

ADDITIONAL SUBJECTS

Code	Name Of The Subject	Credit
FP224	Food Refrigeration and Cold Storage Construction	3:0:0
FP225	Fruit and Vegetable Processing Technology	3:0:0
FP226	Dairy Technology	3:0:0
FP227	Cereals and Pulses Technology	3:0:0
FP228	Sugar and Confectionery Technology	3:0:0
FP229	Food Packaging Technology	3:0:0
FP230	Food Chemistry	3:0:0
FP231	Analysis of Food products of Animal Origin Lab	0:0:2
FP232	Plantation products and Spices Technology	3:0:0
FP233	Milling and Bakery Technology	3:0:0
FP234	Food Additives	3:0:0
FP235	Radiation Preservation and Processing of Food products	3:0:0
FP236	Protein Chemistry and Technology	3:0:0
FP237	Engineering Properties of Foods	3:0:0
FP238	Emerging Technologies in Food Processing	4:0:0
FP239	Food Dehydration Technology	4:0:0
FP240	Processing of Food Commodities	3:0:0
FP241	Analysis of Food Lab – 1	0:0:2
FP242	Analysis of Food Lab – 2	0:0:2
FP243	Analysis of Food Products Lab – 1	0:0:2
FP244	Food Analysis Lab	0:0:2
FP245	Food Product Technology Lab – 1	0:0:2
FP246	Enzymology Lab	0:0:2
FP247	Analysis of Food Products of Plant Origin Lab	0:0:2
FP248	Food Product Technology Lab - 2	0:0:2

FP224 FOODREFRIGERATION AND COLD STORAGE CONSTRUCTION

Credit : 3:0:0

Unit I Principles of Refrigeration

Refrigeration cycles, Vapour Compression and Vapour Absorption cycles, Refrigerants, characteristics of different refrigerants, Ozone Depletion Potentials, Green house Potential Refrigerants, use of non polluting refrigerants, net refrigerating effect, ton of refrigeration - Components of a Refrigeration system: Compressor, condenser, Evaporator, Expansion valves piping and different controls. Atmospheric air and its properties, Psychometrics, Energy considerations

Unit II 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. 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. Cold Storage practice, Stacking and handling of material in and around cold rooms, Optimum temperatures of storage for different food materials-meat and poultry products, marine products, fruits and vegetables, spices and food grains

Unit III Operation and maintenance - Controlled atmosphere and modified atmosphere storages

Operation and maintenance, Cleanliness, defrosting practices, preventive maintenance, safety measures

Controlled atmosphere and Modified atmosphere storages

Principles and basics of their construction

Unit IV Chilling of Foods

Chilling equipment for liquid foods. Secondary refrigerants and direct expansion techniques in chilling. Chilled foods transport and display cabinets - Basics of Chilled foods microbiology, Packaging of Chilled foods - Hygienic design considerations for chillers and chilled Storages. Cool storages and their applications. Evaporative cooling and its applications

Unit V Freezing of foods

Freezing equipment, Freezing rates, growth rate of ice crystals, crystal size and its effect of texture and quality of foods, Freezer types, Blast freezers, Contact Plate Freezers, conveyORIZED quick freezers, Individual quick freezing. Cryogenic Freezing, Freezing practice as applied to marine foods, meat and poultry, fruits and vegetables.

Text/Reference Books

1. Raymond R.Gunther: *Refrigeration, Air conditioning and Cold Storage* Chiltan Company, Philadelphia, USA 1957
2. Clive D.J.Dellino: *Cold and Chilled Storage Technology* Publisher: Kluwer Academic Publishers (1997)
3. S. Domkundwar and Subhash Arora: *A Course in refrigeration and Air Conditioning*: Dhanpat Rai and sons, Publishers, New Delhi (1994)
4. Andrew D Althouse and others: *Refrigeration and air Conditioning* Goodheart – Willcox Company Inc. 1982
5. E.R.Hollowell: *Cold Storage and Freezer Storage Manual* AVI Publishing Co. (1980)
6. Ed. C.P.Mallet: *Frozen Food Technology* Balckie Academic and Professional, (1993)
7. Aurel Gobaneu and Gabriela Laseha and others (1976) *Cooling Technology in the Food Industry*: Abacus Press, Tunbridge Wells, U.K.
8. Colin Dennis and Michael Stringer: *Chilled Foods – A Comprehensive Guide* Ellis Horwood Publishing, New york (1992)
9. D.K.Tressler and C.F.Evers: *The Freezing Preservation of Foods (Vol.1&2)* AVI Publishing Company Inc. USA (1965)
10. J.S.Pruthi: *Quick Freezing Preservation of Foods (2 Volumes)* Allied Publishers, Mumbai (1999)

FP225 FRUIT AND VEGETABLE PROCESSING TECHNOLOGY

Credit : 3:0:0

Objectives

- To know about the status of fruit and vegetable production in India with importance to losses.
- To study about the canning of fruits and vegetables.
- To impart knowledge about the various products from them.
- To study the various methods of drying of fruits and vegetables.

Unit I Introduction

Production of Fruits and vegetables in India., Composition of each of the major fruits and vegetables produced in the country - Mangoes, Pineapple, Guava, Papaya, Grapes among fruits - Beans, Carrot, Tomatoes, Potato, Onion, Brinjal among Vegetables. Cause for heavy losses. Spoilage factors, Post harvest field operations, including methods to reduce the post harvest losses, General methods of preservation of fruits and vegetables.

Unit II Canning of Fruits and Vegetables

Reception, sorting and Storage operations for fruit and vegetables. Preparation of fruits and vegetables for canning. – Washing, peeling, grating, slicing dicing, deseeding, blanching - Importance of Blanching operations - Batch and Continuous Blanching.- Hot water and Steam Blanching.- Canning operations – precautions in canning operations, Spoilage of canned foods. Common machinery for operations like Peeling, Slicing/Dicing, Pulping, Grating and canning process.

Unit III Fruit and vegetable products

Juice and pulp extraction – various extractors used including Hydraulic Press - Hot and Cold Break process - Clarification - Clarification centrifuges – Decanters and desludgers. Preparation and packaging of pulps, Jams, Jellies, Marmalades, Squashes Pickles, Puree, Ketchup, Sauce - Different types Glass and Plastic Containers, Large capacity storage containers in plastic, in plastic and SS containers. Different filling, closing and sterilization operations. Different preservatives used for long and short-term storage

Specialty products - Fruit Bars , Fruit juice concentrates – methods of concentration - evaporators used for concentration of fruit juices and pulp - Tubular, Plate and scraped surface evaporators and Fruit Powders - Preparation of Fruit material for powder production - Working of Spray Dryer and Drum Dryer - Fruit juice aroma Recovery and its importance. Brief on Aroma Recovery equipment.

Unit IV Dehydration

Dehydration principles - Preparation of fruits and vegetables for dehydration. - Equipments used for drying with their principles - Cross Flow Shelf Dryers, Vacuum Shelf Dryers, Tunnel Dryers, Foam mat dryers, Freeze Dryers, Fluidized bed dryers, Infra red dryers. Simple estimation of drying costs. Packaging of Dried slices, Dices and powder.

Unit V Aseptic and other methods of processing

Aseptic processing and Bulk packing of Fruit juice concentrates, Pulps and Puree - Brief information on Asepticity and how it is strictly maintained in the plant - Aseptic heat exchangers for sterilizing and concentrating the product - Aseptic fillers. Different system of filling practiced. Tetra pack for small quantities - Dole system and Scholle system for bulk storage in Bag & Boxes and Bag & Drums. - Storage of Aseptically packed products. Minimal Processing and packaging of vegetables, Brief study of Hurdle technology as applied to Vegetable and Fruit processing.

Text Books

1. Dauthy, M.E.: Fruit and Vegetable Processing. International Book Distributing Co. Lucknow, India. (1997)
2. Hamson, L.P: Commercial Processing of Vegetables. Noyes Data Corporation, New Jersey. (1975)
3. Jagtiani J., Chan, H.T. and Sakal, W.S.: Tropical Fruit Processing Academic Press, London. (Ed. 1988)
4. Lal, G., Siddappa, G. and Tondon G.L. : Preservation of Fruits and Vegetables, Indian Council of Agricultural Research, New Delhi. (1986)
5. Srivastava,R.P., and Sanjeev Kumar: Fruit and vegetable preservation; principles and practices.: International Book Distributing Co., Lucknow. 1998

Reference Books

1. Y.H.Hui and Others: Hand Book of Vegetable Preservation and Processing Marcel Dekker New York 2004
2. Salunkhe, D.K. and Kadam, S.S.: Handbook of Fruit Science and Technology: Production, Composition and Processing. Marcel Dekker, New York. (1995)
3. Salunkhe, D.K. and Kadam, S.S.: Handbook of Vegetable Science and Technology. Production, Composition, Storage and processing Marcel Dekker, New York. (1995)
4. Seymour, G.B., Taylor, J.E. and Tucker, G.A: Biochemistry of Fruit Ripening. Chapman and Hall, London. (1993)
5. Srivastava, R.P. and Kumar, S.: Fruit and Vegetable Preservation: Principles and Practices. International Book Distributing Co. Lucknow (2nd Edition 1998).
6. Chakraverty, A., Mujumdar A.S., Raghavan G.S.V and Ramaswamy H.S. Handbook of Post-harvest Technology: Marcel Dekker Press, USA (2001)
7. Manorajan Kalia and Sangita Sood.. Food Preservation and Processing, Kalyani Publishers, Ludhiana. 1996

FP226 DAIRY TECHNOLOGY

Credit : 3:0:0

Objectives

To enable the student to understand

- The basic composition and properties of milk.
- Study the processing of milk with the use of equipments.
- To know about the manufacture of different dairy products and the equipments used.
- To impart the knowledge on fermented dairy products..

Unit I Dairy Chemistry and Microbiology

Introduction, Milk - composition, food and nutritive value, physico-chemical properties. Buying and collection of milk – transportation of milk – milk reception – contaminants - Milk reception in dairies, Quality and Quantity tests at reception - Applications of enzymes in dairy industry

Unit II Milk Processing

Milk Processing flow sheet – Filtration / clarification, Storage of milk, Standardization – simple problems in standardization, Homogenization, Pasteurization – Types of pasteurization process. Equipments used in each process - Cream separating centrifuges, Pasteurizers (Heat Exchangers), Homogenizers, Bottle and pouch fillers, Milk Chillers, Plant piping, Pumps.

Unit III Manufacture of Dairy Products

Manufacture of Cream, Butter, Ghee, Milk powder, Cheese – Types and Defects in cheese. Quality aspects of these products. Equipments used for manufacture of each product like Butter churn, ghee boiler, Spray and Drum Dryers, Product instantizing equipment etc.

Unit IV Manufacture of Ice Cream and other Dairy Products

Manufacture of Ice cream – Chemistry and technology – Microbiology of ice cream - Quality aspects. Manufacture of paneer, Toned Milk, Sweetened Condensed milk, Khoa. Extraction of casein from milk – properties - composition and industrial uses. Production of lactose and whey

Unit V Fermented dairy products

Fermented products – Yoghurt, Curd, acidophilus milk, butter milk.

Dairy plant sanitization – Cleaning in place – bottle and can washing, cleaning of tankers and silos – Detergents and sanitizers used.

Energy use in Dairy plant - sources and cost of energy, Control of energy losses and Energy conservation.

Text books

1. Sukumar De, Outlines of Dairy Technology, Oxford University Press, India (1980).
2. Tufail Ahmad: Dairy Plant Systems Engineering Kitab Mahal, Allahabad, India (1985)
3. Edger Spreer & Axel Mixa: Milk and Dairy Product technology Mercel dekker Inc. N.Y. (1998)
4. National Institute of Industrial Research, Modern Technology of Milk processing and Dairy products, II Edition, NIIR Publications, India, 2004.

Reference Books

1. Arthur W. Farral: Engineering of Dairy and food Products (II Edition 1970) Robert E. Krieger Publishing Co. NY
2. Garret Smit : Dairy Processing (Improved Quality) Woodhead Publishing Ltd. CRC Press (2003)
3. W.M. Clunie Harvey and Harry Hill: Milk Products Bio Tech Books, New Delhi (1999)

4. Prof. H.G. Kessler: Food Engineering and Dairy Technology Verlag Kessler Publishing House, Germany (1981)
5. W. James Harper and Carl W. Hall: Dairy Technology and Engineering AVI Publishing, Westport, USA (1976)
6. Edger Spreer: Milk and Dairy Product Technology Mercel Dekkar Inc. New York, USA (2005)

FP227 CEREALS AND PULSES TECHNOLOGY

Credit : 3:0:0

Objectives

- To create awareness about the processing of major cereals like paddy, maize etc.
- To study the storage and handling techniques of cereals.
- To study about the by products obtained during processing along with their uses.
- To gain knowledge on processing and milling of pulses.

Unit I Paddy Processing:

Paddy Varieties - Their Composition and Quality characteristics. Curing of Paddy. Parboiling Processes, Cold Water soaking and Hot water soaking processes, Paddy Dryer - LSU Dryer. By Products of Paddy Processing - Paddy husk and its uses as boiler fuel, husk ash, activated carbon, furfural and other by products. Production of Flattened Rice and Puffed Rice from Paddy

Unit II Rice Milling:

Paddy Dehusking Processes. Rice Mill Flow Chart. Engelberg Huller Mills. Modern Rice Mills – Their Components - Pre Cleaners, Shellers, Under Runner Shellers and Centrifugal Shellers, Paddy Separators – Satake and Schule Designs, Polishers - Cone polishers and other types, Bran and Broken separators. Rice Mill yields and loss due to broken at different stages of milling. Use of Rice Bran in Edible oil Industry.

Unit III Milling of Pulses:

Major Pulses grown in the country and their application, Status of Pulse milling industry in India, need for modernization, Traditional milling process - merits and demerits. Drying of legumes - Sun drying, Traditional Processing steps – Pre-cleaning, Pitting, Oil application, conditioning, Dehusking and splitting - Machinery and equipment employed, mass balance, losses during milling. Modern milling process - Process flow chart -Mechanical hot air drying and conditioning - merits and demerits, Dehusking in Pulse Pearler, Water conditioning, splitting of pulses in Pulse splitter, Merits and demerits. Mini dhal mill - working principle - advantages and disadvantages. Grinding of split pulses, pulse flour products, their applications, equipment used.

Unit IV Milling and Processing of Maize:

Dry milling of maize: Storage and drying, Pre-cleaning, cleaning equipment, Degermination and Dehusking, Roller milling, Sifting, Purifying, Aspiration, Pneumatics in a maize mill.

Products of milling - Flour, Semolina, Brewers' grits etc and their applications. Wet milling of Maize and corn: Modern methods of processing, Cleaning, Steeping, Degermination, Bran and Fibre separation, Gluten and Starch Separation,. Equipment needed for Degermination, Debraning and starch separation. Starch conversion into other value added products - Acid Hydrolysis, Enzyme Hydrolysis, Isomerization processes. Processing for Dextrose, Malto Dextrin and other products. Extraction and refining of Corn oil in brief.

Unit V Grain Storage and Handling:

Bag Storage - Advantages and Disadvantages - Bag Storage structure design. Parameters of good storage structure, Cover Plinth Storage Structures, CAP storage (Ceiling and Plinth Storage), Plans for Bag storage, lay outs, Dunnage, Materials for Dunnage, Pallets, Protection against Rodents, Fungi, Pests and Mites. Fumigation Processes for bag storage piles.

Bulk Storage in silos and large Bins - Problems of Silo storage, Construction of Silos - concrete and Metal Silos, Physical load and mechanical strength of Silos, Silo flow problems, Relative merits and demerits of Silo storage to Bag Storage, Relative Costs of Silo and Bag Storage. Conveyors and Elevators for feeding and discharging into Silos. In silo Aeration and Drying, Problems of Dust Explosion in Grain Storages, Quality Changes of Grains during storages and remedial measures to prevent unwanted quality changes.

Text Books

1. Chakraverty, A.: Post Harvest Technology of Cereals, Pulses and Oilseeds. Oxford and IBH Publishing Co, Calcutta (1995)
2. Samuel Matz: The Chemistry and Technology of Cereals as Food and Feed, Chapman & Hall (1992)
3. N.L.Kent and A.D.Evans: Technology of Cereals (4th Edition) Elsevier Science (Pergaman), Oxford, UK, (1994)
4. George E Inglett: Maize-Recent Progress in Chemistry and Technology Academic Press, London (1982)
5. Ruth H. Matthews: Pulses – Chemistry, Technology and Nutrition Mercel Dekker Inc. USA (1989)

Reference Books

1. J. Smartt: Tropical Pulses Longman Group Ltd. London (1980)
2. Y. Pomeranz: Modern Cereal Science and Technology VCH Publishing Inc. New York (1987)
3. Cryde M. Christensen: Storage of Cereal Grains and their Products American Association of Cereal Chemists inc., St. Paul, USA 1982
4. Bernard Godon and Claude Willm: Primary Processing of Cereals Berns and Noble Publishers (1994)
5. Karel Kulp and Joseph P Pante:Hand Book Of Cereal Science and Technology Mercel Dekkar USA (2000).

FP228 SUGAR AND CONFECTIONERY TECHNOLOGY

Credit : 3:0:0

Objectives:

1. To study the methods of manufacturing of sugar and other allied products.
2. To study about the machineries involved in confectionery manufacturing.

Unit I Introduction

Sugarcane and sugarbeet as sugar raw materials. Flow charts for manufacture of Granulated sugar and Liquid sugars. Properties of Granulated sucrose and Liquid Sugars. Invert sugar and their characteristics. Speciality products of Sugar Industry. Back strap Molasses and its uses. Applications in animal feed

Unit II Sugar production processes

Extraction of juice, extraction yields, drying and uses of Bagasse, Purification of juices-juice filtration and chemical purification, Clarification stages, Lime addition, pH control, Treatment of clarified juice, evaporation –multiple effect evaporators, Vacuum pans, Crystallization, Washing of sugar crystals and centrifugal separation/dewatering of sugar and other related processes. Sugar Refining, Sugar analysis, Sugar recovery –improvement, /Sugar balance, energy conservation, Sugar plant sanitation.

Unit III : Technology of Chocolate manufacturing

Ingredients and their role as food additives in chocolate manufacturing. Machineries involved in the process of manufacturing chocolates.

Unit IV : Technology of Confectionery manufacture

General technical aspects of industrial sugar confectionery manufacture, Manufacture of high boiled sweets – Ingredients, Methods of manufacture – Types – Center – filled, lollipops, coextruded products. Manufacture of gums and jellies – Quality aspects

Unit V : Manufacture of Miscellaneous Products

Caramel, Toffee and fudge – Liquorice paste and aerated confectionery, Lozenges, sugar pannings and Chewing gum, Countlines - Quality aspects

Text Books

1. E.B. Jackson: Sugar Confectionery Manufacture, Second edition, Aspen publishers Inc., 1999. Great Britain
2. Guilford L Spencer and George P. Made: Cane Sugar Hand Book (1993) John Wiley and sons Inc. London
3. P. Manohara Rao: Industrial Utilization of Sugar Cane and its co-products P.J.International Consultants, New Delhi

Reference Books

1. Maurice Shachman, Soft Drinks Companion: A Technical Handbook for the Beverage Industry, CRC press, Florida, USA (2005)
2. W.Ray, Junk & Harry M. Pancost: Hand Book of Sugars – for Processors, Chemists and Technologists: AVI Puvblishing, West port (1973)
3. Oliver Lyle: Technology of Sugar for Refinery Workers Chapman and Hall Ltd., (1950)
- 4.E.Hugott: Hand Book of Cane Sugar Engineering Elsevier Publishing /company, London (1986)

FP229 FOOD PACKAGING TECHNOLOGY

Credit : 3:0:0

Objectives

- To study about the functions of packaging along with the influence of various factors on food.
- To know about the different packaging materials like cans, bottles, flexible films etc.
- To study about the various methods of packaging to improve the shelf life of the products.
- To learn about the equipments used for packaging.

Unit I : Introduction to Food Packaging

Protection of Food products - major role of food packaging - Functions of packaging, Effect of environmental factors like Light, Oxygen, Moisture, Temperature and mechanical forces and biological factors on food quality and shelf life, Need for protective packaging. Estimating the Shelf life requirement of food products for packaging - accelerated storage studies etc. Tests on packaging materials - Mechanical strength (Tension, notch and tearing strengths), Gas and water vapour transmission rates.

Unit II : Metal Cans and Glass Bottles as Packaging

Merits and demerits, Metallic can types employed, Tin cans and Aluminum cans, relative merits and demerits, specialty of Open top sanitary cans (OTS), Lacquers and their use, Three piece cans and Two piece cans, Aerosol Cans, Relative merits and demerits. Basics of Canning operations, Can closures. Glass jars and Bottles in food packaging, Design features and applications, Sterilization of bottles, advantages and problems, Bottle and jar closures, different types of caps and liners used.

Unit III : Flexible Films Packaging

Relative merits and demerits. Formation of Films and pouches, Plastics used and their Specific applications, advantages and disadvantages – Polyethylene (LDPE and HDPE), Cellulose, Polypropylene (PP), Polyesters, Polyvinylidene Chloride (PVDC - Diofan, Ixan and Saran), Polyvinyl chloride, Copolymers their applications. Co-extruded films and Laminates - Their applications. Filling (Volumetric and Gravimetric) and Sealing of pouches, Pouch form fill seal machines: Rigid and Semi rigid plastic packaging –Fabrication methods in brief –Thermo forming, Blow moulding, Injection moulding, Extrusion Blow moulding etc., applications: Laminated Paper board Cartons, Fibre Board and Corrugated Card Board packaging and their applications.

