein, nomenclature, chemistry and physicochemical properties; whey proteins, nomenclature chemistry and physicochemical properties; determination of milk proteins, acid and rennet coagulation, analytical methods; lipids: composition and physical properties, crystallization, structure of fat granules, lipolysis, antioxidation, determination of milk fats; salt of milks – micro and macro elements, ash; vitamins, enzymes and hormones in milks; milk contaminants – somatic cells; effect of different temperatures on milk; heat stability; sampling of farmers milk; assessment of raw milk quality; heat treatment of milk, pasteurization, homogenization, sterilization of milk; technology and equipment used; in-plant handling – pumps, pipelines, storage and process tanks; packaging, storage, transportation and distribution of milk:

Milk products: Processing of condensed milk, toned milk, dry milk, evaporated milk, khoa, channa, cottage cheese, fermented milk products: traditional Assamese curd; cream separation, properties of cream, treatment of cream for butter production; ice cream technology and properties; whey processing, lactose production; membrane process in dairy industry; effect of processing on nutritive value; hygiene and sanitation in dairy industry – in-plant cleaning system.

Practicals:
Milk pasteurization, sterilization; study of the effectiveness of the processes; preparation of the fermented milk products, cream, butter, cheese, paneer, ice cream, flavored milk, milk powder; visit to dairy plants.

Text/References:

**FP 409 Technology of Fruits and Vegetables 2 - 0 - 1**

**Fruits:** Introduction to fruit processing; processing on a global scale, factors influencing processing, fruit types for processing, controlling factors in ripening of fruits, biosynthesis of flavours, factors influencing fruit quality and crop yield, flavour characteristics; biochemistry of fruits and its implications on processing; minimally processed fruits: factors affecting shelf life and the quality of minimally processed fruits, physiology and biochemistry of fresh cut fruits, technology to extend shelf life of minimally processed fruits, enzymes catalysed reactions during processing, browning reaction during processing, development of bitter principles in fruit products, anthocyanins and their changes during processing, discoloration during processing and storage; storage, ripening and handling of fruits: maturity and ripeness, temperature, storage atmospheres, maintaining quality; production of nonfermented fruit products: fruit quality, temperate fruit juices, tropical fruit juices, cloudy fruit juices – their stabilization, clarification of fruit juices, equipment used, method of preservation, concentration of fruit juices, product derived from the fruit juices, adulteration of fruit juice; fermented fruit beverage: cider, wine, spirits and liqueurs; production of thermally processed and frozen fruits: raw materials, canning of fruits, bottling, freezing, aseptic packaging equipments used; the manufacture of preserves, flavorings and dried fruits: preserves, fruits preserved by sugars, fruits preserved by drying, flavouring from fruits, tomato puree; by product of fruit processing: by product of citrus processing, natural colour extraction from fruit wastes, apple waste treatments, production of pectins; effect of processing on nutritive value.

**Vegetables:** Introduction to vegetables and health, health benefits of increased vegetable consumption, antioxidants in vegetables, effect of different processing technologies on the nutritive value and antioxidant activities, improving the nutritional quality of processed vegetables; maintaining the post harvest quality of vegetables; measuring the vegetable quality: advanced optical methods; maximizing the quality of thermally processed vegetables; safety of cooked chilled fruits containing vegetables; improving the shelf life of vegetables by genetic modification; minimal processing of vegetables, new modified atmosphere packaging (MAP) technologies for processed vegetables; high pressure processing of vegetables; the use of vacuum technologies to improve processed vegetables.
Practicals:
Equipments for fruits and vegetables processing; plant layout; preparation fruit juices e.g. carambola, orange, pineapple, mango etc., syrups, squashes, cordials and R.T.S. beverages; canning of fruits and vegetables, preparation of jams and jellies from different locally popular fruits, marmalade, preserves and candies e.g. tutti frutti; preparation of pickles, chutneys and tomato products e.g. tomato ketchup, tomato puree, tomato sauce; drying of fruit and vegetables e.g. dried whole green leaves powder; quality control of processed products; visit to fruits and vegetable processing industries; processing of mushrooms.

Text/ References:

FP 410 Technology of Plantation Products 2 - 0 - 1

Tea: History, production, types, processing: rolling, fermentation, firing/drying; chemistry of tea manufacturing and tea quality; tea aroma precursors; tea flavour; tea grades; storing of tea; tea and health: organic tea; polyphenolic constituents, methods of extraction of polyphenolic constituents; antioxidative action of tea polyphenols; tea products and their processing: instant tea, tea concentrates, decaffeinated tea, flavoured tea; herbal tea.