Unit IV : Filling and Sealing Operations for various types of packages.

Can double seam - can seam formation and defects- terminology, Metal caps for bottles and jars – Crown corks, lug caps, Twist off lid and ROPP caps, Description and applications. Closing and sealing of Rigid plastic containers. Filling and sealing of Flexible plastic containers, Seal types - Bead seals, Lap Seals and Fin seals – Differences and advantages, Hot wire sealing, hot bar sealing and impulse sealing – differences and relative advantages, Form fill Seal equipment. Printing on packages, Bar codes, Nutrition labeling and legislative requirements.

Unit V : Interaction of Food Material with Packaging Material

Active packaging, Moisture control, CO₂ and Oxygen scavenging, Modified atmosphere packaging – principles, applications. Vacuum and Inert Gas Packaging.

Text Books

1. Gordon L. Robertson: Food Packaging- Principles and Practice Marcel Dekker Inc, USA (1993)
2. Donald Downing: Complete Course in Canning (3 Volumes) CTI Publications inc, USA (1996)
3. Mathlouthi M. (Editor): Food Packaging and Preservation Elsevier Applied Science Publications Essex, UK (1986)
4. J. R.D.David, R. H Graves and V.R.Carlson: Aseptic Processing and Packaging of Foods: CRC Press, New York

Reference Books

1. NIIR Board: Food Packaging Technology Handbook National Institute of Industrial Research, New Delhi (2004)
2. Frank A. Paine and Heather Y.Paine: A Hand Book of Food Packaging Leonard Hill Publications (Blackie and sons) (1983)
3. O.G.Pirenger and A.L.Baver: Plastic Packaging Materials for Food Wiely VCH, GmbH, Germany (2000)
4. Shirly V.Vangrade and Morgy Woodburn: Food Preservation and Safety Surabhi Publications, Jaipur India

FP230 FOOD CHEMISTRY

Credit : 3:0:0

Objectives

To enable the student to understand:

- Chemistry of the constituents forming a food
- Interaction between constituents and its effect on food quality
- Importance of these interactions in developing Technologies / Processes

Unit I : Water and ice

Importance of water in foods. Structure of water & ice. Concept of bound & free water & their implications. Sorption Phenomena and Sorption isotherms, examples – Dispersed systems – some basic considerations

Chemistry of Carbohydrates: Nomenclature Classification & structure of carbohydrates, Chemical reactions of carbohydrates. Physical & chemical properties of sugars

Unit II: Chemistry of Polysaccharides

Chemistry, properties and preparation of Pectic substances, gums & polysaccharides, Starch and its hydrolytic products, maltodextrins, Cellulose, Cyclodextrins

Unit III : Chemistry of Lipids

Definition & classification of lipids. Basic Structures, Chemistry of fatty acids & glycerides. Components of Fatty acids, Phospholipids, and unsaponifiables, Auto oxidation and hydrolysis, Physical & chemical characteristics of fats & oils, hydrogenated fats,

shortening agents, confectionary fats etc. Rancidity of fats & oils, and its prevention, antioxidants. Process flow sheet for the manufacture of edible oils (refined and hydrogenated)

Unit IV : Chemistry of Proteins

Importance of Proteins. Nomenclature, classification, structure and chemistry of amino acids, peptides & Proteins. Sources and distribution of Proteins. Isolation, identification & purity of Proteins. Denaturation. Physical & chemical characteristics of Proteins.

Enzymes: Introduction, Nature, Function, classification & nomenclature of enzymes. Specificity. Amylases, Pectic Enzymes, Proteases; Oxidoreductases- Phenolases, Glucose Oxidases, Catalases, Peroxidases, Lipoxigenases, Xanthine Oxidases, Immobilized enzyme- One example of working of each enzyme. Assay Techniques. Isolation & purification of enzymes & their importance.

Unit V : Chemistry of Vitamins

Summary of vitamin stability – Toxicity and sources of vitamins – Bioavailability of vitamins – Reasons for the loss of vitamins in foods – Fat-soluble and water soluble vitamins – Choline, carnitine

Text Books:

1. Owen R Fennema : Food Chemistry – III edition Marcel Dekkar Inc. New York (1996).
2. L.H.Meyer : Food Chemistry Van Nostrand Reinhold Co. New York, (1960)

Reference Books

1. H-D Belitz, W Grosch and P Schieberle: Food Chemistry - 3rd Edition, Springer Verlag March 2004
2. Zdzislaw E. Sikorski: Chemical and Functional Properties of Food Components Technomic Publishing, Lancaster, USA 1997
3. Eskin, N. A. With Henderson, H. M: Biochemistry Of Foods Harcourt Publishers Ltd, USA (Edition #2, 1990)
4. *David S.Robinson: Food Biochemistry and Nutritional Value Longman Scientific and Technical Publishers, USA (1987)*
5. J.B.S.Breverman: Introduction to Biochemistry of Foods Elsevier Publishing Company, USA (1963)
6. Pieter Walstra: Physical Chemistry of Foods Marcel Dekker Publishing, New York (2003)
7. Zdzislaw and E.Sikorski: Chemical and functional Properties of Food Components: Technomic Publishing company, USA (1997)
8. T.P.Coulter: Food – Chemistry of its Components Royal Society of Chemistry, USA (1984)

FP231 ANALYSIS OF FOOD PRODUCTS OF ANIMAL ORIGIN LAB

Credit: 0:0:2

12 experiments will be notified by the HOD from time to time

FP232 PLANTATION PRODUCTS AND SPICES TECHNOLOGY

Credit:3:0:0

Objectives

To enable the students to understand

1. Basics of plantation and spice products
2. Techniques in processing these products
3. Developing new Technology .

Unit I : Chemistry and Technology of Coffee

Coffee – Occurrence – chemical constituents – harvesting – fermentation of coffee beans – changes taking place during fermentation – drying – roasting – Process flow sheet for the manufacture of coffee powder – Instant coffee, technology – Chicory chemistry - Quality grading of coffee

Unit II : Tea – Chemistry and Technology

Occurrence – chemistry of constituents – harvesting – types of tea – green, oolong and ctc – Chemistry and technology of CTC tea – Manufacturing process – Green tea manufacture – Instant tea manufacture – Grading of tea

Unit III : Chemistry and Technology of Cocoa and Cocoa Products

Occurrence – Chemistry of the cocoa bean – changes taking place during fermentation of cocoa bean – Processing of cocoa bean – cocoa powder – cocoa liquor manufacture
Chocolates – Types – Chemistry and technology of chocolate manufacture – Quality control of chocolates

Unit IV : Chemistry and Technology of Major Spices

Pepper, Cardamom, ginger and turmeric – Oleoresins and essential oils – Method of manufacture – Chemistry of the volatiles –Enzymatic synthesis of flavour identicals - Quality control

Unit V : Chemistry and Technology of Minor Spices

Cumin, Coriander, Cinnamon, fenugreek, Garlic, Clove and Vanilla - Oleoresins and essential oils – Method of manufacture – Chemistry of the volatiles – Quality control

Present trends in synthesis of volatiles – micro-organisms, plant suspension cultures

Text Books / Reference books

1. Salunkhe, D.K. and Kadam S.S. Ed. 1998. Hand book of Vegetable Science and Technology, Marcel Dekker, New York, USA.
2. Chocolate, Cocoa and Confectionery Technology, Minifie Bernard W., III Edition, Aspen Publication, 1999.
3. Handbook on Spices, National Institute of Industrial Research (NIIR) Board, Asia Pacific Business Press Inc., New Delhi 2004.

FP233 MILLING AND BAKERY TECHNOLOGY

Credit:3:0:0

Objectives

To enable the students to understand

1. Lab tests done in industries
2. milling process in wheat
3. wheat and wheat products

Unit I : Fundamentals of Market Analysis for Wheat and Wheat Products

Laboratory testing of Wheat grain Quality, Moisture tests, Grain hardness testing. Testing, Visco graph, Amylograph, Ferinograph.

Unit II : Outline of the Wheat Milling Process

Wheat milling Flow sheet, explanation of steps in milling operations of milling-Cleaning, Sifters, Destoners, Roller milling – Break rolls, fluted rolls and plane rollers , purifier, plan sifter; . Pneumatic conveying ,wheat products and wheat by-products.

Unit III : Bakery Equipment and Engineering

Bulk handling of ingredients, Weighing equipment, Dough mixers, Dividers, rounders, Proofing, moulding, Ovens, Slicers, Packaging materials and equipment, Sanitation and safety.

Unit IV : Baked Products

Materials of baking ,Bread manufacturing process – Straight dough fermentation, Sponge and dough, Biscuit-Types of biscuit doughs – Developed doughs, short doughs, semi-sweet, enzyme modified doughs and batters- importance of the consistency of the dough-Cake – Flour specification – ingredients – manufacturing process – types of chemically aerated goods.

Unit V: Confectionery Technology

Types of Confectionery, raw materials and processing of toffee,chocolates,fruit drops,hard boiled candies

Text/Reference Books

1. *Association of Operative Millers Cereal Millers Hand Book*: Burgess Publishing company, USA 1963
2. Y. Pomeranz *Modern Cereal science and Technology*: MVCH Publications, NY (1987)
3. N.L.Kent, A.D.Evers *Technology of Cereals*: Peregaman Press (Elsevier Publishers) (1994)
4. Samuel A. Matz : *Bakery Technology and Engineering (3rd Edition)* Published by Chapman & Hall (1992)
5. Samuel A. Matz: *Equipment for Bakers* Pan Tech International Publication (1988)
6. Stanley P Cauvain, Linda S Young: *Technology of Breadmaking*: Second Edition Aspen publication, 1999

7. Duncan Manley: *Biscuit Doughs Manual 2*, by Woodhead Publishing Ltd., England 1998.
8. A Bent, E B Bennion, G S T Bamford: *The technology of cake making*, Sixth edition, Blackie Academic and Professional, UK. 1997
9. Stanley P. Cauvein: *Bread Making – Improving Quality* Woodhead Publishing(CRC Press 2003)
10. Duncan J.R. Manley: *Technology of Biscuits, Crackers, and Cookies* Ellis Horwood Ltd (1983)

FP234 FOOD ADDITIVES

Credit : 3:0:0

Objectives

To enable the student to understand:

1. Chemistry of the additives added to a food
2. Importance of additives in maintaining or improving food quality
3. Know the limits of addition as prescribed by FAO/WHO and PFA
4. Develop newer additives with improved safety standards

Unit I Introduction

Food additives definition – Determination of the limit for addition – NOEL – Toxicity data – Method of determining toxicity – LD50, carcinogenicity, teratogenicity – PFA, FDA, FPO regulations – GRAS additives

Unit II

Types, chemical properties, levels of additions in individual products, toxicity data of Acidulants – Preservatives – Emulsifiers and gums - Antioxidants

Unit III

Types, chemical properties, levels of additions in individual products, toxicity data of Dough conditioners - flour improvers – Humectants –Enzymes, Starches

Unit IV

Types, chemical properties, levels of additions in individual products, toxicity data of Colourants – Natural and artificial, Flavourants, Flavour enhancers, Fat substitutes and replacers

Unit V

Types, chemical properties, levels of additions in individual products, toxicity data Sweeteners – Natural and synthetic, Chelating agents, antibrowning agents, Nutritional additives

Text book

1. Food additives by Brannen A.L., Davidson P.M., Salminen S. and Thorngate J.H. Second Edition, Revised and Expanded. Marcel dekker Inc. USA, 2002.
2. Handbook of Food additives by Thomas Furia,

FP235 RADIATION PRESERVATION AND PROCESSING OF FOOD PRODUCTS

Credit: 3:0:0

Objectives:

1. To study the importance of non-thermal methods like irradiation as an alternative to the conventional methods of processing.
2. To study the effect of radiation as a processing and preservation method
3. To study the importance and safety issues of the irradiated foods

Unit I Basics of Radiation Chemistry

Electromagnetic energy, ionizing radiation, Concept of radiation, dielectric properties, ionization and excitation, Radiation chemistry basics - primary chemical effects and secondary effects on food, G value, irradiation parameters, instruments for measuring radiation, effect of food irradiation and potentialities for radiation processing of foods.

Unit II Radiation Chemistry of Food Components

Basics-carbohydrates, proteins, lipids, vitamins etc. Radiation effect on contaminating microorganisms like bacteria, viruses, yeasts and molds - Dosages of radiation for various plant foods and animal foods-meat and poultry, fruits, vegetables, spices, dairy products; Radiation equipment, salient features; Packaging of irradiated foods and safety issues.

Unit III Microwaves In Food Processing

Microwave heating, nature of energy, batch and continuous ovens, microwave generators, wave guides, brief description of oven construction, application of microwave radiation and safety measures.

Unit IV Infra red Radiation

Absorption and scattering characteristics of various food materials, Polarization characteristics of IR radiation, Propagation of IR radiation in food stuffs. IR generators, applications, Relative merits and demerits.

Unit V Radio Frequency Heating Principles

RF heating equipment, Advantages of Radio frequency heating of foods - Ultra violet radiation and its effect on microorganisms in foods - UV treatment application and equipment.

Text Books

1. J.F.Diehl: *Safety of Radiated Foods* Marcel Dekker Inc. NY (1995)
2. Robert V. Decareau: *Microwaves in Food Processing Industry* Academic Press inc. New York (1985)
3. Gould G.W. *New Methods of Food Preservation*, Aspen Publisheres Inc. Maryland. 1999.

Reference Books

1. Welter M. Urbain: *Food Irradiation* Academic Press, New York (1986)
2. Wilkinson Guild: *Food Irradiation – A Reference Guide* Woodhead Publishing, Cambridge, UK (1996)

3. Ohlsson and Bengtson: *Microwave Processing Technologies* Woodhead Publishing, Cambridge, UK (2002)
4. S.G.Llyasor and V.V. Krasnikov: *Physical Principles of Infra Red Irradiation of Food Stuffs*: Hemisphere Publishing Corporation, London (1991)
5. Philip Richardson: *Thermal Technologies for Food Processing* Woodhead Publishing Limited, CRC Press. (2001)
6. Robert V. Decareau: *Microwave Foods, New Product Development* Food & Nutrition Press Inc. USA (1992)
7. A.S. Ginzburg: *Applications of Infra-Red Radiation in Food Processing* Leonard Hill, London (1969)

FP236 PROTEIN CHEMISTRY AND TECHNOLOGY

Credit : 3:0:0

Objectives

To enable the student to understand:

1. Chemistry of the protein found in food
2. Importance of proteins in modifying the textural properties of food systems
3. Importance of protein engineering in improving the nutritional and functional properties of food
4. Develop newer technologies and sources of proteins

Unit I Basics of amino acids and protein chemistry

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

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

Unit II Protein Architecture

Primary structure: peptide mapping, peptide sequencing - automated Edman method & mass-spec. High-throughput protein sequencing setup

Secondary structure: Alpha, beta and loop structures and methods to determine (Basics only)

Basics of Super-secondary structure: Alpha-turn-alpha, beta-turn-beta (hairpin), beta-sheets, alpha-beta-alpha, topology diagrams, up and down & TIM barrel structures nucleotide binding folds, prediction of substrate binding sites

Tertiary structure: Domains, folding, denaturation and renaturation, overview of methods to determine 3D structures, Quaternary structure: Modular nature, formation of complexes.

Unit III Protein Engineering

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

Unit IV Basics of the Properties of Food proteins – Animal and Marine sources

Caseins and Whey proteins

Caseins – Heterogeneity and Molecular properties – caseins micelles – Mechanism of stabilization – Structure models – Structure of whey proteins and improvement of functionality

Muscle proteins – Structure and functionality – Application of muscle proteins in foods

Sea weed proteins – Protein content and functionality, digestibility of algal proteins – applications to food systems

Unit V Basics of the properties of Food proteins – Plant sources

Composition, Properties and functional properties of soya, rapeseed, peanut.

Leaf as a protein source – Basic and Food applications of rubisco

Text Books

1. Voet D. and Voet G., “Biochemistry”, Third Edn. John Wiley and Sons, 2001
2. Branden C. and Tooze J., “Introduction to Protein Structured, Second Edition”, Garland Publishing, NY, USA, 1999
3. P. F. Fox, J. J. Condon. Food Proteins, Kluwer Science, 1982.
4. B. J. F. Hudson. New and Developing Sources of Food Proteins, Chapman and Hall, 1994.
5. Zidziszław E. Sikorski, Chemical and Functional Properties of Food Proteins, CRC Press, 2001.

Reference Books

1. Creighton T.E. Proteins, Freeman WH, Second Edition, 1993
2. Moody P.C.E. and Wilkinson A.J. “Protein Engineering”, IRL Press, Oxford, UK, 1999

FP237 ENGINEERING PROPERTIES OF FOODS

Credit : 3:0:0

Objectives:

1. To study the various engineering properties of food materials under different conditions.
2. To study about the different methods of determining the quality and properties of different foods

Unit I : Physical Properties of Foods

Methods of estimation of - Shape, size, volume, density, porosity and surface area.

Unit II : Rheological Properties of Foods

Rheological Classification and models, Static tests for solid foods, Creep, relaxation, Dynamic testing of solid foods, stress and strain in solid foods, stress-strain diagram, visco-

elastic fluids, measurement methods, Viscometers and Rheometers of different design and their applications, texture measuring instruments, Hardness and brittleness of food materials.

Unit III : Thermal Properties of Foods

Definitions - specific heat, enthalpy, conductivity and diffusivity, surface heat transfer coefficient. Measurement of thermal properties like specific heat, enthalpy, conductivity and diffusivity;

Unit IV : Aerodynamic and hydrodynamic properties of Foods

Drag coefficient, terminal velocity and their application in the handling and separation of food materials.

Unit V: Electrical properties of foods

Dielectric properties, electric energy transmission properties, Electro-magnetic field effects, Dielectric measurements, Polar solvents, Ionic solutions.

Text Books

1. Nuri N. Mohsenin: Physical Properties of Plant and Animal Materials Gordon and Reach Science Publishers (1970)
2. Nuri N. Mohsenin: Thermal Properties of Food & Agricultural materials Gordon and Reach Science Publishers (1970)

Reference Books

1. M.A.Rao and S.S.H.Rizvi: Engineering Properties of Foods MerceL Dekker inc. New York (1998)
2. M.J.Lewis: Physical Properties of Foods and Food Processing Systems Woodhead Publishing Cambridge, UK (1990)
3. Reynold Jewitt and Others: Physical Properties of Foods Allied Science Publishers (1983)
4. Shafiur Rehman: Food Properties Hand Book CRC Press Inc. New York (1995)
5. J.H.Prentice: Measurements in the Rheology of Food Stuffs Elsevier Applied Science Publishers (1984)
6. Micha Peleg and Edward B.Bagley: Physical Properties of Foods AVI Publishing company Inc, Westport USA (1983)
7. R. P.Kachru and R.K.Gupta: Physico-Chemical Constituents and Engineering Properties of Food Crops : Scientific Publishers, Jodhpur.

FP238 EMERGING TECHNOLOGIES IN FOOD PROCESSING

Credit: 4:0:0

Objectives

To enable the student to understand:

1. Emerging / alternative technologies applied to food processing
2. Relative advantages / disadvantages over existing technologies
3. Economics and commercialization of newer technologies

4. Strategies for applying the same to a wide range of food

Unit I High pressure processing of Foods

Principles – applications to food systems – effect on quality – textural, nutritional and microbiological quality – factors affecting the quality – modeling of high pressure processes – High Pressure Freezing, Principles and Applications

Unit II Pulsed electric field processing of Foods

Principles – Mechanism of action – PEF treatment systems – Main processing parameters – PEF Technology – Equipments – Mechanism of microbial and enzyme inactivation- safety aspects– Processing of liquid foods using PEF – Process models – Comparison of High pressure processing and PEF – Enzymatic Inactivation by PEF, Examples – Microbiological and chemical safety of PEF foods

Unit III Osmotic dehydration of Foods

Principle – Mechanism of osmotic dehydration – Effect of process parameters on mass transfer – Methods to increase the rate of mass transfer – Applications – Limitations of osmotic dehydration – Management of osmotic solutions

Unit IV Ohmic and Ultrasound Processing of Foods

Principle of ultrasound – Fundamentals – Ultrasound as a processing and preservation aid – Effect on properties of foods

Basics of ohmic heating – Electrical conductivity - generic configurations- treatment of products

Unit V Hurdle technology

Basics of hurdle technology – Mechanism

Application to foods - Newer Chemical and Biochemical hurdles- organic acids – Plant-derived antimicrobials – Antimicrobial enzymes – bacteriocins – chitin / chitosan (only one representative example for each group of chemical and biochemical hurdle)

Text Books

Da-wen Sun: *Emerging Technologies for Food Processing*, Elsevier Academic Press/ Marcel Dekker Inc. NY (1995)

Reference Books

1. Leistner L. and Gould G. *Hurdle Technologies – Combination treatments for food stability safety and quality*, Kluwer Academics / Plenum Publishers, New York (2002)
2. Novel Food Processing Technologies (Food Science and Technology Series) by Gustavo V. Barbosa-Canovas, Maria S. Tapia, M. Soledad Tapia, M. Pilar Cano, Publisher: CRC Press, November 2004, ISBN-13: 9780824753337,
3. Pulsed electric fields in food processing: Fundamental aspects and applications: a volume in the Food Preservation Technology series, Edited by G V Barbosa-Cánovas, Washington State University and Q H Zhang, Ohio State University, USA, Woodhead Publishing Limited, Abington Hall, Abington, Cambridge, CB1 6AH, England, 2001

4. Pulsed electric field technology for the food industry: Fundamentals & applications (Food engineering series) RASO J., HEINZ V, 2006
5. Ohmic Heating: A Value-added Food Processing Tool **Marybeth Lima**, Tuoxiu Zhong and N. Rao Lakkakula
6. Thermal Technologies in Food Processing: Edited by P Richardson, Campden and Chorleywood Food Research Association, UK, Woodhead Publishing Limited, Abington Hall, Abington, Cambridge, CB1 6AH, England, 2001
7. Minimal Processing Technologies in the Food Industry By Thomas Ohlsson, Nils Woodhead Publishing Limited, Abington Hall, Abington, Cambridge, CB1 6AH, England, 2002
8. Pulsed Electric Fields in Food Processing (1999). Gustava C Barbosa-Canovas, Q Howard Zhang (editors). Lancaster Pa: Technomic Publishing Co. (ISBN 1566767830)
9. Food Processing Operations Modelling (2001). Joseph Irudavarai (editor). Marcel Dekker (ISBN 0824704886)
10. Processing of Foods – Quality Optimization and Process Assessment Edited by Fernando A.R.Oliveira and Jorge C. OliveiraCRC Press Boca Raton, London and New York 1999
11. Food Processing Hand Book, Edited by James G.Brennen Wiley – VCH Verlag GmbH 2006

FP239 FOOD DEHYDRATION TECHNOLOGY

Credit: 4:0:0

Objectives

To enable the student to understand:

1. Basic theory of drying and its significance in food systems
2. Importance of drying as a method of food processing
3. Relative advantages / disadvantages of each method of drying
4. Economics and commercialization of technologies
5. Develop strategies for applying the same to a wide range of food

Unit I Basics of dehydration

Principles of drying– Fundamentals of air-water mixtures – psychrometric chart – Heat and mass transfer in ideal dryers – with and without recirculation

Theories of drying – constant and falling rate period - diffusion theory, capillary theory, evaporation – condensation theory, Luikov, Philip and De Vries theory

Water content in foods and its determination – Theoretical and empirical models for determining water activity

Unit II Cabinet, Vacuum and Drum drying of Foods

Fundamentals of cabinet drying – Mass and Heat balances in dryers (batch and continuous) (simple problems only) – description of batch and continuous dryers – Application in Food industry – Vacuum and Drum driers

Unit III 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

Unit IV Freeze drying of Foods

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 processes : prefreezing, preconcentration, condensation, defrosting – Industrial freeze driers – Atmospheric freeze drying - Applications in food industry

Unit V Fluidised bed drying, Microwave drying and Extrusion of Foods

Fluidised bed drying – Batch and Continuous dryers – Pneumatic dryers
Extrusion cooking – Single and Twin-screw extruders
Packaging of dehydrated products

Text Books

1. Gustavo V. Barbosa –Cánovas and Vega-Mercado H.: *Dehydration of Foods*, Chapman & Hall (1996)

Reference Books

1. Y. H. Hui :*Food Drying Science and Technology, Microbiology, Chemistry, Application*, CHIPS (2008)
2. Arun S. Mujumdar: *Handbook of Industrial Drying*, 3rd Edition, CHIPS (2006)

FP240 PROCESSING OF FOOD COMMODITIES

Credit:3:0:0

Objectives:

- 1) To study various processing methods for various food materials like fruits & vegetables, dairy products, cereals, meat, poultry, fish and bakery products
- 2) To study various innovative food processing techniques

Unit I Fruits and vegetable processing

Production of Fruits and vegetables in India, Cause for heavy losses, preservation treatments - Canning of Fruits and Vegetables, Minimal processing and Hurdle technology as applied to Vegetable and Fruit processing, Processing of fruit juices, Dehydration, Aseptic and other methods of processing.

Unit II Dairy processing

Basic dairy terminology, composition, Quality and Quantity tests at reception, dairy Processing Equipments, various dairy Products, Packaging of milk in bottles and sachets.

Unit III Milling and bakery Technology

Fundamentals of Market Analysis for Wheat and Wheat Products, Laboratory testing of Wheat grain Quality, Moisture tests, Outline of the Wheat Milling Process, equipments

Unit IV Meat, Fish and Poultry processing

Meat composition from different sources, Definitions and measurements, Slaughtering and Carcass Processing, Meat Products, Processing of Poultry Products, Fish and other Marine Products Processing.

Unit V Cereal technology

Paddy Processing - Varieties, their Composition and Quality characteristics, Curing of Paddy, Parboiling Processes, By Products. Rice milling and equipments, Milling of Pulses, Grain Storage and Handling.

Text Books

6. Srivastava, R.P. and Kumar, S.: Fruit and Vegetable Preservation: Principles and Practices. International Book Distributing Co. Lucknow (2nd Edition 1998).
7. Chakraverty, A., Mujumdar A.S., Raghavan G.S.V and Ramaswamy H.S. Handbook of Post-harvest Technology: Marcel Dekker Press, USA (2001)
8. W. James Harper and Carl W. Hall: Dairy Technology and Engineering AVI Publishing, Westport, USA (1976)
9. Karel Kulp and Joseph P Pante:Hand Book Of Cereal Science and Technology Mercel Dekkar USA (2000)

FP241 ANALYSIS OF FOOD LAB – 1

Credit 0:0:2

12 experiments will be notified by the HOD from time to time

FP242 ANALYSIS OF FOOD LAB– 2

Credit 0:0:2

12 experiments will be notified by the HOD from time to time

FP243 ANALYSIS OF FOOD PRODUCTS LAB – 1

Credit 0:0:2

12 experiments will be notified by the HOD from time to time

FP244 FOOD ANALYSIS LAB

Credit 0:0:2

12 experiments will be notified by the HOD from time to time

FP245 FOOD PRODUCT TECHNOLOGY LAB - 1

Credit 0:0:2

12 experiments will be notified by the HOD from time to time

FP246 ENZYMOLOGY LAB

Credit 0:0:2

12 experiments will be notified by the HOD from time to time

FP247 ANALYSIS OF FOOD PRODUCTS OF PLANT ORIGIN LAB

Credit 0:0:2

12 experiments will be notified by the HOD from time to time

FP248 FOOD PRODUCT TECHNOLOGY LAB - 2

Credit 0:0:2

12 experiments will be notified by the HOD from time to time

**SCHOOL OF FOOD SCIENCES
AND
TECHNOLOGY**

Karunya University

ADDITIONAL SUBJECTS

Subject Code	Subject Name	Credits
FP318	Advances in Food Engineering I	4 : 0: 0
FP319	Engineering properties of Food Materials	4 : 0: 0
FP320	Transport processes in Food Engineering	4 : 0: 0
FP321	Advances in Food Engineering II	4 : 0: 0
FP322	Food Packaging and Storage Engineering	4 : 0: 0
FP323	Technology of Food Flavourants and Colourants	4 : 0: 0
09FP201	Food Engineering Operations	4:0:0
09FP202	Drying Technology	4:0:0
09FP203	Fat & Oil Processing Technology	4:0:0
09FP204	Spices & Plantation Technology	4:0:0
09FP205	Food Safety Regulations & Control	4:0:0
09FP206	Unit Operations in Food Processing II	4:0:0
09FP301	Advances in Food Microbiology	4:0:0
09FP302	Kinetics of Food Systems	4:0:0
09FP303	Engineering properties of Food Materials	4:0:0
09FP304	Transport Processes in Food Engineering	4:0:0
09FP305	Food Engineering	4:0:0
09FP306	Emerging Trends in Food Process Engineering	4:0:0
09FP307	Food Packaging and Storage Engineering	4:0:0
09FP308	Technology of Food Flavourants & Colourants	4:0:0
09FP309	Food Analysis Lab	0:0:2
09FP310	Food Microbiology Lab	0:0:2
09FP311	Food Engineering Lab	0:0:2
09FP312	Fruit & Vegetable Process Engineering	4:0:0
09FP313	Food Product Technology and Packing Lab	0:0:2
09FP314	Transport Process in Food Engineering Lab	0:0:2
09FP315	Food Enzymology Lab	0:0:2

FP 318 ADVANCES IN FOOD ENGINEERING – I**Credit : 4:0:0****Unit – I Heat preservation of foods**

Heat preservation of foods - thermo bacteriology, process calculation and selection - low temperature preservation - microbiological aspects, cooling and cold storage - physical methods of preservation - freeze concentration - membrane process - ultra filtration, reverse osmosis

Unit – II Hurdle technology

Hurdle technology - principles and applications -hurdle effect in fermented food, shelf stable products, intermediate moisture foods- total quality of foods - optimal range of hurdles and potential safety -application of hurdle technology - fruit and vegetable preservation, dairy products and meat

Unit- III Irradiation, Microwave and High pressure processing

Food irradiation - advantages and applications, Equipment Microwave processing – equipments interaction with food materials, material properties, effect of microorganisms, High pressure processing – Principles -equipment, processing and effect on microorganisms.

Unit-IV Ultrasound and Electrical resistance processing

Application of heat and ultrasound - inactivation of microorganisms and enzymes, Ohmic heating - models- treatment of products

Unit-V Aseptic processing and Extrusion

Advances in aseptic processing and packaging - processes, design of process, Commercial sterilization, Preventive measures for contamination.

Extrusion cooking - recent developments, methods, equipment, and design criteria of extruders.

Text Books

1. Emerging Technologies for Food Processing, Da-Wen Sun, Contributor Da-Wen Sun, Published by Academic Press, 2005.
2. Food Processing Technology: Principles and Practice, By P. Fellows, Second Edition, Woodhead Publishing Limited, 2000.

Reference Books

- 1 Novel Food Processing Technologies, Ed., Barbosa-Canovas, G.V.; Tapia M.S.; Pilar Cano M. Pub. Routledge (Taylor and Francis Group), USA. 2004. **ISBN:** 978-0-8247-5333-7 (hardback) 978-0-203-99727-7 (electronic).
- 2 Food Processing Operations Modeling Design and Analysis, Irudayaraj J.M. Second Edition, Routledge (Taylor and Francis Group), USA. 2001 **ISBN:** 978-0-8247-0488-9 (hardback) 978-0-8247-4516-5 (electronic)
- 3 Engineering Properties of Foods, By M.A.Rao and S.S.H.Rizvi, Mercel Dekker Inc. New York (1998).
- 4 New methods of food preservation, By Gould,G.W (Ed). First Edition. Blackie Academic & Professional, London. 1996.

- 5 Processing tropical crops - technological approach, Asiedu, J.J. MacMillan Publishers. 1989
- 6 Extrusion cooking technology , By Ronald Jowitt.. Elsevier applied Science Publisher. 1984.
- 7 Freeze drying and advanced food technology. Goldblith.,S.A., I.Rey and W.W.Rothmayr. Academic Press. (1975).

FP 319 ENGINEERING PROPERTIES OF FOOD MATERIALS

Credits :4:0:0

Unit I Physical Properties

Engineering properties - physical, thermal, aerodynamic and dielectric properties - importance and applications in process design - factors affecting the properties. Physical characteristics - grains, fruits and vegetables - shape - size - description. Volume - determination - bulk density and particle density – porosity - air comparison pycnometer. Surface area – importance – determination - projection method - tracing method. Friction - concept - laws of friction - measurement of static and kinetic friction - effect of normal load, sliding velocity, surface, moisture and environment - rolling resistance - angle of internal friction and angle of repose - determination. Flow of bulk granular materials - in bins and hoppers, through orifices, chutes and flow of solids.

Unit II Rheological Properties

Rheology - definition - various types of materials - Hook's law – classic ideal material. Stress – strain - density relationship - Rheological models - Rheometers- Maxwell model - creep behaviour of materials - uses - elastic - plastic materials – generalised Maxwell model. Kelvin model - stress relaxation behaviour of materials - generalised Kelvin model. Four elements Burger's model - Newtonian and Non-Newtonian fluids - flow behaviour equations.

Unit III Textural Properties

Texture of food materials - Measurement methods - imitative and empirical tests - dynamic test. Firmness and Hardness - different methods of measurements on various produce and foods - dynamic hardness. Physical damage on food - causes - Detection and evaluation Static and dynamic resistance to mechanical damage – Compression, Impact and Vibration damage

Unit IV Thermal Properties

Thermal properties - specific heat - determination - methods for solids and slurries Determination of thermal conductivity - steady state and unsteady state methods. Thermal diffusivity - determination - relationship among specific heat, thermal conductivity, bulk density and thermal diffusivity - effect of moisture content on thermal properties.

Unit V Electrical and Aerodynamic properties

Electrical properties - resistance, capacitance - uses - Dielectric loss factor - method of determination. A.C. conductivity and dielectric constant - determination - Q meter. Effect of moisture content on electrical properties - energy absorption from high frequency electric field. Aerodynamic properties - lift and drag - drag coefficient - friction drag - pressure drag -

terminal velocity - importance - spherical bodies and non-spherical bodies - Reynold's number relationship - separation of foreign materials - pneumatic handling and transportation - applications.

Text Books

1. Engineering Properties of Biological Materials. By Singhal,O.P. and Samuel,D.V.K. Saroj Prakasan, Allahabad, 2003.
2. Engineering Properties of Foods, By M.A.Rao and S.S.H.Rizvi, Mercel Dekker Inc. New York (1998).
3. Serpil Sahim and Servet Gulum Sumnu 2006. "Physical Properties of Foods" Springer, USA.

Reference Books.

- 1 Food Properties Hand Book , by Shafiur Rehman: CRC Press Inc. New York (1995)
- 2 Physical Properties of Foods and Food Processing Systems, By M.J.Lewis: Woodhead Publishing Cambridge, UK (1990).
- 3 Thermal properties of Foods and Agricultural Materials. By, Mohesenin. N.N., Gordon and Breach Science Publishers, New York (1980).
- 4 Physical properties of Plant and Animal Materials. Mohesenin. N.N. Gordon and Breach Science Publishers, New York. (1980).

FP320 TRANSPORT PROCESSES IN FOOD ENGINEERING

Credits : 4:0:0

Unit I Introduction & Momentum transfer

Introduction – Transport processes and separation processes – momentum transfer – overall momentum balance – design equations for laminar and turbulent flow in pipes – compressible flow of gases – Differential equations of momentum transfer – Boundary layer flow and turbulence – Dimensional analysis in momentum transfer – Applications specific to food systems

Unit II Unsteady State Heat Transfer

Unsteady State Heat Transfer-Derivation in basic equation- unsteady state heat conduction in various geometries- Numerical finite difference methods for unsteady state conduction-differential equation of energy change- boundary layer flow and turbulence in heat transfer - Applications specific to food systems

Unit III Unsteady state diffusion mass transfer

Unsteady state diffusion mass transfer– Convective mass transfer coefficients- mass transfer coefficient for various geometries- molecular diffusion plus convection- numerical methods for unsteady state molecular diffusion- dimensional analysis in mass transfer - Applications specific to food systems

Unit IV Applications to drying

Predicted transfer coefficients for constant and falling rate drying period- combined conduction, radiation & convection heat transfer in constant rate period- drying in falling rate period by

diffusion- continuous counter current drying- derivation of equation for freeze drying - Applications specific to food systems

Unit V Applications to unsteady state thermal processing

Unsteady state thermal processing of biological materials- mass transfer between phases- estimation of mass transfer coefficients for packed towers- heat effects and temperature variations in absorption - Applications specific to food systems

Text Book

1. Transport Processes and Separation Process Principles (Includes Unit Operations) (4th Edition) (Pie), Christie John Geankoplis , Published by Prentice Hall PTR, 2003.

Reference Books

- 1 Fundamentals of Heat and Mass Transfer, Frank P. Incropera, David P. DeWitt , Theodore L. Bergman, Adrienne S. Lavine, Published by Wiley; 6 edition, 2006.
- 2 Transport Phenomena, R. Byron Bird Stewart W E & Lightfoot E N, Published by John Wiley & Sons Inc., 1960

FP 321 ADVANCES IN FOOD ENGINEERING – II

Credits : 4:0:0

Unit-I Minimal Processing of Foods

Minimal Processing of Foods with thermal methods and non thermal methods- safety criteria in minimally processed foods- Minimal processing in practice- fruits & vegetables-seafood- effect on enzymatic and textural properties- quality changes- packaging and storage conditions- Future developments

Unit-II High Intensity Electrical Pulse Technique

High-intensity electric pulse technique- Processing systems- design of static chambers- continuous chambers- other chamber designs- generation of different voltage waveforms- oscillation magnetic fields for food processing- generation of magnetic fields - inactivation of microorganisms

Unit- III Advanced Methods of Preservation Extraction

Application of pulses of light in sterilization of foods and packaging materials - Extraction and distillation process – Super critical fluid extraction - Energy calculation process

Unit-IV Recent Developments in drying Technology.

Recent developments on design and practice of spray drying - drying behavior of droplets – Instantisation Techniques - Recent advances in Foam mat drying, osmotic dehydration, heat pump drying and freeze drying - Energy requirements for different methods of dehydration

Unit-V Enzymes and Biosensors

Food Enzymes -Sources-Types- Processes and Production methods- Enzymatic Synthesis of food additives and flavours - Biosensors- types-application of biosensors in food industry

Text Books.

1. Emerging Technologies for Food Processing, Da-Wen Sun, Published by Academic Press, 2005
2. Minimal Processing Technologies in the Food Industry, Thomas Ohlsson, Nils Bengtsson, Thomas Ohlsson Ohlsson, Knovel (Firm, Knovel (Firm), Thomas Ohlsson, Nils Bengtsson, Published by Woodhead Publishing, 2002.
3. Nonthermal Preservation of Foods. Gustavo V. Barbosa-Canovas, Usha R. Pothakamury, Enrique Palou and Barry G. Swanson. Published by Marcel Dekker, Inc., 270, Madison Avenue, New Yorkm 10016, 1998.

Reference Books.

- 1 Trends in Food Engineering, Jorge E. Lozano, Cristina Anon, Efren Parada-Arias, Gustavo V. Barbosa-Canovas, Contributor Jorge E. Lozano, Published by CRC Press, 2000
- 2 Arnold Spicer. 1974. Advances in pre-concentration and dehydration of foods. Applied science publisher Ltd., London.
- 3 Biosensors for food analysis, A O Scott, The Tetley Group Limited, UK, Woodhead Publishing Limited, Abington Hall, Abington, Cambridge, CB21 6AH, England, 2008.

FP 322 FOOD PACKAGING AND STORAGE ENGINEERING

Credits : 4:0:0

Unit I Introduction

Importance of packaging, packaging materials, their selection, form and testing – paper boards, plastic films, laminates, metals, glasses, retort pouches - storage of dehydrated products

Unit II Packaging for different types of foods

Package for different individual groups of foods like dehydrated foods, liquid foods, frozen foods, processed (cooked) foods – vacuum packaging of fruits and vegetables – equipment and method – packaging equipment for solid, semi – solid and liquid food. Types of fillers – filler for glass bottle, pouches.

Unit III Form-fill- seal process and Shrink wrapping

Form fill seal equipment, sealing equipment, labelling, capping, canning, and cartooning equipment – shrink wrapping.

Unit IV Grain storage engineering

Storage of grains – biochemical changes during storage – production, distribution and storage capacity estimate models – ecology, storage factors affecting losses, storage requirements, bag and bulk storage – pressure distribution – theories – rat proof godowns and rodent control –

method of stacking – preventive method, bio-engineering properties of stored products – function, structural and thermal design of structures.

Unit V Cold storage, Controlled and Modified atmosphere storage

Cold storage, Controlled and Modified atmosphere storage – effects of nitrogen, oxygen, and carbon-di-oxide on storage of durable and perishable commodities Determination of cooling load.

Text Book

1. Food Packaging: Principles and Practice, By G. L. Robertson, 2nd Edn. CRC Press Pub. (Taylor and Francis group), 2006 ISBN 0849337755, 9780849337758

Reference Books

2. Innovations in Food Packaging, By Jung H. Han, Academic Press Pub. , 2005. ISBN 123116325, 780123116321.
3. The Mechanics and Physics of Modern Grain Aeration Management, By S. Navarro, R. T. Noyes, CRC Press Pub. , 2001. ISBN 0849313554, 9780849313554
4. Preservation and Storage of grains, seeds and their by-products, Multon, J.L. (Ed) CBS Publishers and Distributors, Delhi – 32. 1989.
5. Controlled atmosphere and fumigation in grain storage. Ripp, B. E. Elsevier Science Publishing Co. London. 1984.
6. Design and Operation of Cold Storages in Developing Countries, FAO, FAO Publications Rome. 1984.
7. Automatic control of food manufacturing. McFarlane Ian, Applied Science Publishers, London. 1983.
8. Principles of food packaging. By Sacharow, S and R. C. Grittin. AVI Publishers Co., USA. 1980.
9. Controlled atmosphere storage of grains. Shejbal, J. (Ed) Elsevier Scientific Publishing Co. London. 1980.

FP323 TECHNOLOGY OF FOOD FLAVOURANTS AND COLOURANTS

Credits : 4:0:0

Unit I – Basics of flavours and colours

Olfactory perception of flavour and taste – Theories of olfaction - Molecular structure and activity relationships of taste – Sweet, bitter, acid and salt, Chemicals causing pungency, astringency, cooling effect – properties. Classification of flavours – Natural, Nature identical and synthetic – Flavor potentiators. Basics of colour – Hue, chroma, brightness. Regulations regarding additions – Toxicology and safety aspects

Unit II – Chemistry and Technology of Natural flavours

Classification – Alliaceous flavours – Bittering agents, Coffee and Cocoa, Fruit flavours. Evolution of flavours during processing – enzymatic development, effect of roasting, cooking, frying on flavour developments- Essential oils and oleoresins – Extraction – Super critical fluid extraction - Continuous and semi-continuous methods- Effect of types of solvents used. Liquid

and dry flavour production - Staling of flavours. Microbial and cell suspensions in the synthesis of flavours

Unit III – Chemistry and Technology of natural pigments

Chlorophyll and chlorophyll derivatives, Haems and bilins, Carotenoids, annatto, Crocetin, Curcumin- Stability to pH, temperature and other processing conditions - Technology for the production of dried colourants - Caramel colour. Microbial and cell suspensions in the synthesis of colours.