Coffee: History, production, drying, density and colour sorting, processing: roasting and brewing of coffee; characteristics of freshly roasted coffee powder; flavour characteristics; coffee storage; polyphenolic constituents; blending of coffee with chicory; coffee products and their processing; soluble coffee, espresso coffee, decaffeinated coffee, monsooned coffee, coffee brew concentrate; coffee and health.

Cocoa: Production, processing, chemical composition; cocoa butter and cocoa powder; processing and nutritive value; chocolate: characteristics, types and their manufacturing process.
Spices: Types, production, pre-harvest and post-harvest problems in processing, properties, drying, storage and packaging, health benefits; flavouring components; spice powder: their processing, quality, storage; spice based food additives; volatiles, essential oils and oleoresins: their characteristics, extraction procedure and utilization.

Practicals:
Estimation of caffeine and tannins in tea and coffee; estimation of theaflavin, thearubigin and theobromine in tea; determination of volatile content in spices; determination of aromatic compounds in spices; estimation of capsaicin content in chillies and curcumin content in turmeric; coffee roasting; tasting of tea and coffee brew; visit of tea/coffee garden and tea processing unit.

Text/ References:
5. NIIR Board, *Handbook on Spices*, National Institute of Industrial Research,

FP 503 Technology of Fish, Meat and Poultry 2 - 0 -1

Fish: World production of fish, meat and poultry, consumption pattern and nutritive value; introduction to meat, fish and poultry industry; characteristics and structure of fish, meat and poultry muscle; effect of method of catching and handling on the quality of fish; handling fish from catching to transportation; post mortem changes, rigor mortis, autolytic changes, bacteriological changes, rancidity, physical changes; preservation of fish by different methods: chilling, freezing, modified atmosphere packaging, canning, curing, marinate; changes in fish proteins on storage; manufacture of fish protein concentrate, fish sauce, fermented fish: traditional products of the North East; packaging of fish; hygiene in fish processing spoilage of fish; effect of processing on nutritive value; contaminants and naturally occurring toxicants in fish; by product utilization; waste from fish industry.
Meat: Animal production, feeds and raising of animals; abattoir design, stunning and slaughter methods; carcass evaluation; muscle contraction, water holding capacity, post mortem changes, meat colour, meat tenderizer; processing of meat and meat products: freezing, cooking, drying, curing, smoking; composition of smoke, cancerogenic contents, additives used; manufacture of sausages, comminuted meat products: ham, bacon, meat analogues; effect of processing on nutritive value; hygiene in meat processing, spoilage of meat, contaminants and naturally occurring toxicants; packaging of meat and meat products; by product utilization; waste from meat industry.

Poultry: Processing of poultry; egg structure, composition, nutritive value, egg products, dehydrated egg powder; effect of processing on nutritive value; additives used in poultry products; by product utilization; waste from poultry industry.

Practicals:
Carcass evaluation; evaluation of meat and fish for quality and spoilage; processing of ham, bacon, sausage, cured meat, fermented fish, fish sauce, fish protein concentrate; thermal processing of meat, fish and poultry products; evaluation of canned meat; effect of freezing of meat and fish; measurement of meat texture; measurement of egg quality; visit to abattoirs, poultry farms, fish and meat processing factory.

Text/References:

FP 504 Technology of Oilseeds and Fats 2 - 0 - 1

Oilseeds: Production and consumption, different oilseeds, oilseed characteristics, traditional methods of oil expelling, ghani, expeller oil processing, solvent extraction of oil, supercritical extraction; extrusion technology; oil refining procedures and steps; processing and utilization of byproducts of oil extraction; characteristics of oil seed mills; functional and nutritional quality of
oil seed proteins, technology of oilseed protein isolates; antinutritional factors and their removal; hydrogenated fats; chemical adjuncts: lecithin, monoglycerides, and derivatives, propylene glycol esters, polyglycol esters; shortening: characteristics, uses, manufacturing process, types of shortening; margarine: composition, properties, uses, manufacturing process; mayonnaise: process, characteristics, stability, salad oil; imitation dairy products, peanut butter, vegetable ghee; traditional oilseed products: kharali and kharisa; cocoa fat extraction, composition, utilization; characterization and types of fat replacers and their specific uses; effect of processing on nutritive value.