Unit IV - Chemistry and Technology of natural pigments

Anthocyanins and betalains, Less common colourants – Acylated β -ring substituted anthocyanins, Monascus, Cochineal and related pigments, Stability to pH, temperature and other processing conditions. Technology for the production of dried colourants

Unit V –Techniques of analysis of flavours and colours

Total component analysis– Basics and methods – Recent developments. Head space analysis – static and dynamic methods – basic principles – method and developments - Solid phase micro extraction of aroma components - E nose technology. Tristimulus colorimetry – Basics and application to foods

Text books

1. Flavor Chemistry and Technology, By Gary Reineccius, Henry B. Heath, 2nd Edn., Taylor and Francis group, CRC Press, 2006
2. Natural Food Colorants: Science and Technology, By Gabriel J. Lauro, Frederick John Francis, CRC Press Pub., 2000.
3. Natural food colorants, Ed. By G. A. F. Hendry, J. D. Houghton, 2nd Edn., Chapman and Hall (India), 1996

Reference Books

- 1 Handbook of Flavor Characterization (Food Science and Technology) Ed., Kathryn D. Deibler, Jeannine Delwiche, Marcell Dekker Inc., 2004.
- 2 Flavour Science: Recent Advances and Trends, By W. L. P. Bredie and M.A. Petersen, Elsevier Pub., 2006. ISBN 0444527427, 9780444527424.
- 3 Volatile components in Foods and Beverages Edited by H. Maarse, Marcel Dekker Inc., 1991.
- 4 Food Flavours – Biology and Chemistry, By Carolyn Fisher, Thomas R. Scott, RSC Publishing, 1997

09FP201 FOOD ENGINEERING OPERATIONS

Credits: 4:0:0

Objectives:

To enable the student to understand

1. The importance of unit operations in biological systems engineering
2. Applications of various unit operations in food industries.

UNIT –I Cleaning & Grading:

Screening- types of screens: Revolving screen/cylinder sorter- shaking, rotary, vibratory & horizontal- Screen openings- perforated & wiremesh screens- ideal & actual screens- effectiveness of screen. Equipments- based upon size-air screen cleaners- design consideration of air-screen cleaner- Disk, Indent cylinder, spiral, & specific gravity, stone, inclined belt, Pneumatic & aspirator separators- separation based on fluidization technique- magnetic, cyclone & colour separator.

UNIT- II Mixing& Forming

Characteristics of mixtures- measurement of mixing-particle mixing- rates of mixing, energy input in mixing, liquid mixing- power & Froude number- mixing equipment- liquid, powder and particle mixtures, dough and paste mixtures. Forming - Pie & biscuit formers-Bread & Confectionery moulders.

UNIT –III Size Reduction

Principles of size reduction - size reduction procedures - energy used in grinding - kicks law, rittingers law, bonds law, work index, new surface formed by grinding(shape factors) - grinding equipment - crushers, hammer mills, fixed head mills, plate mills, ball mills, roller mills, cutters. Sieving - particle size analysis.

UNIT-IV Blanching, frying, peeling & enrobing

Blanching – theory - equipment- steam blanchers - hot water blanchers - effect on food –frying – theory – shallow frying -deep fat frying- equipment - effect on foods – Peeling – Flash peeling- steam peeling - Knife peeling – Abrasion peeling -lye peeling - Flame peeling- coating-enrobing- dusting- pan coating- soft, hard & chocolate coating.

UNIT-V Cold operations

Freezing – Theory- Ice crystal formation-solute concentration- volume changes- calculation of freezing time- equipment- cooled air freezers, cooled liquid freezers and cooled surface freezers, & cryogenic freezers- changes in foods. Freeze concentration-theory- equipment - effect on foods.

Textbooks:

1. Fellows, P. 2000. Food Processing Technology. CRC Press
2. Sahay, K. M. & K. K. Singh. 2007. Unit Operations of Agricultural Processing (II revised). Vikas Publishing House Pvt. Ltd., New Delhi

Reference books:

1. Earle, R.L. 2003. Unit Operations in Food Processing. Ebook – hosted by **New Zealand Institute of Food Science & Technology (Inc.)**
2. Richardson, J.F, J. H. Harker & J. R. Backhurst. 2006. Coulson & Richardson's Chemical Engineering – Vol. 2. Elsevier Publications

09FP202 DRYING TECHNOLOGY**Credit: 4:0:0**

Objectives:

To enable the student to understand:

1. Basic theory of drying and its significance in food systems
2. Importance of drying as a method of food processing
3. Relative advantages / disadvantages of each method of drying

UNIT I Theory of Drying

Principles of drying – Fundamentals of air-water mixtures – Psychrometric chart – Problems based on psychrometry – Drying curves – constant and falling rate period - Heat and mass transfer in dryers – with and without recirculation. Water content in foods and its determination - Cabinet drying – Vacuum drying

UNIT II Drum drying, Foam Mat Drying & Osmotic dehydration of Foods

Drum driers - Types of Drum Dryers - Principles of Operation of the Drum Dryer - Steam Consumption – Types of Feeding – Final product form. Foam Mat Drying- Principles- Equipments- Factors affecting Foam mat drying. Osmotic dehydration – Principles – Factors affecting osmosis- Equipment used.

UNIT III Spray drying of Foods

Principles of Spray Drying Processes – Atomization - Drop Size and Size Distribution Wheel Atomizers - Pressure Nozzles - Pneumatic Nozzles - Chamber Design - Chamber Shape - Air-Droplet Contact Systems - Powder and Air Discharge Systems - Ancillary Equipment - Fans - Powder Separators – Reconstitution of powders – Foam spray drying

UNIT IV Freeze drying and Microwave drying of Foods

Fundamentals of freeze drying – Freezing – Primary drying stage – secondary drying stage - Changes during freeze drying – Condensation, defrosting – Industrial freeze driers. Fundamentals of microwave and dielectric drying - Equipment for microwave and dielectric heating and drying.

UNIT V Fluidized bed and Pneumatic drying

Fluidized bed drying – Introduction – Effect of operating parameters – conventional and modified fluidized bed dryer – Pneumatic / Flash dryers - Basic Operation Principle and Applications of Flash Dryers - Design of Flash Dryers - Materials Dried in Flash Dryers.

Text Books

1. Arun S. Mujumdar: *Handbook of Industrial Drying*, 3rd Edition, CHIPS (2006)
2. Paul Singh, R and Dennis R. Heldman. 2001. *Introduction to Food Engineering*. Academic Press

Reference Books

1. Y. H. Hui :*Food Drying Science and Technology, Microbiology, Chemistry, Application*, CHIPS (2008)
2. Loesecke,H. W. V., 2005. *Drying & Dehydration of Foods*, Published by Agrobios (India)

3. **Gustavo V. Barbosa –Cánovas and Vega-Mercado H.:** *Dehydration of Foods*, Chapman & Hall (1996)

09FP203 FAT AND OIL PROCESSING TECHNOLOGY

Credits: 4:0:0

Objectives:

To enable the students to understand

1. Physical and chemical properties of fats and oils
2. Extraction and refining processes
3. Packaging, quality standards of fats and oils.

UNIT I: Physical and chemical properties

Fats and oils – formation – functions of oil in human body - fatty acids – double bonds and their position in oil – Geneva type classification - sources of vegetable oils – production status-oil content – coconut , palm, peanut , rice bran, sesame, mustard and sunflower seeds oil - physical and chemical properties of fats and oils - chemical reactions of oil – hydrolysis – hydrogenation, oxidation and polymerization.

UNIT II: Extraction methods

Oil extraction methods –mechanical expression – ghani , power ghani, rotary, hydraulic press, screw press, expellers, filter press - principle of operation and maintenance-solvent extraction process – steps involved, batch and continuous-continuous solvent extraction process for rice bran, soy bean and sunflower-oil extraction process for groundnut and cotton seed-production of special oils – palm oil, virgin coconut oil – extraction process.

UNIT III: Refining of Oils

Refining of oils – objectives – characterization - degumming – Zeneath process – deacidification process – continuous acid refining-bleaching of oil – continuous bleaching process – decolourising agents-deodorization process winterization processes-hydrogenation of oil – selectivity – catalyst – batch type hydrogenation – regeneration of catalyst-vasaspati, ghee and margarine – production process-partial sterilization, emulsification, chilling, kneading and rolling, incorporation of salt, colouring substances-production of special fats – butter – types - production and storage.

UNIT IV: Packaging of edible oils

Packaging of edible oils – requirements – types – tinfoil, semi rigid, glass, Polyethylene Terephthalate, Poly Vinyl Chloride, flexible pouches – packaging for vasaspati and ghee-changes during storage of oil –rancidity – causes – atmospheric oxidation and enzyme action – free fatty acid – colour-non edible oils – castor oil, linseed oil, vegetable waxes – production and processing.

UNIT V: Industrial applications and quality standards

Industrial applications of fats and oils – quality regulations - manufacture of soap, candle, paints and varnishes - ISI and Agmark standards – site selection for oil extraction plant- safety aspects-HACCP standards in oil industries.

Text books

1. Harry Lawson. 1997. Food oils and Fats, Technology, Utilization and Nutrition. CBS Publishers and Distributors, New Delhi
2. Weiss, T.J. 1970. Food Oils and their uses. The AVI Publishing Company, Inc. Westport, Connecticut.

Reference books

1. Acharia, K.T. 1990. Oil seeds and oil milling in India. Oxford and IBH publication, New Delhi.
2. Panda, H. 2000. Essential oils – Hand book – National Institute of Industrial Research – ISBN, New Delhi.
3. Anonymous. 2004. Handbook of oils, fats and derivatives with refining and packaging technology. Engineers India Research Institute, New Delhi.

09FP204 SPICES AND PLANTATION CROP TECHNOLOGY

Credit : 4:0:0

Objectives:

To enable the student to understand

1. The importance and different basic unit operations in processing of spices
2. Processing methods of plantation crops.

UNIT I: Importance of spices

Spices – production and importance – pepper, cardamom, chilli, turmeric, ginger, clove, nutmeg and other minor spices – stage of harvesting and harvesting methods – threshing, shelling, decortication of spices - methods – merits and demerits

UNIT II: Cleaning, grading and packaging of spices

Processing of spices – drying - traditional and mechanical drying – cleaning, grading and grinding – construction and operation of different mills – cryogenic grinding, packaging and storage of spices

UNIT III: Processing of spices

Processing of major and minor spices – pepper, cardamom, chilli, turmeric, ginger, clove, nutmeg, – quality analysis of spices- processes involved in the manufacture of oleoresins and essential oils.

UNIT IV: Processing of coconut, oilpalm, arecanut and cashew

Processing of plantation crops – production and importance – processing of coconut, oilpalm, arecanut, cashew– harvesting and stages of harvest – drying, cleaning and grading – production of value added products – packaging and storage of produces.

UNIT V : Processing of coffee, tea, cocoa and vanilla

Processing of coffee, tea, cocoa and vanilla – methods, process and equipment – value added products – packaging and storage

Text books

1. Pruthi, J.S. 2001. Minor Spices and Condiments: Crop management and post harvest technology, ICAR Publications, New Delhi, India pp. 1-781.
2. Pruthi, J.S. 1998. Major Spices and Condiments: Crop management and post harvest technology, Reprint: ICAR Publications, New Delhi, India pp. 1-514.

References:

1. K. V. Peter, 2004, Handbook of herbs and spices, Woodhead Publishing Ltd , Cambridge England
2. The complete Book on Coconut & Coconut Products (Cultivation & Processing). By NIIR Board, Asia Pacific Business Press Inc., New Delhi – 110 007.
3. Hand Book on Spices. By NIIR Board, Asia Pacific Business Press Inc., New Delhi – 110 007.

09FP205 FOOD SAFETY REGULATIONS AND CONTROL

Credits: 4:0:0

Objectives:

To enable the student to understand

1. Importance of Food Safety
2. Regulating authorities for food safety world over

UNIT-1: Food Regulations

World Trade order – Functioning and responsibilities of the WTO - Codex Alimentarius – History, operations of Codex alimentarius, Responsibilities – Codex standards and Maximum residue limits – Current Issues under consideration – SPS (Sanitary and phytosanitary measures) agreement. World Health Organisation – History and mandate – Operations and responsibilities – ICGFI – Functions and responsibilities

UNIT 2 - Food authority in India

Food safety and Standards Act – organizational chart – role of individual authority –principles to be followed –Provisions as to articles of food –imported items – Responsibilities of the food business operator – Liability of manufacturers, packers, wholesalers, distributors and sellers – Enforcement of the act – Licensing and registration of food business – Food safety officer and their powers – Analysis of food – regulations regarding labs involved in food analysis – Offences and penalties – Adjudication and food safety appellate tribunal – Laws relating to Food Processing Industries in India - FPO, MMPO, PFA, AGMARK, Essential Commodities Act, BIS

UNIT 3 - Food labeling

Need for labeling – Developing labeling standards at the world level – Limitations of labeling-safety issues – Labeling regarding methods of processing – Irradiated products – Products derived from modern biotechnology – organic produce - Genetically modified foods – EU rules on nutritional labeling – US rules on nutritional labeling – Health claims – Approach of US and EU

UNIT 4 -Microbiological food safety

Concept of HACCP – Assembling the team – Product description – Describing the product's intended use – Establishing a process flow diagram – on site confirmation - Listing potential hazards and control measures - Determination of critical points – decision tree for CCPs- Establishing monitoring procedures- establishing corrective actions – establishing verification procedures

UNIT 5 - Safety aspects of water

Safety aspects of drinking water (microbiological and chemical) - the epidemiological triangle-diseases caused by drinking of contaminated water , bottled water – setting of guideline values (microbiological and chemical) – risks and advantages of chlorination of water-Bottled water – origin of water- nutritional and physiological aspect – safety aspects – microbiological and chemical quality – Regulations for bottled water – EU, US and India

Text Books:

1. International Food Safety Handbook: Science, International Regulation, and Control, By Kees A. van der Heijden, Sanford Miller, Published by CRC Press, 1999. ISBN 0824793544, 9780824793548
2. The Food Safety and Standards Act 2006

Reference Book:

1. Food Safety Regulation Concerns And Trade- The Developing Country Perspective, Ed. By Rajesh Mehta And J. George, Published by Macmillan India Ltd., New Delhi. 2005

09FP206 UNIT OPERATIONS IN FOOD PROCESSING - II

Credits: 4:0:0

Objectives:

To enable the student to understand

1. The importance of separation process.
2. Size reduction and mixing operations in industries
3. Develop processes with better efficiency and economics

Unit –I Mechanical & Centrifugal Separation:

Sedimentation-gravity sedimentation- sedimentation of solid particles in gas media. Particle velocity and basics of centrifugal separation. Different types of centrifuges- basket, tubular bowl, decanting, disc bowl, desludging bowl centrifuge, nozzle centrifuge.

Unit- II Filtration

Rates of filtration- filter cake resistance- equation for flow through filter- constant rate filter- constant pressure filtration- filter cake compressibility- filtration equipment- plate and frame filter press- rotary filters-centrifugal filters

Unit –III |Membrane separation

Osmotic pressure- cross flow microfiltration- ultra filtration- reverse osmosis- rate of flow through membrane – vanthoff equation- diffusion equation- Sherwood number-schmidt number- membrane equipment- membrane fouling-

Unit-IV Mixing

Characteristics of mixtures- measurement of mixing-particle mixing- rates of mixing, energy input in mixing, liquid mixing- power number, Froude number- mixing equipment- liquid mixtures, powder and particle mixtures, dough and paste mixtures

Unit-V Size Reduction

Grinding and cutting- energy used in grinding- Kicks law, Rittingers law, Bonds law, work index, new surface formed by grinding(shape factors)- grinding equipment- crushers, hammer mills, fixed head mills, plate mills, roller mills, cutters. Sieving- particle size analysis.

Textbooks:

1. Earle, R.L. 2003. Unit Operations in Food Processing. Ebook – hosted by **New Zealand Institute of Food Science & Technology (Inc.)**
2. Richardson, J.F, J. H. Harker & J. R. Backhurst. 2006. Coulson & Richardson's Chemical Engineering – Vol. 2. Elsevier Publications

Reference book:

1. Fellows, P. 2000. Food Processing Technology. CRC Press
- Sahay, K. M. & K. K. Singh. 2007. Unit Operations of Agricultural Processing (II revised) Vikas Publishing House Pvt. Ltd., New Delhi

09FP301 ADVANCES IN FOOD MICROBIOLOGY

Credit: 4:0:0

Objectives: To enable the student to understand:

1. The interaction between food and microbes.
2. The uses of microbes in the development of food products.
3. Importance of microbiology in relation to sanitation.

UNIT I: Food and Microorganisms

Factors affecting growth of microorganisms – pH, water activity, oxidation – reduction potential, nutrient content, inhibitory substances and biological structure – combined effects of factors affecting growth.

UNIT II Microbiology of preservation

General concepts about molds, bacteria and yeasts. Effect of high temperature on microbes – TDT, D value, Z value, 12D concept, calculation of process time. Effect of low temperature, radiation, drying on microbes.

UNIT III: Food fermentation

Manufacture, spoilage and defects of Bread, malt beverages, wines, vinegar, fermented vegetables, fermented dairy products, oriental fermented foods.

UNIT IV: Foods and enzymes from microorganisms

General principles of culture maintenance and preparation for food fermentation – Single cell protein – Fats from microbes – production of amino acids - production of other substances added to food - production of enzymes.

UNIT V: Microbiology in Food Sanitation

Bacteriology of water supplies - Sewage and waste treatment and disposal – Microbiology of the food product - Good Manufacturing Practices (GMP) – Hazard Analysis and Critical Control Points (HACCP).

Text Book

1. William C Frazier and Dennis C. Westhoff 2008. *Food Microbiology*, Fourth edition, Tata McGraw – Hill.

Reference Book

1. Adama, M.R. and Moses, M.O. (2003) *Food Microbiology*, second edition (2003).

09FP302 KINETICS OF FOOD SYSTEMS

Credits – 3:1:0

Objectives

- 1) To enable students understand the physical chemistry and kinetics of food systems
- 2) To make the students understand the interaction of food constituents in maintaining the texture and structure of a food

UNIT 1: Glass Transitions in Foods

Basics of theory of glass transitions – crystalline and amorphous polymers, - difference, Glass transition temperature, crystallite melting point, Crystal melting point – Key elements of the food polymer science approach –Fringed micelle structural model – the dynamics map – Effect of

molecular weight on T_g – Plasticizer – water as a plasticizer - Crystallisation – gelation mechanism – Polymer crystallization kinetics theory - Importance in food systems

UNIT 2: Physical Chemistry of Food Gels & gelling

Nature of the gel state – Mechanism of gel formation in food systems – point cross linking, extended junction zone formation, particle association and spinodal decomposition – gel network types. Basic Theories of gelation – Flory –Stockmayer theory – percolation theory, diffusion – limited aggregation model - mechanical properties of cured gels – Small deformation studies – differentiation between strong and weak gels - frequency dependence, strain dependence and temperature dependence of viscoelastic modulus – Large deformation studies – failure envelopes

UNIT 3: Generation of Engineered Gel Structures

Foods as composite materials – Characteristics of composite materials – solid foams and sponges – Fibrous structures – Reinforcement by solid particles and fibers – Mixed dairy gels – filled dairy gels – Cellular structures of fruits and vegetables

UNIT 4: Structures & Properties Of Food Emulsions

General aspects of emulsions – Types of food emulsions – Oil in water, water in oil, water in oil in water- Measurement of particle size and size distributions in emulsions - Factors affecting stability of emulsions – Structures of adsorbed layers on the surfaces of emulsion droplets - Importance of interfacial layer – Protein stabilized emulsions and foams

UNIT 5: Kinetics of Non-enzymatic browning

Introduction –Mechanism of Maillard Reaction – Factors influencing Maillard reaction – Type of amino acid, pH, type of sugar, solvent state, sugar – amine ratio, temperature, Fluorescence (pH and Temperature interactions)– Kinetics of Maillard browning

Text Books

1. Physical Chemistry of Foods – by Henry G. Schwartzberg and Richard W. Hartel, Marcel Dekker Inc. USA. 1992
2. Food Emulsions by Friberg S., Larsson K. and Sjoblom S. Fourth Edition, Revised and Expanded, CRC Press Pub., 2003.

Reference Books

1. Food Chemistry – by Owen R Fennema, III edition Marcel Dekkar Inc. New York (1996).
2. Food Chemistry by H-D Belitz, W Grosch and P Schieberle: - 3rd Edition Springer Verlag March 2004

09FP303 ENGINEERING PROPERTIES OF FOOD MATERIALS

Credits – 4:0:0

Objectives

- 1) To enable students to understand the different engineering properties of food materials.
- 2) To make the students to acquire knowledge of engineering properties in the designing of food processing systems.

UNIT I : Physical Properties

Engineering properties - physical, thermal, aerodynamic and dielectric properties - importance and applications in the crop processing design - factors affecting the properties. Physical characteristics - grains, fruits and vegetables - shape - size - description. Volume - determination - platform scale method - bulk density and particle density – porosity - air comparison pycnometer. Surface area – importance – determination - projection method - tracing method. Friction - concept - laws of friction - measurement of static and kinetic friction - effect of normal load, sliding velocity, surface, moisture and environment - rolling resistance - angle of internal friction and angle of repose - determination. Flow of bulk granular materials - in bins and hoppers, through orifices, chutes and flow of solids.

UNIT II : Rheological Properties

Rheology - definition - various types of materials - Hook's law – classic ideal material. Stress – strain - density relationship - Rheological models - Maxwell model - creep behaviour of materials - uses - elastic - plastic materials – generalised Maxwell model. Kelvin model - stress relaxation behaviour of materials - generalised Kelvin model. Four elements Burger's model. Viscometry - Newtonian and Non-Newtonian fluids - flow behaviour equations – mechanics of flow in rotational and capillary viscometers. Yield stress and power law equations for Newtonian and Non-Newtonian fluids.

UNIT III : Textural Properties

Texture of food materials - subjective and objective methods - imitative and empirical tests - dynamic test. Firmness and Hardness - different methods of measurements on various produce and foods - dynamic hardness. Mechanical damage on food - causes - biological and chemical reactions following mechanical damage - Detection and evaluation - static and dynamic resistance to mechanical damage – comparison. Impact damage - damage under dead load. Vibration damage - stress cracking.

UNIT IV: Thermal Properties

Thermal properties - specific heat - determination - methods for solids and powders. Determination of thermal conductivity - steady state and unsteady state methods. Thermal diffusivity - determination - relationship among specific heat, thermal conductivity, bulk density and thermal diffusivity - effect of moisture content on thermal properties.

UNIT V:Electrical and Aerodynamic properties

Electrical properties - resistance, capacitance - uses - Dielectric loss factor - method of determination. A.C. conductivity and dielectric constant - determination - Q meter. Effect of moisture content on electrical properties - energy absorption from high frequency electric field. Aerodynamic properties - lift and drag - drag coefficient - friction drag - pressure drag - terminal velocity - importance - spherical bodies and non-spherical bodies - drag coefficient - Reynold's number relationship - separation of foreign materials - pneumatic handling and transportation - applications.

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Text Books:

1. Mohesenin. N.N. 1980. Thermal properties of Foods and Agricultural Materials. Gordon and Breach Science Publishers, New York.
2. Mohesenin. N.N.1980. Physical properties of Plant and Animal Materials. Gordon and Breach Science Publishers, New York.

Reference Books:

1. Rao, M.A and S.S.H.Rizvi (eds) 1986. Engineering Properties of Foods. Marcel Dekker Inc. New York.
2. Singhal,O.P. and Samuel,D.V.K. 2003. Engineering Properties of Biological Materials. Saroj Prakasan, Allahabad
3. Peleg, M.and E.B.Bagelay.1983. Physical properties of foods. AVI publishing Co. USA.

09FP304 TRANSPORT PROCESSES IN FOOD ENGINEERING**Credits – 4:0:0****Objectives**

- 1) To enable the students to understand the systems of Heat transfer in food applications.
- 2) To enable the students to understand the systems of Mass transfer in food applications.

UNIT I : Introduction

Introduction – Transport processes and separation processes – momentum transfer – overall momentum balance – design equations for laminar and turbulent flow in pipes – compressible flow of gases – Differential equations of momentum transfer – Boundary layer flow and turbulence – Dimensional analysis in momentum transfer.

UNIT II : Unsteady state heat transfer

Unsteady State Heat Transfer-Derivation in basic equation- unsteady state heat conduction in various geometries- Numerical finite difference methods for unsteady state conduction-differential equation of energy change- boundary layer flow and turbulence in heat transfer.

UNIT III : Unsteady state Mass Transfer

Unsteady state diffusion mass transfer– Convective mass transfer coefficients- mass transfer coefficient for various geometries- molecular diffusion plus convection- numerical methods for unsteady state molecular diffusion- dimensional analysis in mass transfer.

UNIT IV : Drying Process

Predicted transfer coefficients for constant and falling rate drying period- combined conduction, radiation & convection heat transfer in constant rate period- drying in falling rate period by diffusion- continuous counter current drying- derivation of equation for freeze drying.

UNIT V : Contact Equilibrium Process

Unsteady state thermal processing & biological materials- mass transfer between phases- estimation of mass transfer coefficients for packed towers- heat effects and temperature variations in sorption phenomenon.

Text Books:

1. Transport Processes and Separation Process Principles (Includes Unit Operations) (4th Edition), Christie John Geankoplis, Published by Prentice Hall PTR, 2003.

Reference Books:

1. Fundamentals of Heat and Mass Transfer, Frank P. Incropera, David P. DeWitt, Theodore L. Bergman, Adrienne S. Lavine, Published by Wiley; 6 edition, 2006.
2. Transport Phenomena, R. Byron Bird Stewart W E & Lightfoot E N, Published by John Wiley & Sons Inc., 1960

09FP305 FOOD ENGINEERING

Credits: 4:0:0

Objectives:

To enable the students to study & understand the

1. Heat preservation methods.
2. Aseptic Packaging of processed foods

UNIT – I: Preservation Aspects

Heat preservation of foods -thermo bacteriology, process calculation and selection - low temperature preservation - microbiological aspects, cooling and cold storage - physical methods of preservation - freeze concentration - membrane process -ultrafiltration, Reverse osmosis

UNIT-II: Minimal Processing

Minimal Processing of Foods with thermal methods and non thermal methods- safety criteria in minimally processed foods- Minimal processing in practice- fruits & vegetables-seafood- effect on enzymatic and texture property- quality changes- packaging and storage conditions- Future developments

UNIT- III: Osmotic, Heat Pump & Freeze Drying

Application of light pulses in sterilization of foods and packaging materials- Foam mat drying - osmotic dehydration –heat pump drying - freeze drying - recent advances in freeze drying

UNIT-IV : Spray Drying

Recent developments on design and practice of spray drying - drying behavior of droplets - flash evaporation - extraction and distillation process – energy calculation process - energy requirements in different methods of dehydration - super critical fluid extraction

UNIT-V Aseptic Packaging & Extrusion

Advances in aseptic processing and packaging - processes, design of process, decontamination of packaging - extrusion cooking - recent developments, methods, equipment, and design criteria of extruders.

Text Books:

1. Emerging Technologies for Food Processing, Da-Wen Sun, Contributor Da-Wen Sun, Published by Academic Press, 2005
2. Minimal Processing Technologies in the Food Industry, Thomas Ohlsson, Nils Bengtsson, Thomas Ohlsson Ohlsson, Knovel (Firm, Knovel (Firm), Thomas Ohlsson, Nils Bengtsson, Published by Woodhead Publishing, 2002

Reference Books.

- 1 Ronald Jowitt. 1984. Extrusion cooking technology. Elsevier applied Science Publisher.
- 2 Asiedu, J.J. 1989. Processing tropical crops - technological approach MacMillan Publishers.
- 3 Gould,G.W (Ed).1996.New methods of food preservation. First Edition. Blackie Academic & Professional, London.

09FP306 EMERGING TRENDS IN FOOD PROCESS ENGINEERING

Credits: 4:0:0

Objectives:

To enable the student to understand

1. High Intensity Pulse Techniques, Light Pulses,
2. Food irradiation, high pressure processing and biocatalysts.

UNIT –I: Hurdle Technology

Hurdle technology - principles and applications -hurdle effect in fermented food, shelf stable products, intermediate moisture foods- total quality of foods - optimal range of hurdles and potential safety -application of hurdle technology - fruit preservation, dairy products and meat

UNIT-II Light Pulse Technique

High-intensity pulse technique- Processing systems- design of static chambers- continuous chambers- other chamber designs- generation of different voltage waveforms-oscillation magnetic fields for food processing- generation of magnetic fields -mechanisms of inactivation of microorganisms in food preservation.

UNIT-III: Ohmic Heating

Application of heat and ultrasound - inactivation of microorganisms and enzymes -electrical resistance heating of food - ohmic heating, heating models- treatment of products - high voltage pulse technique - Elsteril process, influence on microorganisms, food ingredients - decontamination of packaging - decontamination of microorganisms by surface treatment

UNIT- IV: Food Irradiation & High Pressure Processing

Food irradiation - advantages and applications, microwave processing - interaction with food materials, material properties, effect of microorganisms, microwave equipment – high pressure processing – Principles -equipment, processing and effect on microorganisms.

UNIT-V: Biocatalysts Biocatalysts- Sources-Types- Processes in Food Industry- Enzymatic Synthesis of Food Additives – Biocatalysis using enzymes-flavours & fragrance - Biosensors-types-application of biosensors to food industry requirements- Development of Biosensors-

Text Books:

1. Nonthermal Preservation of Foods. Gustavo V. Barbosa-Canovas, Usha R. Pothakamury, Enrique Palou and Barry G. Swanson. Published by Marcel Dekker, Inc., 270, Madison Avenue, New Yorkm 10016, 1998.
2. Biosensors for food analysis, A O Scott, The Tetley Group Limited, UK, Woodhead Publishing Limited, Abington Hall, Abington, Cambridge, CB21 6AH, England, 2008.

Reference Books

1. Trends in Food Engineering, Jorge E. Lozano, Cristina Anon, Efren Parada-Arias, Gustavo V. Barbosa-Canovas, Contributor Jorge E. Lozano, Published by CRC Press, 2000.

09FP307 FOOD PACKAGING AND STORAGE ENGINEERING

Credits: 4:0:0

Objectives:

To enable the students to understand

1. Different packaging techniques
2. Different Storage techniques

UNIT I : Packaging – Importance & Materials

Importance of packaging & packaging materials, form and testing – paper boards- tensile, tearing, bursting, water absorption, plastic films & laminates - test for tensile strength, bursting strength, tear strength, permeability (water vapor & gas), stretch, metals, glasses & retort pouches.

UNIT II: Selection of Packages

Migration characteristics, Package for different individual groups of foods like dehydrated, liquid, frozen & processed foods–vacuum packaging of fruits & vegetables–equipment & method– packaging equipment for solid, semi–solid & liquid food. Types of filling machines – glass bottle, pouches.

UNIT III Packaging methods

Form filling- form filling & sealing equipment, labeling- methods-, capping & closures. Metallic containers- Basic canning operations-reforming, seaming,-Testing of cans for seaming and vacuum - Glass packaging- cartons- Manufacture & ply rating – shrink wrapping.

UNIT IV: Storage Engineering

Storage of grains–biochemical changes during storage–production, distribution and storage capacity estimate models–storage capacity models–ecology, storage factors affecting losses, storage requirements, bag and bulk storage– pressure distribution– theories–rodent control– method of stacking– preventive method, bio-engineering properties of stored products–function, structural and thermal design of structures.

UNIT V Cold, MA & CA Storages

Cold storage controlled and modified atmosphere storage – effects of nitrogen, oxygen, and carbon-di-oxide on storage of durable and perishable commodities – storage of dehydrated products – food spoilage and prevention.

Text Books:

1. Crosby, N.T. 1981. Food Packaging Materials. Applied Science Publishers, London.
2. McFarlane Ian, 1983. Automatic control of food manufacturing. Applied Science Publishers, London.

Reference Books

1. Sacharow, S and R. C. Grittin. 1980. Principles of food packaging. AVI Publishers Co., USA.
2. Shejbal, J. (ed) 1980. Controlled atmosphere storage of grains. Elsevier Scientific Publishing Co. London
3. FAO, 1984. Design and Operation of Cold Storages in Developing Countries. FAO Publications Rome.

09FP308 TECHNOLOGY OF FOOD FLAVOURANTS & COLOURANTS

Credits – 4:0:0

Objectives:

To enable the student to understand

1. Basics of foods flavors and colours
2. Chemistry & technology of natural flavours, pigments

UNIT 1 – Basics of flavours and colours

Olfactory perception of flavour and taste – Theories of olfaction - Molecular structure and activity relationships of taste – Sweet, bitter, acid and salt, Chemicals causing pungency, astringency, cooling effect – properties. Classification of flavours – Natural, Nature identical and synthetic – Flavor potentiators. Basics of colour – Hue, chroma, brightness. Regulations regarding additions – Toxicology and safety aspects

UNIT 2 –Technology of Natural flavours

Classification – Alliaceous flavours – Bittering agents, Coffee and Cocoa, Fruit flavours. Evolution of flavours during processing – enzymatic development, effect of roasting, cooking, frying on flavour developments- Essential oils and oleoresins – Extraction – Super critical fluid extraction - Continuous and semi-continuous methods- Effect of types of solvents used. Liquid and dry flavour production - Staling of flavours. Microbial and cell suspensions in the synthesis of flavours

UNIT 3 – Chlorophyll & Carotenoids

Chlorophyll and chlorophyll derivatives, Haems and bilins, Carotenoids, annatto, saffron, turmeric- Stability to pH, temperature and other processing conditions - Technology for the

production of dried colourants - Caramel colour. Microbial and cell suspensions in the synthesis of colours.

UNIT 4 - Anthocyanins & Flavanoids

Anthocyanins and betalains, Less common colourants – Acylated β -ring substituted anthocyanins, Monascus, cochineal and related pigments, Stability to pH, temperature and other processing conditions. Technology for the production of dried colourants.

UNIT 5 –Analysis of flavours and colours

Total component analysis– Basics and methods – Recent developments. Head space analysis – static and dynamic methods – basic principles – method and developments - Solid phase micro extraction of aroma components - E nose technology. Tristimulus colorimetry – Basics and application to foods

Text Books :

1. *Flavor Chemistry and Technology*, By Gary Reineccius, Henry B. Heath, 2nd Edn., Taylor and Francis group, CRC Press, 2006
2. *Natural Food Colorants: Science and Technology*, By Gabriel J. Lauro, , Frederick John Francis, CRC Press Pub., 2000.

Reference Books

1. *Volatile components in Foods and Beverages* Edited by H. Maarse, Marcel Dekker Inc., 1991.
2. *Food Flavours – Biology and Chemistry*, By Carolyn Fisher, Thomas R. Scott, RSC Publishing, 1997
3. *Handbook of Flavor Characterization (Food Science and Technology)* Ed., Kathryn D. Deibler, Jeannine Delwiche, Marcell Dekker Inc., 2004.

09FP309 FOOD ANALYSIS LAB

Credits: 0:0:2

12 experiments will be notified by the HOD from time to time

List of Experiments:

1. Analysis of Jam – Moisture and Total sugars
2. Analysis of Jam – Fiber and Ash
3. Analysis of milk – Determination of fat content by Gerber's method
4. Analysis of Coffee – Estimation of total extractives
5. Analysis of Coffee – Determination of caffeine content
6. Analysis of tea – Total extractives in tea
7. Analysis of tea – Tannin content of tea
8. Kinetics of bi-phasic (solid-liquid) extraction of natural colours – anthocyanins
9. Kinetics of bi-phasic (liquid-liquid) extraction of natural colours – carotenoids
10. Kinetics of degradation of colours
11. Column chromatographic separation of colours
12. Kinetics of Maillard browning

13. Sensory analysis
14. Estimation of iron content
15. Estimation of copper

09FP310 FOOD MICROBIOLOGY LAB

Credits: 0:0:2

12 experiments will be notified by the HOD from time to time

List of Experiments:

1. Experiment on Microscopy
2. Experiment on sterilization and disinfection
3. Experiment on isolation of microorganisms by pure culture technique
4. Experiment on monochrome staining & gram staining
5. Experiment on negative staining & spore staining
6. Experiment on Hanging drop technique
7. Experiment on isolation of MO from spoiled food
8. Experiment on isolation of MO from air
9. Experiment on water quality analysis
10. Experiment on Lactophenol cotton blue staining
11. Experiment on methylene blue reduction test, phosphate test for milk samples
12. Experiment on biochemical test (TSI, catalase, oxidase, hydrogen peroxide)
13. Experiment on production of wine
14. Experiment on production on enzyme amylase
15. Experiment on phenol coefficient test.

09FP311 FOOD ENGINEERING LAB

Credits: 0:0:2

12 experiments will be notified by the HOD from time to time.

List of Experiments:

1. Experiment on Vacuum shelf drier
2. Experiment on plate pasteurizer
3. Experiment on tubular pasteurizer
4. Experiment on vibro fluidizer
5. Experiment on Fluidized bed drier
6. Experiment on Spray drier
7. Experiment on Freeze drier
8. Experiment on canning of vegetables
9. Experiment on canning of fruits
10. Experiment on twin screw extruder
11. Experiment on Sigma mixer

12. Experiment on retort pouch sterilizing unit
13. Experiment on bottling of fruit juices
14. Experiment on bottling of vegetable products
15. Experiment on vacuum packaging

09FP312 FRUIT AND VEGETABLE PROCESS ENGINEERING

Credits: 4:0:0

Objectives:

To enable the student to know about

1. Post harvest technology of fruits and vegetables
2. Processing & preservation techniques of fruits and vegetables

Unit-I Concepts of fruit and vegetable processing

Importance of post harvest technology of fruits and vegetables -post harvest handling and physiology of fruits and vegetables -Fruit ripening – changes during ripening-recommended ripening conditions for fruits – sources of ethylene for ripening – ethylene reactions with O₂ and CO₂. Spoilage of fruits and vegetables and their processed products -Deteriorative factors and their control – enzymatic changes, chemical changes, physical, changes and biological changes

Unit-II Preservation techniques

Biochemistry of fruits-implication on processing- Principles and methods of preservation of fruits and vegetables-Pre-treatments- blanching – methods-Commercial canning of fruits and vegetables-Minimal processing of fruits and vegetables-merits and demerits-Hurdle technology – applications Thermal and non-thermal preservation of fruits and vegetables - Quick freezing preservation of fruits and vegetables – principle – advantages

Unit-III Drying & dehydration

-Dehydration of fruits and vegetables –methods – tunnel drier, cabinet Tray drier, drum drier, spray drier, fluidized bed drier – components and working-Osmotic dehydration of fruits and vegetables – principle - Merits and demerits-Foam mat drying of fruits and vegetables – principle – advantages and disadvantages-Freeze drying – principle- application – heat and mass transfer in freeze drying - heat of -sublimation – methods

Unit-IV Emerging preservation techniques

Microwave heating – principle – absorption of microwave energy –applications in fruits -and vegetables-Radiation preservation of fruits and vegetables –application of radiation – irradiation sources-Intermediate moisture foods – types- applications- advantages and disadvantages-Ohmic heating – principle - advantages over conventional heating-High pressure processing of fruits and vegetables –principle- application -Sensory evaluation of fruits, vegetables and their products

Unit-V Packaging and storage

Packaging technology of fruits, vegetables and their products – packaging materials-Aseptic packaging – principle – applications –Merits-General principles of quality control –quality

attributes – tests--Storage systems of fruits and vegetables and their products – recommended storage -conditions for selected fruits and vegetables-Cold storage of fruits and vegetables – cooling load calculation – design of cold storage – cost economics of cold storage-Modified & Control Atmosphere Storage of fruits & vegetables.

Text Books:

1. Verma, L.R and Joshi, V.K. 2000. Post harvest technology of fruits & vegetables (Vol I & II). Indus publishing company, New Delhi.
2. Srivastava, R.P. and Sanjeev kumar. 1994. Fruit and vegetable preservation. Principles and practices. International book Distributing Co., Lucknow.

Reference Books

1. Shafiur Rahman. 2006. Handbook of Food Preservation. Replika Press Pvt. Ltd. India.
2. The Completer Technology Book on Processing, Dehydration, canning, Preservation of Fruits & Vegetables by NIIR Board, New Delhi
3. Loesecke. 2001. Drying and dehydration of foods. Agrobios (India), Jodhpur

09FP313 FOOD PRODUCT TECHNOLOGY & PACKAGING LAB**Credits: 0:0:2**

12 experiments will be notified by the HOD from time to time

S.No.**LIST OF EXPERIMENTS**

1. Preparation and calculation of material balance of on *khoa*- and *chhana* – based traditional dairy products
2. Preparation of traditional aerated confectionery
3. Preparation of traditional products from legumes
4. Determination of quality parameters of premixes
5. Determination of water vapour transmission rate of the given packaging material - polythene
6. Estimation of water vapour transmission rate of the given packaging material - polypropylene
7. Determination of migration characteristics of packaging materials using different simulants - alcohol as a simulant

8. Determination of migration characteristics of packaging materials using different simulants - acid as simulant
9. Determination of continuity of tin coating in cans by thiocyanate test for porosity
10. Estimation of thermal shock resistance of glass bottles
11. Determination of grease resistance of papers used in food industry – butter paper & toffee wraps
12. Determination of half value (hvp) of products stored in ldpe (low density polyethylene) films by direct weighing method & break down method
13. Estimation of half value (hvp) of products stored in hdpe (high density polyethylene) films by direct weighing method & break down method
14. Determination of bacterial counts of polymer – packed foods during storage
15. Determination of coliforms and fungal counts of polymer – packed foods during storage

09FP314 TRANSPORT PROCESSES IN FOOD ENGINEERING LAB

Credits: 0:0:2

12 experiments will be notified by the HOD from time to time

S.No.

LIST OF EXPERIMENTS

1. Drying studies using through flow dryer – drying rate and drying curve
2. Determination of overall heat-transfer co-efficient of a tubular pasteuriser
3. Determination of crushing efficiency of sugar cane crusher
4. Performance evaluation of an extruder
5. Calibration of rota meter
6. Determination of heat transfer through composite walls
7. Determination of pressure losses in pipes due to sudden enlargement and contraction.
8. Calibration of venturi meter and orifice meter
9. Determination of friction coefficient in annular pipe

10. Determination of overall heat transfer coefficient in shell and tube heat exchanger
11. Determination of aerodynamic properties using fluidised bed column
12. Determination of mixing index of a mixer – sigma, ribbon, planetary mixers
13. Determination of mass transfer coefficient using Fick's law
14. Determination of enthalpy balances in single effect evaporator
15. Determination of mass transfer rate in leaching / extraction

09FP315 – FOOD ENZYMOLOGY LAB

Credits: 0:0:2

12 experiments will be notified by the HOD from time to time

Sr. No.