**Practicals:**
Extraction of oil from different sources following different techniques; refining of oil; manufacture of hydrogenated fats, shortening, margarine, peanut butter; storage studies on fats and oils; visit to oil extraction and refining units

**Text/ References:**

**FP 520 Waste Management and Byproduct Utilisation in Food Industries**

Food industry wastes, food waste treatment, ISO 14001 standards, necessity of food waste utilization, environmental legislation, treatment according to established standards and directives, environmental best-practice technologies for waste minimization, basic unit operations in waste water treatment, advanced waste water treatment practices, removal and recovery of solids in process water and reuse water within the processing plant, water stream segregation of dissolved and particulate solids, use of efficient membranes, water reuse in the processing plant, alternative techniques to reduce the use of chlorine for water treatment, zero-discharge system, zero-emission system, anaerobic digestion of organic residences and wastes, anaerobic digestion of food industry waste water, waste water treatment of brewery winery and distillery, anaerobic degradation of animal by-products, utilization of whey, utilization of plant by products for the recovery of proteins, dietary fibers, anti-oxidants and their use as neutraceuticals, colorants, identification of market for by products, utilization of by products of fish industry, composting and incineration of food plant waste.

**Practicals:**
Study of ETP; waste water analysis; waste material recovery; water filtration; byproduct utilization.

Text/References:

FP 521 Food Supply Chain Management 2 - 0 - 1
Supplier management: Supplier pre-assessment and review, supplier documentation, internal audits, external audits, study of regulatory compliance, food quality management sanitation programs in the supply chain, food safety assessment, employee training, environmental monitoring, foreign material control, label control programs and consumer packaging, product and ingredient tracing, product testing, control of non-conforming product, consumer complaints, recalls and market withdrawals, crisis management.
Supply chain: catering and food retail industries, the scope and structure of the food supply chain, supply chain management, inter-firm relationships in food and drinks supply chain, relationship with state holders and responsibilities, Supply chain perspectives, internationalization of the food chain.
Management of the supply chain: strategic supply and management of relationships, logistics and information management, human resource management.
Practicals:
Case study of food supply chains, their management system.

Text/References:

FP 522 Novel Separation Techniques 2 - 0 - 1
General Review of conventional processes, Recent advances in separation techniques based on size, surface properties, ionic properties and other special characteristics of substances, Process
concept, Theory and equipment used in cross flow filtration, cross flow electrofiltration, dual functional filter, Surface based solid - liquid separations involving a second liquid, Sirofloc filter.

Membrane Separations: Types and choice of membranes, Plate and frame, tubular, spiral wound and hollow fibre membrane reactors and their relative merits, Commercial, pilot plant and laboratory membrane permeators involving dialysis, reverse osmosis, Nanofiltration, ultrafiltration, Microfiltration and Donnan dialysis, Economics of membrandem operations, Ceramic membranes.

Separation by Adsorption Techniques: Mechanism, Types and choice of adsorbents, Normal adsorption techniques, Affinity chromatography and immuno chromatography. Types of equipment and commercial processes, Recent advances and process economics.


Ionic Separations: Controlling factors, Applications, Types of equipment employed for electrophoresis, Dielectrophoresis, Ion exchange chromatography and electrodialysis, Commercial Processes.

Other Techniques: Separations involving lyophilisation, Prevaporation and permeation techniques for solids, liquids and gases. Industrial viability and examples, Zone melting, Addluctive crystallization, Other separation process, Supercritical fluid extraction, Oil spill Management, Industrial effluent treatment by modern techniques.

Practicals:

Separation of different colours, flavours, impurities and other ingredients from food materials by use of distillation, adsorption, membrane separation and other techniques

Text/ References:

FP 601  Computational Methods in Engineering  2 - 0 - 1


Practicals:
Based on Theory

Text/ References:

FP 602  Bioprocess Engineering  2 - 0 - 1

Basic concepts of bioprocess: Historical development of bioprocess technology, an overview of traditional and modern applications of biotech process, role of bioprocess in biotech industry, Outline of integrated bioprocess and various (upstream and downstream) unit operations involved in bioprocess, generalized process flow sheets. Kinetics of microbial growth and product
formation. Phases of cell growth in batch cultures, Simple unstructured kinetic models for microbial growth, Monod model, Growth of filamentous organisms. Growth associated (primary) and non-growth associated (secondary) product formation kinetics

Fermentation process: Basic design and construction of fermentor and ancillaries, main parameters to be monitored and controlled in fermentation processes. Overview of aerobic and anaerobic fermentation processes and their application in biotech industry, Solid substrate and submerged fermentation and its application. Fermenter types; Modeling of batch and continuous Fermenter.