LIST OF EXPERIMENTS

1. Estimation of reducing sugars by dinitrosalicylic acid method
2. Estimation of proteins by the hartree-lowry method
3. Amylases - optimisation of ph & temperature
4. Optimisation of enzyme-substrate ratio and determination of michaelis–menten kinetics
5. Time study / enzyme kinetics of amylases
6. Optimisation of ph and temperature of protease
7. Optimisation of enzyme-substrate ratio and determination of michaelis–menten kinetics - protease
8. Time study / enzyme kinetics of protease
9. Characterisation of activity of crude amylase
10. Characterisation of activity of crude protease
11. Techniques of enzyme immobilization
12. Michaelis – menten kinetics and half-life of immobilized enzymes -
13. Qualitative tests for presence of enzymes – catalase, peroxidase and urease
14. Tests for cellulase activity
15. Test for phosphatase activity in milk

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ADDITIONAL SUBJECTS

Code	Subject Name	Credits
10FP201	Processing of Food Commodities	3:0:0
09FP213	Processing of Food Lab-1	0:0:2
09FP218	Processing of Food Lab – 2	0:0:2

10FP201 PROCESSING OF FOOD COMMODITIES

Credits: 3:0:0

Objectives:

- 1) To study various processing methods for various food materials like fruits & vegetables, dairy products, cereals, meat, poultry, fish and bakery products
- 2) To study various innovative food processing techniques

Outcomes:

- 1) Students to acquire knowledge on the basics of food processing
- 2) Students will have a know-how on the various processing technologies involving fruits and vegetables, dairy, cereals, meat, fish, egg and plantation products
- 3) Students to acquire basic knowledge on microbiology of food products
- 4) Students will have an overview of the possible arena of entrepreneurial activity related to food products.

Unit I Cereal, Pulses and Oil seeds Technology

Rice milling, Pulse milling, Wheat milling – Oil extraction - Methods of manufacture of Bread – different processes of manufacture – types of breads – buns, biscuits, cakes and cookies –Pasta products -Tortilla – Method of manufacture

Unit II Fruits and vegetable processing

Production of Fruits and vegetables in India, Cause for heavy losses, preservation treatments – Basics of Canning, Minimal processing and Hurdle technology as applied to Vegetable and Fruit processing, Processing of fruit juices, Dehydration, Aseptic processing

Unit III Dairy processing

Basic dairy terminology, composition, General tests at reception, Dairy Processing – Method of manufacture of Standardised, toned and double toned milk, milk powder – Equipments – Pasteurizers, homogenisers and pumps - Method of manufacture of dairy products – Icecream, Cheese, *Paneer*, Yoghurt – Pasteurisation and microorganisms involved in spoilage of milk.

Unit IV Meat, Fish and Poultry processing

Meat composition from different sources, Definitions and measurements, Carcass Processing, Meat Products, Processing of Poultry Products, Fish and other Marine Products Processing

Unit V Plantation product technology

Processing of Tea, Coffee and Cocoa – Outline of the methods of manufacture of – green tea, black tea, instant tea, Instant coffee, Cocoa and Chocolate. Outline of the methods of processing of Pepper, cardamom, ginger, vanilla and turmeric

Text Books

1. Srivastava, R.P. and Kumar, S.: Fruit and Vegetable Preservation: Principles and Practices. International Book Distributing Co. Lucknow (2nd Edition 1998).
2. Chakraverty, A., Mujumdar A.S., Raghavan G.S.V and Ramaswamy H.S. Handbook of Post-harvest Technology: Marcel Dekker Press, USA (2001)
3. W. James Harper and Carl W. Hall: Dairy Technology and Engineering AVI Publishing, Westport, USA (1976)
4. Karel Kulp and Joseph P Pante:Hand Book Of Cereal Science and Technology Mercel Dekkar USA (2000)
5. Samuel Matz: The Chemistry and Technology of Cereals as Food and Feed, Chapman & Hall (1992)

09FP213 PROCESSING OF FOOD LAB -1

Credits: 0:0:2

12 experiments will be notified by the HOD from time to time

Objectives

To make the students

- a) Understand the basics of fruit and vegetable processing
- b) Know the process of manufacture of fruit and vegetable products
- c) Understand the importance of mass and material balances

Outcome

- a) Know the process of manufacture o processed fruits and vegetables
- b) Understand the Laws and standards governing the product.

List of Experiments:

1. Preparation of syrups
2. Preparation of Grape squash
3. Preparation of orange squash
4. Preparation of pineapple RTS
5. Preparation of lime cordial
6. Preparation of mango jam
7. Preparation of mixed fruit jam
8. Preparation of Jellies
9. Preparation of marmalades
10. Preparation of fruit bars
11. Preparation of tomato ketchup
12. Preparation of Pumpkin sauce
13. Vinegar – salt – oil pickles
14. Preparation of gummies, fondants and fudges
15. Preparation of toffees.

09FP218 PROCESSING OF FOOD LAB -2

Credits: 0:0:2

12 experiments will be notified by the HOD from time to time

Objectives

To make the students

- a) Understand the basics of bakery products processing
- b) Know the process of manufacture of bakery products
- c) Understand the importance of mass and material balances

Outcome –

- a) Know the process of manufacture of bakery products
- b) Understand the Laws and standards governing the product.

List of Experiments:

1. Preparation of whole wheat bread
2. Preparation of multigrain bread
3. Preparation of bun
4. Preparation of puffs
5. Preparation of doughnuts
6. Preparation of Hard dough biscuits
7. Preparation of soft dough biscuits
8. Preparation of multigrain biscuits
9. Preparation of high fiber biscuits
10. Preparation of cookies
11. Preparation of rusks
12. Preparation of angel cake
13. Preparation of pound cake
14. Preparation of eggless cake
15. Preparation of puddings

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NEW SUBJECTS

Code	Name of the subject	Credits
10FP301	Food Safety Regulations and Control	3:1:0
10FP302	Instrumental Techniques of Food Analysis	3:1:0
10FP303	Food Biochemistry and Nutrition	3:1:0
10FP304	Advances in Food and Water Microbiology	4:0:0

10FP301 FOOD SAFETY REGULATIONS AND CONTROL

Credit : 3:1:0

Objectives

- 1) To enable the students to understand the basics of food safety and regulations governing the same, the world over
- 2) To make the students to understand the role of individual personnel of the regulatory authority

Outcome

Students will be able to develop - (a) protocols based on GMP for Food Processing Industries (b) develop new innovative norms and (c) ensure implementation of adequate safety regulations and control.

Unit I: Structure, Organization and practical operation of International / Intergovernmental Food regulation bodies

World Trade order – Functioning and responsibilities of the WTO - Codex Alimentarius – History, operations of Codex alimentarius, Responsibilities – Codex standards and Maximum residue limits – Current Issues under consideration – SPS (Sanitary and phytosanitary measures) agreement.

World Health Organization – History and mandate – Operations and responsibilities – ICGFI – Functions and responsibilities.

Unit II : Regulating authority of Food safety in India and its role

Food safety and Standards Act – organizational chart – role of individual authority – principles to be followed –Provisions as to articles of food –imported items – Responsibilities of the food business operator – Liability of manufacturers, packers, wholesalers, distributors and sellers – Enforcement of the act – Licensing and registration of food business – Food safety officer and their powers – Analysis of food – regulations regarding labs involved in food analysis – Offences and penalties – Adjudication and food safety appellate tribunal – Laws relating to Food Processing Industries in India - FPO, MMPO, PFA, AGMARK, Essential Commodities Act, BIS.

Unit III: Food labeling – Regulations

Need for labeling – Developing labeling standards at the world level – Limitations of labeling- safety issues – Labeling regarding methods of processing – Irradiated products – Products derived from modern biotechnology – organic produce - Genetically modified foods

– EU rules on nutritional labeling – US rules on nutritional labeling – Health claims – Approach of US and EU.

Unit IV: General aspects of food safety

Concept of HACCP – Assembling the team – Product description – Describing the product's intended use – Establishing a process flow diagram – on site confirmation - Listing potential hazards and control measures - Determination of critical points – decision tree for CCPs- Establishing monitoring procedures- establishing corrective actions – establishing verification procedures.

Unit V: ISO 22000 Regulations

Basics and differences with HACCP. Implementing HACCP & ISO 22000 for foods of Animal origin – Dairy Foods, Meat & Meat Products and Poultry.

Safety aspects of drinking water (microbiological and chemical) - risks and advantages of chlorination of water. Bottled water – origin of water- safety aspects – microbiological and chemical quality – Regulations for bottled water – EU, US and India.

Text Books

1. Kees A. van der Heijden & Sanford Miller- International Food Safety Handbook: Science, International Regulation, and Control 1999, Published by CRC Press. ISBN 0824793544, 9780824793548.
2. Guide to The Food Safety and Standards Act 2006, Taxmann Allied Services Pvt. Ltd., ISBN – 10 – 8174968288.

Reference Book

Rajesh Mehta and J. George - Food Safety Regulation Concerns and Trade- The Developing Country Perspective, 2005, Published by Macmillan India Ltd., New Delhi.

10FP302 INSTRUMENTAL TECHNIQUES OF FOOD ANALYSIS

Credit : 3:1:0

Objectives

- 1) To enable the students to understand the basics of various techniques available for the analysis of a food commodity
- 2) To make the students appreciate the instruments for analysis and their advancements till date

Outcome

Students will be able to – (a) apply the instrumental techniques learnt towards the analysis of food materials and (b) develop / improve methods of analysis with improved sensitivity and reproducibility

Unit I: Basic concepts in chromatography - Chromatogram, distribution coefficient, retention volume, capacity factor, Gaussian profile, theoretical plates, selectivity, resolution, kinetic processes – Physical forces and interactions – Ionic interactions, van der Waals

forces, hydrogen bonding, charge transfer – Modes of separation – Adsorption, Partition, Ion-exchange, size-exclusion

High performance liquid chromatography – Basic principles – Mobile phase – Instrumentation – Injector, Column, Pump, detector, Types of detector – advantages of HPLC over other techniques – Applications of HPLC to food analysis

Unit II: Gas Chromatography and FTIR Spectroscopy

Principles – Definitions, terms relating to Retention of analytes, column efficiency, sample component separation- Theory of Gas chromatography – Instrumentation – Carrier gas source, inlet system, columns, types of detectors – FID, TCD, ECD, MSD – application of GC to food analysis

FTIR Spectroscopy

Principles of Infrared spectroscopy – Instrumentation- Data handling Techniques, Spectral ratioing, co-adding, Baseline correction, peak measurements, measurement of overlapping bands, smoothing and interpolation, spectral subtraction – quantitative analysis- Sampling methods , transmission cells, attenuated total reflectance – Applications in foods

Unit III: Atomic absorption spectroscopy

Introduction to AAS – Components of an AA spectrometer – Overview, Light sources, Nebuliser / Atomiser assemblies, Nebulisers, flames, optics, detectors, support gases, AAS measurements- approaches to improving the S/N ratio – Interferences – Chemical, Physical, Ionisation, Background and spectral – Calibration techniques – External standards and Standard additions – Minimising uncertainties – Atomisation techniques

Atomic emission spectrometry (AES) - ICP – Mass spectrometry - Atomic Fluorescence Spectrometry (AFS) - Trace metal determinations in Biological samples

Unit IV: Nuclear Magnetic Resonance spectroscopy

Electromagnetic spectrum – The NMR Phenomenon – Types of information provided by NMR spectra – Instrumental and Experimental Considerations – Solid state NMR – application of NMR to Food analysis

Unit V: Mass spectrometry

Process – Ionisation techniques – Instrumentation – Linked scanning techniques – application of MS in Food Science – application of GC/MS, LC/MS / FAB/MS / MS/MS and linked scan techniques

Capillary electrophoresis

Instrumentation and components – Modes of CE – Capillary zone electrophoresis, Micellar electrokinetic chromatography (MECK), Capillary gel electrophoresis (CGE), Capillary isoelectric focusing (CIEF), Capillary Isotachopheresis (CITP) – Applications of CE in analysis of food substances

Text book:

1. J.R.J. Pare and J.M.r. Belanger, 1997. Instrumental Methods of Food Analysis, Elsevier Science B.V., The Netherlands. ISBN: 0-444-81868-5

Reference Books:

1. Rouessac F. and Rouessac A. Chemical Analysis: Modern Instrumentation Methods and Techniques, 2007, 2nd Edition, John Wiley and Sons. Ltd. England. ISBN: 978-0-470-85903-2
2. David L. B. Wetzel, George Charalambous, 1998. Instrumental Methods of Food and Beverage Analysis, Elsevier Science BV.

10FP303 FOOD BIOCHEMISTRY AND NUTRITION

Credit : 3:1:0

Objectives

- 1) To enable students understand the basics of food biochemistry and nutrition
- 2) To make the students appreciate the importance of nutrition and enable them to develop new products of high nutritive value

Outcome

Students will be able to apply their knowledge in Food Biochemistry and nutrition in designing new range of products with improved nutritional characteristics (Nutraceuticals, probiotics etc.)

Unit I:

Electron transport chain - glycolysis, TCA cycle, gluconeogenesis, Pentose phosphate shunt, Embden Meyerhof Pathway (EMP), urea cycle, interconnection of pathways, Metabolic regulation, Bioenergetics: Respiratory chain ATP cycle, energy rich compounds

Unit II:

Biosyntheses and degradation of fatty acids, and cholesterol - Biosyntheses and degradation of amino acids (one example each for sulphur containing, aliphatic, aromatic, heterocyclic, basic and acidic amino acids), peptides and proteins; Biosynthesis and degradation of purines, pyrimidines and nucleic acids.

Unit III:

Basic concept of nutrition – Importance of nutrition and dietetics - Assessment of nutritional status – energy value of carbohydrates, proteins and fats – determination of energy value – balanced diet – Recommended dietary intake – Acceptable dietary intake – Protein efficiency ratio – Net protein utilisation and their determinations – Malnutrition and its problems – Nutrient supplementation – fortification - Nutritional labeling and its importance - Effect of processing on protein quality, essential amino acids - Digestibility, carbohydrates in food and dietary fibre

Unit IV:

Inborn errors of carbohydrate, protein and fat metabolisms - Nutrition and disorders associated with organs such as liver and kidney - Naturally occurring anti-nutritional factors – Cyanogens, lectins, enzyme inhibitors, phytoalexins, phytates

Unit V:

Nutrition for specialized purposes – Pediatric nutrition – geriatric nutrition – Sports nutrition – Nutrition during pregnancy - Functional foods

Ageing –Theories of ageing – Nutrition and ageing – Cancer and its prevention - Age-related metabolic disorders – Nutrition in the treatment of age-related disorders like hypertension, diabetes, alzheimer’s disease

Text Books:

1. Voet D, Voet G, Principles of Biochemistry, Third Edition, John Wiley and Sons, 2008. ISBN-13: 9780470233962, 978-0470233962.
2. Martin Eastwood . Principles of Human nutrition – Second Edition, Ed. Wiley - Blackwell Publishing, 2003. ISBN: 978-0-632-05811-2

Reference Books:

1. Ronald Ross Watson, Functional foods and Nutraceuticals in Cancer Prevention, Ed. Wiley – Blackwell, 2003. ISBN-13: 978-0813818542
2. Lehninger A.L, Nelson D.L., M.M. Cox, Principles of Biochemistry, W.H. Freeman & Company Publications, 2008. ISBN - 071677108X

10FP304 ADVANCES IN FOOD AND WATER MICROBIOLOGY

CREDITS- 4:0:0

Objectives

- 1) To enable students to understand the basics of microbiology and its importance in food and water
- 2) To study their impact on health and diseases transmitted
- 3) To recycle waste and appreciate the importance of anaerobic digestion in relation to energy

Outcome

Students demonstrate their ability to – (a) identify and solve problems related to Food and Water Microbiology and (b) develop ways for ensuring a microbially safe product in Food Industries

UNIT I: Food and Microorganisms

General concepts about bacteria, molds and yeasts -Factors affecting the growth of microorganisms – pH, water activity, oxidation – reduction potential, nutrient content, inhibitory substances and biological structure – combined effects of factors affecting growth

Unit II: Microbiology of water

Soft and hard water – its implications in Food processing industry- Definition of potable water, contaminated water and polluted water – Diseases transmitted through water – cholera, typhoid, dysentery (Amoebic / Bacillary) – coliforms and its importance – MPN count of coliforms – Permissible limits in drinking water – Advantages and disadvantages of chlorination of water

Unit III: Food spoilage and defects

Classification- Food infections – bacterial and other types; Food intoxications and poisonings – bacterial and non-bacterial; food spoilage – factors responsible for food spoilage – spoilage of canned foods

Unit IV: Foods and Enzymes from microorganisms

General principles of culture maintenance and preparation for food fermentation – single cell protein – fats from microbes – production of amino acids – production of other substances added to food – production of enzymes

Unit V: Microbiology in Food Sanitation

Bacteriology of water supplies – sewage and waste treatment and disposal – Anaerobic digestion pathways in relation to biogas output – Good Manufacturing Practices (GMP) – Hazard Analysis and Critical Control Points (HACCP)

Text Books

1. B. Sivasanker, 2002: Food Processing and preservation– Prentice Hall India Pvt. Ltd., New Delhi.
2. Frazier, W.C and Westhoff, D. C. 2008, Food Microbiology, 4th Edition, McGraw-Hill Education India Ltd. ISBN - 9780070667181

Reference Books

1. Adams M.R. and Moss M.O., 2007 Food Microbiology, New Age International Ltd. Publication. ISBN-13: 9788122410143, 978-8122410143

**SCHOOL OF FOOD SCIENCES AND
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ADDITIONAL SUBJECTS

	Code	Name Of The Subject	Credit
1.	11FP201	Food Microbiology	3:0:0
2.	11FP202	Process Engineering Calculations	4:0:0
3.	11FP203	Food Microbiology Lab	0:0:2
4.	11FP204	Principles of Fluid Mechanics and Heat Transfer	4:0:0
5.	11FP205	Food Biochemistry and Nutrition	3:0:0
6.	11FP206	Chemical Engineering Lab	0:0:2
7.	11FP207	Food Biochemistry Lab	0:0:2
8.	11FP208	Unit Operations in Food Processing – I	4:0:0
9.	11FP209	Food Engineering and Packaging Lab	0:0:2
10.	11FP210	Technology of Meat, Fish and Poultry Processing	3:0:0
11.	11FP211	Process Economics and Plant design for Food Engineers	4:0:0
12.	11FP212	Food Chemistry	3:0:0
13.	11FP213	Food Additives	3:0:0
14.	11FP214	Fruit and Vegetable Processing Technology	3:0:0
15.	11FP215	Cereal & Pulses Technology	3:0:0
16.	11FP216	Sugar and Confectionary Technology	3:0:0
17.	11FP217	Dairy Technology	3:0:0
18.	11FP218	Food Packaging Technology	3:0:0
19.	11FP219	Milling and Bakery Technology	3:0:0
20.	11FP220	Plantation Products and Spices Technology	3:0:0
21.	11FP221	Engineering Properties of Foods	3:0:0
22.	11FP222	Analysis of Food Lab - I	0:0:2
23.	11FP223	Analysis of Food Lab – II	0:0:2
24.	11FP224	Food Product Technology Lab – I	0:0:2
25.	11FP225	Enzymology Lab	0:0:2
26.	11FP226	Analysis of Food Products of Plant Origin Lab	0:0:2
27.	11FP227	Analysis of Food Products of Animal Origin Lab	0:0:2
28.	11FP228	Food Product Technology Lab – II	0:0:2
29.	11FP229	Food Refrigeration & Cold Storage Construction	3:0:0
30.	11FP230	Radiation Preservation and Processing Techniques	3:0:0
31.	11FP231	Emerging Technologies in Food Processing	3:0:0
32.	11FP232	Economics and food Industry Management	3:0:0
33.	11FP301	Mass Transfer Processes in Food Engineering	4:0:0
34.	11FP302	Separation Processes in Food Engineering	4:0:0

11FP201 FOOD MICROBIOLOGY**Credits: 3:0:0****Course Objectives:**

To enable the students to understand

- Isolation methodology of microorganisms
- Methods of preservation of foods

- Microorganisms of food commodities of plant and animal origin
- Food borne diseases and microorganisms

Course Outcome:

On successful completion of the subject, students will get exposure to

- How to isolate microorganisms and how to utilize microorganism as sources of food
- How to utilize microorganism to produce fermented foods
- How to utilize microorganisms in food industries

Unit I: Introduction, screening and isolation of microorganisms

Micro organisms associated with foods: Bacteria – Beneficial and Contaminants - Molds, Yeast and their importance – Viruses - Intestinal viruses, Bacterial viruses and Fungal Viruses - Factors affecting the growth of bacteria – Recent developments - antimicrobial barriers and constituents. Methods of screening, isolation and enumeration of bacteria and fungi.

Unit II: Conventional methods of preservation

Thermal mode of preservation – Pasteurisation and appertization – determination of D and Z values – spoilage of canned foods – aseptic packaging - Low-temperature storage

Non-thermal methods of preservation : High pressure processing – Pascalisation - Irradiation – Brief account of microwave, UV and ionizing radiation - Use of chemical preservatives, Natural food preservatives - Microbiological quality control and HACCP

Unit III: Microbiology of Fermented products

Traditional vegetable fermentation – Sauerkraut - Lactic acid, citric acid, and mixed acid fermentations - Alcohol production – Fermentation of oriental food products.

Unit IV: Microbiology of Food commodities of animal / marine origin

Microbiology of water and their importance of processing of foods in industries. Microbiology of milk – Hetero and homo fermentative Lactic acid bacteria – Yogurt and Cheese fermenting organisms - Importance of aflatoxin in canned foods.

Unit V : Food borne pathogens

Food Poisoning and intoxication – food borne diseases – Symptoms, prevention and treatment of Bacillus spp., Clostridium botulinum, Escherichia coli, Salmonella, Staphylococcus aureus, Shigella spp., Hepatitis, Gastroenteritis viruses, Entamoeba histolytica and Entamoeba coli.

Text Book:

1. M.R. Adams and M.O. Moss, Food Microbiology Second Edition Panima Publishing corporation, New Delhi. Third reprint 2004

Reference Books:

1. B.Sivasankar, Food Processing and Preservation, PHI Learning Private Limited, Eastern Economy Edition, 6th edition, 2009.
2. William C Frazier and Dennis C. Westoff, Food Microbiology, Special Edition, Springer, The Mc Graw-Hill Companies, 2008.

11FP202 FOOD PROCESS ENGINEERING CALCULATIONS**Credit: 4:0:0****Course Objective:**

- To enable the students to understand the process engineering calculations in food industries

Course Outcome:

- On completion of the syllabus, the students will be able to develop skill and other engineering knowledge relating to various process engineering calculations essentially required for the food engineers to function effectively.

Unit I: Basics of Food Engineering Calculations

System of measurements; SI system of measurement; Units and Dimensions, Fundamental and derived units, Mole units – Mole, atomic mass and molar mass, Solids, liquids and solutions – important physical properties of solutions

Unit II: Gas Vapour Mixtures and its behavior in Food systems

Ideal and Real gases – Equation of state, kinetic theory of gases, absolute temperature and pressures, quantity of gases, ideal gas equations, P.V.T. relations for ideal gas, Vander Waal equation, critical conditions for gas mixes. Joule Thomson effect – Gas-liquid mixtures – Material balances – Process flow sheet – Material balances without chemical reactions – Psychrometry – Humidity, Relative humidity, Wet and dry bulb temperature, dew point, Humidification and dehumidification – Psychrometric chart for air-water systems – Mixing of air streams

Unit III: Material Balances of unit operations in Food systems

Material balances – basic principles, law of conservation of mass, process flow diagram, system boundaries, total mass balance, component mass balance. Material balance of food processes involving Distillation, Absorption and Stripping, Extraction and leaching.

Unit IV: Material Balances of unit operations in Food systems

Material balance of food processes involving drying, evaporation and concentration by non-thermal processes involving membrane separations

Unit V: Energy Balances

Concept and units – Heat capacity – Sensible heat changes in gases at constant pressure – Sensible heat changes in liquids – Latent heat - calculations of enthalpy changes, general balance without reactions, heats of solution and mixing.

Text Book:

1. Bhatt B I and S M Vora – Stoichiometry, Tata McGraw Hill Publishing company limited, IVth Edn., 2005.

Reference Books:

1. Romeo T.Toledo: Fundamentals of Food Process Engineering, Van Nostrand Reinhold, New York. 2007.

2. Himmelblau D.M. & J. B.Riggs: Basic Principles and Calculations in Chemical Engineering : Prentice Hall International, 7th Edition. 2004.

11FP203 FOOD MICROBIOLOGY LAB

Credits: 0:0:2

Course Objective:

- To study the various microorganisms associated with food.

Course Outcome:

- The students to learn various methods of isolation, characterization and screening of bacteria, fungi and other related organisms which will help them to develop skills to monitor various food processing operations in food industries.

List of Experiments

1. Study of morphology of bacteria and fungi
2. Methods of Sterilization of glass wares and culture media for microbiological work
3. Preparation of nutrient broth and nutrient agar
4. Monochrome staining
5. Differential staining – Gram staining
6. Negative Staining, Lacto phenol cotton blue staining
7. Methods of pure culture techniques for bacteria
8. Hanging drop preparation to observe motility of bacteria
9. Enumeration and isolation of bacteria and fungi from water / milk
10. Enumeration and isolation of bacteria and fungi from any contaminated food
11. IMViC tests
12. Methylene blue reduction test in milk
13. Phenol Coefficient test for disinfectants

11FP204 PRINCIPLES OF FLUID MECHANICS AND HEAT TRANSFER

Credits: 4:0:0

Course Objectives

To enable the student to understand:

1. Basics of Fluid mechanics and thermal flow
2. Importance of thermal fluid sciences in processing of food
3. Develop processes with better heat efficiency and economics

Course Outcome:

On successful completion of the subject, the students will be able to apply their knowledge on thermal fluid sciences in processing of food.

Unit I: Introduction to Fluid Mechanics

Fluids – Properties, vapor pressure, surface tension, capillary effect; Types of fluids. Bernoulli equation; fluid flow – laminar, turbulent; pressure drops in pipes, valves and bends. Orifice meter, Venturi meter, Rotameter, Pitot tube – working principles

Unit II: Introduction to thermodynamics

Thermodynamic system and Control volume, thermodynamic properties, thermodynamic equilibrium, thermodynamic process, Zeroth law of thermodynamics, concept of work and heat transfer. First law of thermodynamics – closed and open system, Carnot cycle - Second law of thermodynamics.

Unit III- Steam and Properties of Steam

Properties of steam – Phase transformation at constant pressure – PVT data – Steam tables – wet and super-heated steam, entropy of water, steam and super-heated steam – Constant pressure, constant volume processes – Adiabatic process- Isothermal and polytropic processes – boilers and their types

Unit IV: Heat Transfer – Conduction

Modes of heat transfer – conduction, Convection and Radiation. Steady heat conduction in simple geometries – Plane wall, cylindrical wall without heat generation. Transient heat conduction – Lumped capacitance method for bodies of infinite thermal conductivity. Theory of insulation, critical radius of insulation Overall heat transfer coefficient.

Unit V – Heat Transfer – Convection and Radiation

Convection heat transfer – forced and natural; Evaluation of convection heat transfer coefficient, turbulent flow over a flat plate, Forced convection inside tubes, heat transfer coefficient for Laminar flow in a tube with constant heat flux and constant wall temperature. Basics of Radiation heat transfer.

Text Book:

1. Rao, D. G. Fundamentals of Food Engineering. PHI Learning Pvt. Ltd., New Delhi. 2010.

Reference Books:

1. McCabe, W.L., Smit, J.C., and Harriott, P. Unit Operations of Chemical Engineering. 7th Edition. McGraw-Hill International Edition, New York. 2005.
2. Ballaney, P.L. Thermal Engineering. Khanna Publishers, New Delhi. 2002.
- 3.

11FP205 FOOD BIOCHEMISTRY AND NUTRITION**Credits: 3:0:0****Course Objectives:**

To enable the students to understand

- Biochemical cycles
- Biosynthesis of macromolecules
- Nutrition and its importance
- Anti-nutritional factors
- Specialized nutrition

Course Outcome:

- On successful completion of the subject, students will get exposure about Nutrition and its importance, nutrition for different group people, nutritive values of different food sources.

Unit I: Carbohydrate metabolism

Electron transport chain, Glycolysis – Embden Meyerhof Pathway (EMP), Pentose phosphate shunt, TCA cycle, gluconeogenesis, urea cycle, inter connections of pathways, metabolic regulation, Bioenergetics – respiratory chain ATP cycle, energy rich compounds.

Unit II: Protein and Fatty acid Metabolism

Biosynthesis and degradation of - fatty acids (saturated and unsaturated), and cholesterol; amino acids (glycine, tyrosine, cysteine, histidine), peptides and proteins; Purines (adenine, thymine), pyrimidines (guanine and cytosine) and nucleic acids (DNA and RNA).

Unit III: Concepts of Nutrition

Basic concept of nutrition – Importance of nutrition and dietetics - Assessment of nutritional status – energy value of carbohydrates, proteins and fats – determination of energy value – balanced diet – Recommended dietary intake – Acceptable dietary intake – Protein efficiency ratio – Net protein utilisation and their determinations – Malnutrition and its problems – Nutrient supplementation – fortification - Nutritional labeling and its importance - Effect of processing on protein quality, essential amino acids - Digestibility, carbohydrates in food and dietary fibre

Unit IV: Nutritional Disorders

Inborn errors of carbohydrate, protein and fat metabolisms - Nutrition and disorders associated with organs such as liver and kidney - Naturally occurring anti-nutritional factors – Cyanogens, lectins, enzyme inhibitors, phytoalexins, and phytates

Unit V: Specialized Nutrition

Nutrition for specialized purposes – Pediatric nutrition – geriatric nutrition – Sports nutrition – Nutrition during pregnancy - Functional foods - Ageing – Theories of ageing – Nutrition and ageing – Cancer and its prevention - Age-related metabolic disorders – Nutrition in the treatment of age-related disorders like hypertension, diabetes, Alzheimer's disease

Text Book

1. Lehninger A.L, Nelson D.L., Cox, M.M. Principles of Biochemistry, W.H. Freeman. 2005.

Reference Books:

1. Voet D, Voet G, Biochemistry, John Wiley and Sons, 2004.
2. Tymoczko, J.L., Berg, J.M., Stryer, L. Biochemistry – A short course. W.H. Freeman. 2009.

11FP206 FLUID MECHANICS AND HEAT TRANSFER LAB

Credits: 0:0:2

Course Objective

- To study the various chemical engineering parameters through practical exercise

Course Outcome

- On completion of the course, the students will be able to develop skills needed to analyse various chemical engineering parameters and study heat transfer, exchanger, pressure drop.etc which will enable them to carry out different chemical engineering operations connected with food industry

List of Experiments

- 1) Determination of pipe friction and pressure drop under sudden contraction and expansion during fluid flow
- 2) Determination of Equivalent Length of pipe fittings during fluid flow
- 3) Determination of Pressure drop in Helical coil
- 4) Determination of Pressure drop in annular pipes
- 5) Calibration of Venturi meter and rotameter /
- 6) Calibration of Orifice meter
- 7) Pressure drop across Packed-bed columns
- 8) Pressure drop across Fluidized bed columns
- 9) Heat transfer studies in a tubular heat exchanger (Parallel and counter flow)
- 10) Heat transfer studies in a plate heat exchanger (Parallel and counter flow)
- 11) Heat transfer studies of a shell and tube heat exchanger
- 12) Heat transfer through composite walls
- 13) Filtration studies using a leaf filter
- 14) Heat transfer studies of a long tube evaporator
- 15) Determination of particle size distribution using a gyratory sieve shaker

11FP207 FOOD BIOCHEMISTRY LAB

Credits: 0:0:2

Course Objective

- To study the biochemical properties of food commodities

Course Outcome

- On completion of the course, the students will be able to develop skills needed to analyse various biochemical constituents of food

List of Experiments

1. Estimation of sugars by DNS method
2. Estimation of sugars by Phenol - Sulfuric acid / Anthrone- Sulfuric acid methods
3. Estimation of proteins by the Biuret method
4. Estimation of proteins by microkjeldahl's method
5. Estimation of proteins by Lowry's method
6. Estimation of proteins by dye-binding method
7. Estimation of thiamine
8. Estimation of ascorbic acid
9. Estimation of riboflavin
10. Estimation of carotenoids
11. Estimation of cholesterol
12. Qualitative tests for checking of milk and water
13. Qualitative test for checking of blanching

11FP208 UNIT OPERATIONS IN FOOD PROCESSING - I**Credits: 4:0:0****Course Objective**

- To enable the students to understand the concepts and applications of distillation, evaporation, separation and super critical fluid extraction processes.

Course Outcome

- On completion of the syllabus, the students will be able to apply their knowledge on distillation, evaporation, separation and super critical fluid extraction processes in various food industries.

Unit I : Introduction

Basic principles of food processing, Conservation of mass and energy, Units and dimensions of engineering parameters, dimensionless ratios, and calculations involving various physical parameters.

Unit II: Distillation

Distillation, Steam distillation, applications and equipment – determination of height equivalent of theoretical plate (HETP) – McCabe-Thiele method – reflux ratio. Molecular distillation, theory and examples. Mass transfer phenomenon applied to food systems

Unit III: Evaporation

Needs, basic principles, Calculations, Single and multiple effect evaporation, Heat economy – enthalpy balances for evaporators, Vapour recompression, Thermo and mechanical systems, boiling point elevation, Falling film, climbing film tubular evaporators, plate evaporators, thin film and scraped surface evaporators.

Unit IV: Contact Equilibrium Separation Processes

Concentrations, Gas-liquid equilibria, Solid liquid equilibria, Equilibrium concentration relationships, operating conditions; Basics of Solid-liquid extraction processes, liquid-liquid extraction, with food application examples, Crystallization

Unit V: Leaching and Extraction

Leaching – Leaching equipments – principles of continuous and countercurrent leaching.

Liquid extraction – extraction equipment – principles of extraction.

Special extraction techniques – supercritical fluid extraction. Applications; extraction of Fatty acids, oleoresins and essential oils; Relative advantages, limitations and economics.

Mechanical extraction – Expellers, screw press, filter press.

Text Book:

1. McCabe, W.L., Smit, J.C., and Harriott, P. Unit Operations of Chemical Engineering. 7th Edition. McGraw-Hill International Edition, New York. 2005.

Reference Books:

1. Albert Ibarz, Cannovas, G.V. Unit Operations in Food Engineering. CRC Press. 2003.
2. J.M. Coulson, J.F. Richardson, J.H. Harker - Coulson & Richardson's Chemical Engineering - Vol 2 Particle Technology and Separation Processes, Fifth Edition, 2002. Butterworth & Heinemann - Elsevier science Ltd.

11FP209 FOOD ENGINEERING AND PACKAGING LAB**Credits: 0:0:2****Course Objectives:**

- To enable the students to understand the principles of food engineering and packaging.
- To enable the students to understand about the working methodology behind instruments used for food engineering and packaging applications.

Course Outcome:

- On completion of the subject, students will be able to apply their knowledge on food engineering and packaging in various food industries.

List of Experiments

1. Characteristics of dehydrated products
2. Characteristics of flaked products
3. Water vapor transmission rate of different packaging materials
4. Determination of migration characteristics of packaging materials
5. Efficiency of a scraped surface heat exchanger
6. Studies on milling characteristics of cereals
7. Determination of viscosity of given fluid using Ostwald viscometer
8. Determination of mixing index of a sigma mixer
9. Determination of overall heat transfer coefficient in tubular pasteurizer
10. Study of the drying characteristics of a cross flow drier
11. Determination of washing efficiency of a continuous washer for root crops
12. Determination of tensile strength of given packaging material
13. Determination of bursting strength of given packaging material
14. Determination of efficiency of extraction using Bollmon extractor
15. Determination of efficiency of rotary flash evaporator
16. Gas transmission rates test on flexible films.
- 17.

11FP210 TECHNOLOGY OF MEAT, POULTRY AND FISH PROCESSING**Credits: 3:0:0****Course Objectives:**

To enable the students to understand about

- Composition, nutritive value of meat, poultry and fish
- Processing technology of meat, poultry and fish
- Meat products, eggs

Course Outcome:

- On completion of the course, the student will be able to understand about how to process meat, poultry and fish, preparation of different types of products from meat, poultry and fish

Unit I: Chemistry and Microbiology of Meat

Meat composition from different sources; Definitions and measurements, Explanation of muscle structure and compositions and its modifiers, White and Red Meat, Description of animal fat and its modifiers, description of bone and its modifiers; Post mortem muscle chemistry, Meat colour, flavors of meat products, meat microbiology and safety

Unit II: Slaughtering and Carcass Processing

Modern abattoirs and some features, Ante mortem handling and welfare of animals, design of handling facilities, Hoisting rail and traveling pulley system, and stunning methods, stunning pen, slaughtering equipment, Washing area, Sticking, bleeding, dressing, Beef/Sheep and Pig Dressing operations, Offal handling and inspection, Inedible by products: Carcass processing equipment, Operational factors affecting meat quality, effects of processing on meat tenderization; meat processing equipment, electrical gadgets and manual gadgets; Typical lay outs.,

Unit III: Meat Products

Canned meat, Frozen meat, Cooked and Refrigerated meat, Dried and preserved meat, Cured meat, Prepared meat products, Production methods for Intermediate moisture and dried meat products, Different kinds of sausages – Equipment used for all the process operations; Meat plant hygiene, Good manufacturing practice and HACCP.

Unit IV: Processing of Poultry Products

Poultry industry in India, measuring the yields and quality characteristics of poultry products, microbiology of poultry meat, spoilage factors; Plant sanitation; Poultry meat processing operations in detail along with equipment used – Defeathering, bleeding, Scalding etc.; Packaging of poultry products, refrigerated storage of poultry meat, by products – eggs, egg products, Whole egg powder, Egg yolk products, their manufacture, packaging and storage.

Unit V: Fish and other Marine Products Processing

Commercially important marine products from India, Product export and its sustenance, Basic biochemistry, spoilage factors of fish, field refrigeration and icing practice, merits and demerits, Use of dry ice and liquid nitrogen as preservation elements, use of Refrigerated Sea Water (RSW) for preservation, Changes during storage in RSW and CSW; Freeze preservation; freezing of prawn and shrimp, weighing, filling and glazing, Individual quick freezing, in pack freezing, relative merits and demerits, Canning operations, Salting and drying of fish, pickling and preparation of fish protein concentrate, fish oil and other by products.

Text Book

1. Hui, Y.H., Nip, W.K., Rogers, R.W. Meat Science and Applications. Marcel Dekkar Inc. New York. 2001.

Reference Books

1. Joseph Kerry, John Kerry and David Ledwood: Meat Processing Woodhead Publishing Limited (CRC Press 2002)
2. Balachandran, K.K. Post Harvest Technology of Fish and Fish Products. Daya Publishing House, New Delhi. 2001.
3. G Mead (Editor): Poultry meat processing and quality Woodhead Publishing Limited (2004)

Credits: 4:0:0

Course Objective

- To enable the students to understand the various concepts of economics, process development, design consideration and cost estimation in food industry.

Course Outcome

- On completion of the subject, the students will be able to apply their knowledge on plant design and process development in various food industries.

Unit I Food Process Design Development

Technical feasibility survey of Food Industry, process development, Food Process flow sheets – Hygienic food process design - equipment design and specifications – Computed-aided process design – Principles of spread-sheet aided process design (Basic concepts only)

Unit II General design Consideration

Marketability of the product, availability of technology, raw materials, equipments, human resources, land and utilities, site characteristics, waste disposal, Government regulations and other legal restrictions, community factors and other factors affecting investment and production costs.

Unit III Project evaluation and Cost Estimation

Capital investments – fixed capital investments including land, building, equipments and utilities, installation costs (including equipments, instrumentation, piping, electrical installation and other utilities), working capital investments. Manufacturing costs – Direct production costs (including raw materials, human resources, maintenance and repair, operating supplies, power and other utilities, royalties, etc.). – Process Profitability - Application to a Food Processing plant e.g. Tomato processing

Unit IV Plant overheads

Administration, safety and other auxiliary services, payroll overheads, warehouse and storage facilities etc

Unit V Profitability Analysis

Return on original investment, interest rate of return, accounting for uncertainty and variations and future developments. Optimization techniques – Linear and Dynamics programming, Optimization strategies.

Text Book

1. Peters and Timmerhaus, Plant design and Economics for Chemical Engineers, McGraw Hill 5th Edition, 2004 .

Reference Books

1. Maroulis Z.B. and Saravacos G.D. Food Process Design, Marcel Dekker Inc., 2003.
2. Rudd and Watson, Strategy of Process Engineering, Wiley and Sons, 1987.

11FP212 FOOD CHEMISTRY**Credits: 3:0:0****Course Objectives:**

To enable the students to understand the chemistry and importance of water, carbohydrates, lipids, proteins and vitamins

- The importance of water and its role in structure and texture maintenance
- The role of sugars in colour and flavor development and polysaccharides in texture
- The importance of proteins in health and their role in food
- The methods of manufacture of oils and the methods of determining the quality of oils and fats
- The role of vitamins in human nutrition and the effect of various processing methods in maintaining the vitamin content in foods.

Course Outcome:

On successful completion of the subject, students will get exposure to

- The importance of water and its role in structure and texture maintenance
- The role of sugars in color and flavor development and polysaccharides in texture
- The importance of proteins in health and their role in food
- The methods of manufacture of oils and the methods of determining the quality of oils and fats
- The role of vitamins in human nutrition and the effect of various processing methods in maintaining the vitamin content in foods.

Unit I : Water and ice

Importance of water in foods. Structure of water & ice. Bound & free water, water activity (a_w) and their implications. Sorption Phenomena and Sorption isotherms, examples – Dispersed systems – some basic considerations

Chemistry of Carbohydrates: Nomenclature Classification & structure of carbohydrates, Chemical reactions of carbohydrates. Physical & chemical properties of sugars

Unit II: Chemistry of Polysaccharides

Chemistry, properties of Pectins, gums. Starch and its hydrolytic products, maltodextrins, Cellulose, Cyclodextrins, dietary fiber – soluble and detergent fiber.

Unit III : Chemistry of Lipids

Definition & classification of lipids. Basic Structures, Chemistry of fatty acids & glycerides. Components of Fatty acids, Phospholipids and unsaponifiables, Auto oxidation and hydrolysis, Physical & chemical characteristics of fats & oils, hydrogenated fats, shortening agents, confectionary fats etc. Rancidity of fats & oils, and its prevention, antioxidants. Process flow sheet for the manufacture of edible oils (refined and hydrogenated)

Unit IV : Chemistry of Proteins

Importance of Proteins. Nomenclature, classification, structure and chemistry of amino acids, peptides & Proteins. Sources and distribution of Proteins. Isolation, identification & purity of Proteins. Denaturation, Physical & chemical characteristics of Proteins.