Down stream processing operations; Solid- Liquid and Liquid- Liquid Separation processes, Extraction, Micro Filtration membrane filtration and centrifugal separation techniques, Chromatographic techniques for separation, drying of products; Bio process control and control instrumentation.

Industrial production of Important products; Production of pectic Enzymes-sub merged fermentation and semisolid fermentation Techniques: Industrial production of Glucose transforming enzymes; Organisms involved, production, purification and immobilization of (a) Glucose isomerase and (b) Glucose Oxidase. Industrial scale production of Bakers’ yeast and Brewer’s yeast; Microbial oil production and Bio pesticides.

Biosensors; Definitions, immobilization and membranes, transducer combinations; Biosensor development and diversification, Conducto-metric biosensors, Direct Electron transfer biosensors and Optic biosensors, Practical forms of Biosensors, specific applications of biosensors.

Practicals:
Production of different fermentation products, immobilization of whole cells and enzymes, separation of pure chemicals.

Text/References:
5. A. H. Patel, Industrial Microbiology, McMillan India Ltd. 1985
General: Functions of single and multiple variables - optimality criteria, direct and indirect search methods.
Linearization: Constraint optimality criteria, transformation methods based on linearization.
Quadratic and Geometric Programming: Quadratic and geometric programming problems, calculus of variations.
Artificial Intelligence in Optimization: Introduction to Artificial Intelligence in optimization.

**Practicals:**
Based on Theory.

**Text/ References:**

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**FP 604  Food Rheology  2 - 0 - 1**

Food rheology and structure: stress and strain tensors, viscometric properties, shear stress-shear rate relationships, units in rheological measurements, types of fluid flow behaviour, apparent viscosity, intrinsic viscosity, stress-strain behaviour of solid foods, linear viscoelasticity, phase transitions in foods.

Flow and functional models for rheological properties of fluid foods: Time independent flow behaviour, Apparent viscosity- shear rate relationships of shear- thinning foods, models for time-dependent flow behaviour, role of solids fraction in rheology of dispersions, affect of temperature on viscosity, treatment of rheological data using models.

Tube viscometry: introduction, Rabinowitsch Mooney equation, laminar flow velocity profiles, laminar flow criteria, yield stress evaluation, jet expansion, slit viscometry, glass capillary viscometers, pipeline design calculations, velocity profiles in turbulent flow.

Rotational viscometry: introduction, concentric cylinder viscometry, cone and plate viscometry, parallel plate viscometry, mixer viscometry.

Extensional flow: introduction: uniaxial extension, biaxial extension, flow through a converging die, opposing jets, spinning, tubeless siphon, steady sheer properties from squeezing flow data.

Viscoelasticity: introduction, transient tests for viscoelasticity, oscillatory testing, Deborah number, experimental difficulties in oscillatory testing of food, viscometric and linear viscoelastic functions.
Rheology of food gum and starch dispersions: effect of heating, effect of sugar and protein, rheological behaviour of starch, rheology of starch-gum dispersions.

Rheological behaviour of processed fluid and semisolid foods: fruit juice, milk and milk concentrates, chocolate, mayonnaise, margarine, structural analyses of food dispersions, structural components of yield stress.

Rheological behaviour of food gels: rheological tests to evaluate properties of gel systems, gel point and sol-gel transition by rheological measurements.

Application of rheology to fluid food handling and processing: Velocity profiles in tubes, energy requirements for pumping, pump selection and pipe sizing, power consumption in agitation, heat transfer to fluid foods, and role of rheology in thermal processing of canned foods.

Practicals:
Measurement of rheological parameters using cone/plate viscometer and capillary tube rheometer, Determine rheological parameters with volumetric flow rate equations, Rebinwitsch-mooney equations.

Text/References:

FP 605 Drying and Dehydration 2 - 0 - 1


Contact Drying: Fundamentals of contact drying, mass and heat balances in drying, batch and continuous drying. Vacuum dryers, plate dryers, thin film dryers, drum dryers, tunnel dryers, cabinet dryers, etc.

Freeze drying: Fundamentals of freeze drying- Freezing and drying steps- Combined heat and mass transfer (only theory)- Structural changes and volatile retention during freeze drying- Freeze dehydration related processed: prefreezing, preconcentration, condensation, defrosting- Industrial freeze driers- Atmospheric freeze drying- Applications in food industry.
Spray drying of Foods: Fundamentals- Nozzles, Rotary atomizers and two fluid feeds-
Interaction of droplets with air- Drying of droplets with soluble and insoluble solids-
Microstructure of spray dried products- Reconstitution- Foam spray drying- Applications in the
Food industry.
Fluidized bed drying: basics of fluidization, construction of fluidized bed dryer. Types of
fluidized bed dryer: batch, plug-flow, multi stage, vibro, internally heated and mechanically
agitated fluidized bed dryers.
Other types of drying: Osmotic dehydration: Principles and applications. Pneumatic drying,
Extrusion cooking: single and twin screw extruders, Dielectric drying, microwave drying.
Practicals:
Determination of drying characteristics of different food materials in different types of dryers.
Visit to different food processing plants.

Text/ References:
   Springer, 1996

**FP 606 Heat and Mass Transfer 2 - 0 - 1**

Differential equation for conduction - steady state conduction - Langmuir's equation - numerical
method in steady state conduction - unsteady state conduction - Numerical analysis - natural
convection over vertical cylinders, inclined surfaces and horizontal cylinders - forced convection -
boundary layer diffusion equations and convention regimes - thermal boundary layer - diffused
radiation - angle factor - rate of radiant loss - absorption factor method - uniform irradiation
assumption for emissivity determination - radiation surface coefficient - heat exchanger design - shell
and tube exchangers - optimum design of exchangers - heat transfer in boiling liquids.
Mass transfer - molecular diffusion - steady state diffusion and transient diffusion - turbulent
diffusion - interaction of molecular and turbulent diffusion - mixing and dispersion - mass
transfer at phase boundary - two film theory - mass transfer from flat plates, cylinders and disc -
design of mass transfer equipment.

**Practicals:**

**Text/References:**


**BT 412 Fermentation and Process Control 3 - 0 - 1**

Improvement of industrial microorganisms; industrial production of alcoholic beverages, vinegar and other chemicals, antibiotics (penicillin, tetracycline), amino acid and food products (single cell protein); use of immobilized cell systems for the production of industrially important chemicals; methods of food preservation – processing of cheese, curd and dairy products, non conventional food; aerobic and anaerobic fermentation, waste water treatment, biogas production; fundamentals of biochemical engineering - analysis of batch, fed-batch and continuous bio-reactions, mass and energy balances in biological processes, yield concept and maintenance of energy; bioreactors- elementary concepts in reactor engineering, scale up concepts; instrumentation for fermentation plant, reactor designs, stability of microbial reactors and specialized bioreactors ( pulsed, fluidized, photo bioreactor etc.); downstream processing and product recovery; procedures for the isolation of fermentation product (bioprocess engineering) and downstream processing; process control- modeling of bioprocesses, computer application in fermentation technology, biosensors and their use.
Practicals:
Effect of temperature on activity of fermenting organisms; analysis and production of ethanol by yeast; effect of fermented products; preservation of fermented products.

Text/ References:

BT 417  Food Biotechnology  3 - 0 -1

Scope of biotechnology in improvement of food quality; genetic engineering and food quality, improvement of nutritional value of food; seed storage proteins, genetic modification of traits of interest to consumers and processors; improvement of fatty acids in plants; starch branching genes and their use in molecular cloning; molecular characterization of food components – dynamics of cell wall biosynthesis during fruit ripening; regulation of ethylene biosynthesis and its regulation for food quality; regulation and functions of polygalacturonase in tomato; role of repartitioning agents in quality meat production; interaction and contractile proteins; bioprocesses of meats, fish, vegetables and fruits; genetic modification of enzymes used in food processing; production of food additives and processing enzymes by recombinant DNA technology; bioconversion and secondary metabolite production; food quality evaluation; use of RFLP and other molecular techniques for food quality improvement; nonisotopic hybridization systems in the detection of food borne bacteria; society and food quality: profitability, consumer concerns, demographic and social changes; sensory quality; products safety and nutrition; food quality and human health; regulatory considerations on food quality.

Practicals:
Broth culture microbes associated with good quality, isolation and purification of their genomic DNA; molecular characterization of microbial types with RFLP and RAPD techniques.

Text/ References:
4. L.R.Beuchat, *Food and Beverage Mycology*,


Signature of the HoD