Enzymes: Introduction, Nature, Function, classification & nomenclature of enzymes. Specificity. Amylases, Pectic Enzymes, Proteases, Immobilization of enzymes. Importance of enzymes in food industry.

Unit V : Chemistry of Vitamins

Fat soluble and water soluble vitamins – chemistry, their sources, functions, bioavailability. Reasons for loss of vitamins in food.

Text Book:

1. Belitz, H.D., Grosch, W., Schieberle, P. Food Chemistry. 4th and Revised and Extended Edition, Springer Verlag, Germany, 2009.

Reference Books:

1. Pieter Walstra: Physical Chemistry of Foods Marcel Dekker Publishing, New York. 2003.
2. Seema Yadav. Food Chemsitry. Anmol Publications Pvt. Ltd., New Delhi. 2002.

11FP213 FOOD ADDITIVES

Credits : 3:0:0

Course Objectives:

To enable the students to understand

- About food additives and determination of toxicity
- Types and chemical properties of preservatives, emulsifiers, and antioxidants
- Types and chemical properties of humectants, enzymes and starches
- Types and chemical properties of flavorants, fat substitutes
- Types and chemical properties of sweeteners, chelating agents, and anti-browning agents,

Course Outcome:

On successful completion of the subject, students will get exposure to

- Applications of food additives and how to study the toxicity of food additives

Unit I -

Introduction – Food additives - definition and classification, food safety levels as per the specifications, safety evaluation of additives – determination of acute and chronic toxicity - NOEL, ADI, LD50 value, PFA regulations, GRAS status.. Unit II

Types, chemical properties, levels of additions in individual products, toxicity data of Acidulants – Preservatives – Emulsifiers and gums - Antioxidants

Unit III

Types, chemical properties, levels of additions in individual products, toxicity data of Dough conditioners - flour improvers – Humectants

Unit IV

Types, chemical properties, levels of additions in individual products, toxicity data of Colourants – Natural and artificial, Flavourants, Flavour enhancers, Fat substitutes and replacers

Unit V

Types, chemical properties, levels of additions in individual products, toxicity data of Sweeteners – Natural and synthetic, Chelating agents, antibrowning agents, Nutritional additives

Text book

1. Food additives by Brannen A.L., Davidson P.M., Salminen S. and Thorngate J.H. Second Edition, Revised and Expanded. Marcel Dekker Inc. USA, 2002.

Reference Book:

1. Newton, D.E. Food Chemistry. An Imprint of Infobase Publications, New York. 2007.

11FP214 FRUIT AND VEGETABLE TECHNOLOGY

Credits: 3:0:0

Course Objectives:

To enable the students to understand

- Fruits and vegetables of India
- Thermal processing of fruits and vegetables
- Fruit juices
- Methods of dehydration
- Aseptic and non-thermal processing of fruits and vegetables

Course Outcome:

On successful completion of the subject, students will get exposure to

- Processing of fruits and vegetables, preparation of juices and other products from fruits and vegetables

Unit I Introduction

Production of Fruits and vegetables in India. Cause for heavy losses, Composition of each of the major fruits and vegetables produced in the country- Spoilage factors, Post harvest field operations, preservation treatments for freshly harvested fruits and vegetables, Packaging of whole fruits and vegetables for internal and export markets. General methods of preservation of whole fruits/Vegetables and processed fruits and vegetables. Processing and packaging of cut fruits and vegetables.

Unit II Canning of Fruits and Vegetables

Washing, peeling, grating, slicing dicing, deseeding. Juice and pulp extraction and clarification. Bottled Products: Preparation of products like Jams, Jellies, Marmalades, Pickles, Puree, Ketchup, Sauce, Squashes etc. - FPO specifications. Bulk preparation and storage. Different filling, closing and sterilization operations.

Canning of Vegetables. Precautions - Blanching operations - Batch and Continuous Blanching. . Concept of Hurdle technology as applied to fruit and vegetable preservation.

Unit III Processing of fruit juices

Common machinery for operations like Peeling, Slicing/Dicing, Pulping, Grating, Hydraulic Pressing and Clarification.

Preparation of specialty products like, Fruit juice concentrates, Fruit Bars and Fruit powders. Clarification of juices, Viscosity problems. Tomato products – Hot and Cold Break processes.

Tomato Deseeding and clarification. Mango Pulp extraction and concentrations. Clarification centrifuges – Decanters and desludgers. Fruit juice aroma Recovery and its importance. Overview of Aroma Recovery equipment.

Unit IV Dehydration

Dehydration principles and equipment used for drying. Cross Flow Shelf Dryers, Vacuum Shelf Dryers, Freeze Dryers. Freeze drying Principles. Merits and demerits of Freeze Drying. Preparation of Fruit Powders. Working of Spray Dryer and Drum Dryer. Preparation of Fruit material for powder production. Packaging of Dried slices, Dices and powder. Intermediate Moisture Food.

Unit V Aseptic and other methods of processing

Aseptic processing and Bulk packing of Fruit juice concentrates, Pulps and Puree Brief information on Asepticity and how it is strictly maintained in the plant. Aseptic heat exchangers for sterilizing and concentrating the product. Aseptic fillers. Different system of filling practiced. Tetra pack for small quantities, Dole system and Scholle system for bulk storage in Bag and Boxes and Bag & Drums. Storage of Aseptically packed products.

Minimal processing – Basic concepts, Reverse osmosis

Text Book

1. Y.H.Hui and Others: Hand Book of Vegetable Preservation and Processing. Marcel Dekker New York 2004

Reference Books

1. Chakraverty, A., Mujumdar A.S., Raghavan G.S.V and Ramaswamy H.S. Handbook of Post-harvest Technology: Marcel Dekker Press, USA (2001)
2. Srivastava, R.P. and Kumar, S.: Fruit and Vegetable Preservation: Principles and Practices. International Book Distributing Co. Lucknow (2nd Edition 1998).

11FP215 CEREAL AND PULSES TECHNOLOGY

Credits: 3:0:0

Course Objectives:

To enable the students to understand

- Processing of paddy
- Processing of rice, millets, pulses
- Storage of cereals

Course Outcome:

- On successful completion of the subject, students will get exposure about Processing of cereals, and how to store it.

Unit I Paddy Processing and Byproducts Utilization :

Paddy Varieties, Their Composition and Quality characteristics. Curing of Paddy. Parboiling Processes, Cold Water soaking and Hot water soaking processes, Paddy Dryer-LSU Dryer. By Products of Paddy Processing - Paddy husk and its uses - as boiler fuel, husk ash, activated carbon, furfural and other by products. Production of Flattened Rice and Puffed Rice from Paddy

Unit II Rice Milling:

Paddy Dehusking Processes. Rice Mill Flow Chart. Engelberg Huller Mills, Modern Rice Mills. Components of modern Rice mill, Pre Cleaners, Shellers, Under Runner Shellers and Centrifugal Shellers, Paddy Separators – Satake and Schule Designs, Polishers-Cone polishers and other types, Bran and Brokens separators. Rice Mill yields and loss due to brokens at different stages of milling. Rice Mill machinery handling. Use of Rice Bran in Edible oil Industry.

Unit III Milling of Pulses:

Traditional milling process, merits and demerits, Drying of legumes, Sun drying, Pre-cleaning, Pitting, Oil application, conditioning, Dehusking and splitting, Machinery and equipment employed, mass balance, losses during milling; Modern milling process, Mechanical hot air drying and conditioning, Dehusking in Pulse Pearler, Water conditioning, splitting of pulses in Pulse splitter, Grinding of split pulses, pulse flour products, their applications, equipment used.

Unit IV Milling and Processing of Maize:

Pre-cleaning, cleaning equipment, Degermination and Dehusking, Roller milling, Sifting, Purifying, Aspiration, Pneumatics in a maize mill. Products of milling-Flour, Semolina, Brewers' grits etc. and their applications. Dry and Wet Milling Processes. Gluten and Starch Separation, extraction process; Equipments needed for Degermination, Debranning and starch separation - Value added products, Acid Hydrolysis, Enzyme Hydrolysis, Isomerization processes, Processing for Dextrose, Malto Dextrin and other products. Extraction and refining of Corn oil in brief.

Unit V Grain Storage and Handling:

Bag Storage - structure design, Cover and Plinth Storage Structures, Dunnage, Materials for Dunnage, Pallets, Protection against rodents and pests. Fumigation Processes for bag storage piles, Bulk Storage in silos and large Bins; Construction of Silos, Physical load and mechanical strength of Silos, concrete and Metal Silos. In silo Aeration and Drying, Problems of Dust Explosion in Grain Storages, Quality Changes of Grains during storages and remedial measures to prevent unwanted quality changes.

Text Book:

1. Karel Kulp and Joseph P Pante:Hand Book Of Cereal Science and Technology
Mercel Dekkar USA (2000)

Reference Books:

1. Owens, G. Cereals Processing Technology. CRC Press. 2001.
2. Dendy, D.A.V., Dobraszczyk, B.J. Cereals and Cereal Products – Chemistry and Technology. Aspen Publishers Inc., USA. 2001.

11FP216 SUGAR AND CONFECTIONERY TECHNOLOGY**Credits: 3:0:0****Course Objectives:**

To enable the students to understand about

- Sugarcane and its cultivation and processing
- Sugar production methodology
- Alcoholic beverages
- Carbonated beverages

- confectionery

Course Outcome:

- On successful completion of the subject, students will get exposure about Sugarcane and how to utilize sugarcane products in food industry, manufacturing of alcoholic beverages, confectionery products.

Unit I Introduction

Sugarcane and beet as sugar raw materials. Manufacture and properties of Granulated and Liquid sugars. Invert sugar and their characteristics. Specialty products of Sugar Industry. Back strap Molasses and its uses.

Unit II Sugar production process details:

Energy and material balance of cane sugar process. Extraction of juice, extraction yields, drying and uses of Bagasse, Purification of juices-juice filtration and chemical purification, Clarification stages, Lime addition, pH control, Treatment of clarified juice, evaporation –multiple effect evaporators, Vacuum pans, Crystallization, Washing of sugar crystals and centrifugal separation/dewatering of sugar and other related processes. Sugar Refining, Sugar analysis, Sugar recovery –improvement, /Sugar balance, energy conservation, Sugar plant sanitation.

Unit III : Technology of Alcoholic Beverages

Manufacture of beer, wine and champagne - Quality characteristics

Manufacture of distilled beverages including whisky, brandy, rum and gin – Quality aspects

Unit IV : Technology of Carbonated Beverages and Confectionery

Manufacture of carbonated beverages – quality aspects – Manufacture of sugar-free, sugar-less carbonated beverages.

Confectionery manufacture

General technical aspects of industrial sugar confectionery manufacture, Manufacture of high boiled sweets – Ingredients, Methods of manufacture – Types – Center filled, lollipops, coextruded products. Manufacturing technology of gums and jellies – Quality aspects

Unit V : Manufacture of Miscellaneous Products

Caramel, Toffee and fudge – Liquorice paste and aerated confectionery, Lozenges, sugar pannings and Chewing gum, Countlines - Quality aspects

Text Book

1. E.B. Jackson: Sugar Confectionery Manufacture, Second edition, Aspen publishers Inc., 1999. Great Britain

Reference Books

- 1 Maurice Shachman, Soft Drinks Companion: A Technical Handbook for the Beverage Industry, CRC **press**, Florida, USA (2005)
- 2 Minifie, B.W. Chocolate, cocoa and confectionery – Science and Technology. 3rd Edition, Aspen Publishers Inc., Great Britain. 2010.

11FP217 DAIRY TECHNOLOGY

Credits: 3:0:0

Objectives:

To enable the students to understand about

Academic Information

- Milk, milk processing methodologies, milk products (ice creams, fermented milk products)

Outcome: On successful completion of the subject, students will get exposure about

- Milk and how it get processed using various thermal processing methods, fermented and non-fermented products produced utilizing milk as a major substrate.

Unit I Dairy Chemistry and Microbiology

Introduction, Basic dairy terminology, milk as raw material, composition, food value, contaminants, milk reception in dairies and tests, Quality and Quantity tests at reception, Cell count and other tests, Milk transport and storage in dairy plants, Cholesterol, fatty acids and their relation to cardiovascular diseases – Dietary recommendations – Applications of enzymes in dairy industry

Unit II Dairy Processing Equipments

Milk processing terminology, Processing flow sheet, Equipment employed, Pasteurisers – HTST, LTLT, UHT methods, Plant piping, Pumps, Cream separating Centrifuges, Clarifiers, Homogenizers, Bottle and pouch fillers, Milk Chillers, Ice Cream Freezers. Vacuum Evaporators, Spray and Drum Dryers, Product instantizing equipment. Packaging of milk in bottles and sachets, Form – fill packs.

Unit III Manufacture of Dairy Products

Cheese – Types of cheese, Defects in cheese, Manufacture of paneer, Different types of processed milk, Khoa, Milk powder – Quality aspects

Unit IV Manufacture of Ice Cream and other Dairy Products

Manufacture of Ice cream – Chemistry and technology –Microbiology of ice cream - Quality aspects

Manufacture of Butter, Ghee – Grading of butter - Quality aspects

Extraction of casein from milk, properties, composition and industrial uses

Production of lactose and whey

Unit V Fermented dairy products

Fermented products – Yoghurt, Curd, acidophilus milk etc.- Concept of Probiotics and prebiotic foods, Energy use in Dairy plant, sources of energy, cost of energy, Control of energy losses and Energy conservation.

Text Book

Sukumar De. Outlines of Dairy Technology, Oxford University Press. 2001.

Reference Books

1. Garret Smit. G., Dairy Processing. Woodhead Publishing Limited, England. 2005.
2. Edger Spreer: Milk and Dairy Product Technology Marcel Dekkar Inc. New York, USA (2005)

11FP218 FOOD PACKAGING TECHNOLOGY

Credits: 3:0:0

Course Objective

To enable the students to understand about

- Packaging and packaging materials, interaction of food items with packaging materials

Course Outcome

- On successful completion of the subject, students will get exposure about how to package the food items using different techniques, how to use cans and films for packaging and its properties, how food items are interacting with packaging materials.

Unit I : Introduction to Food Packaging:

Functions of packaging, Effect of environmental factors - light, Oxygen, Moisture, Temperature, mechanical forces and biological factors on quality of food. Estimation of shelf life. General Approach, analysis of storage requirement, accelerated storage studies: Vacuum and Inert Gas Packaging: Tests on packaging materials, Mechanical strength (Tension, notch and tearing strengths), Gas and water vapour transmission rates.

Unit II : Metal Cans as Packaging

Metallic can types - Tin cans and Aluminum cans. Specialty of Open top sanitary cans, Lacquers and their use, Three piece cans and Two piece cans, Aerosol Cans, Basics of Canning operations – Can Reformer, Flanger, Seaming, Can closures. Glass jars and Bottles in food packaging, Design features and applications, Sterilization of bottles.

Unit III : Flexible Films Packaging

Formation of Films and pouches, Plastics used and their Specific applications - Polyethylene (LDPE and HDPE), Cellulose, Polypropylene (PP), Polyesters, Polyvinylidene Chloride (PVDC - Diofan, Ixan and Saran), Polyvinyl chloride, Copolymers their applications. Co-extruded films and Laminates. Rigid and Semi rigid plastic packaging –Fabrication methods – Thermo forming, Blow moulding, Injection moulding, Extrusion – Retort pouch packaging. Laminated Paper board Cartons, Fibre Board and Corrugated Card Board packaging and their applications.

Unit IV : Filling and Sealing Operations for various types of packages.

Closing and sealing of Rigid plastic containers. Filling and sealing of Flexible plastic containers, Seal types-Bead seals, Lap Seals and Fin seals –Differences and advantages, Hot wire sealing, hot bar sealing and impulse sealing – differences and relative advantages, Form fill Seal equipment: Printing on packages, Bar codes, Nutrition labeling and legislative requirements. Filling and Sealing of pouches, pouch from fill seal machines.

Unit V : Interaction of Food Material with Packaging Material

Active packaging, Moisture control, CO₂ and Oxygen scavenging, Modified atmosphere packaging – principles, applications. Permeability of gases in packs. Speciality packages.

Text Book

1. Coles, R., Dowell, D.M., Kirwan, J. Food Packaging Technology. Black Well Publishing Ltd., 2003.

Reference Books

1. NIIR Board: Food Packaging Technology Handbook National Institute of Industrial Research, New Delhi (2004)
2. O.G.Pirenger and A.L.Baver: Plastic Packaging Materials for Food Wiley VCH, GmbH, Germany (2000)

11FP219 MILLING AND BAKERY TECHNOLOGY**Credits: 3:0:0****Course Objectives:**

To enable the students to understand about

- Wheat and its processing, market value of wheat products
- Bakery technology, instruments used in bakery technology
- Types of biscuits and its manufacturing technology

Course Outcome:

- On successful completion of the subject, students will get exposure about how to process wheat and how to produce different products using wheat flour

Unit I: Fundamentals of Market Analysis for Wheat and Wheat Products:

Laboratory testing of Wheat grain Quality, Moisture tests, Grain hardness testing. Testing of wheat flour for bread making and Chapathi making, Visco graph, Amylograph, Farinograph and other tests and their significance in bread manufacture.

Unit II: Outline of the Wheat Milling Process

Wheat milling Flow sheet, explanation of steps in milling operations of milling; Cleaning, Sifters, Destoners, Wet Washing, Roller milling – Break rolls, fluted rolls and plane rollers and their applications, Sifting and purifying, plan sifters; Extraction, milling for Atta, Semolina of different particle size, Maida and other products. Pneumatic conveying of products, By products of wheat mill, Grits and Bran, Extruded macaroni products from Wheat semolina.

Unit III: Bakery Equipment and Engineering

Bulk handling of ingredients, Weighing and metering equipment, Dough mixing and mixers, Dividing, rounding, sheeting, and laminating, Fermentation enclosures and brew equipment, Forming and molding bread-like products, Forming cookies, crackers and other products, Ovens and baking, Fryers and frying, Pans, pan handling equipment, and Slicers, Applicators for adjuncts, Packaging materials and equipment; Preservation methods, Computerization in plant and laboratory, Sanitation and safety.

Unit IV: Baking Technology

Bread manufacturing process – Straight dough fermentation, Sponge and dough, Accelerated processing, Chorley wood bread process, Dough retarding and freezing – Specialty fermented goods- Part-baked breads, Yeast laminated products, Ingredients for baking.

Unit V: Biscuits and Cake Manufacture

Biscuits – Ingredients and flour specification - Types of biscuit doughs – Developed doughs, short doughs, semi-sweet, enzyme modified doughs and batters- importance of the consistency of the dough – Layered Products (Wafers).

Cake manufacture – Flour specification – ingredients – manufacturing process – types of chemically aerated goods

Text Book

1. Hui, Y.H. Bakery Products – Science and Technology. Blackwell Publishing Limited, UK. 2006.

Reference Books

1. Stanley P. Cauvein: Bread Making – Improving Quality Woodhead Publishing (CRC Press 2003)
2. Chakraverty, A., Mujumdar, A.S., Raghavan, G.S.V., Ramaswamy, H.S. Handbook of post harvest technology – cereals, fruits, vegetables, tea and spices. Marcel Dekker Inc., New York (Special Indian Reprint). 2010.

11FP220 PLANTATION PRODUCTS AND SPICES TECHNOLOGY**Credits: 3:0:0****Course Objectives:**

To enable the students to understand about

- Coffee and its processing techniques, instant coffee, and quality grading
- Different types of tea and its manufacturing techniques, instant tea, quality parameters of tea
- Cocoa and its processing, chocolate manufacturing technology
- Processing and chemistry of major spices
- Processing and chemistry of minor spices

Course Outcome:

- On completion of the subject, students will be able to understand the processing steps involved for different plantation products and spices.

Unit I : Chemistry and Technology of Coffee

Coffee – Occurrence – chemical constituents – harvesting – fermentation of coffee beans – changes taking place during fermentation – drying – roasting – Process flow sheet for the manufacture of coffee powder – Instant coffee, technology – Chicory chemistry - Quality grading of coffee

Unit II : Tea – Chemistry and Technology

Occurrence – chemistry of constituents – harvesting – types of tea – green, oolong and CTC – Chemistry and technology of CTC tea – Manufacturing process – Green tea manufacture – Instant tea manufacture – Grading of tea

Unit III : Chemistry and Technology of Cocoa and Cocoa Products

Occurrence – Chemistry of the cocoa bean – changes taking place during fermentation of cocoa bean – Processing of cocoa bean – cocoa powder – cocoa liquor manufacture
Chocolates – Types – Chemistry and technology of chocolate manufacture – Quality control of chocolates

Unit IV : Chemistry and Technology of Major Spices

Pepper, Cardamom, ginger, Chilli, mint, and turmeric – Oleoresins and essential oils – Method of manufacture – Chemistry of the volatiles – Enzymatic synthesis of flavor identicals - Quality control

Unit V : Chemistry and Technology of Minor Spices

Cumin, Coriander, Cinnamon, fenugreek, Garlic, Clove and Vanilla - Oleoresins and essential oils – Method of manufacture – Chemistry of the volatiles – Quality control
Synthesis of volatiles using micro-organisms, plant suspension cultures.

Text Book

1. Peter, K.V. Hand book of herbs and spices. Volume 2. Woodhead publishing Ltd., 2004.

Reference Books

1. Tainter, D.R. Grenis, A.T. Spices and Seasonings – A food technology hand book. 2nd edition. John Wiley and Sons, Inc., Canada. 2001.
2. Chakraverty, A., Mujumdar, A.S., Raghavan, G.S.V., Ramaswamy, H.S. Handbook of post harvest technology – cereals, fruits, vegetables, tea and spices. Marcel Dekker Inc., New York (Special Indian Reprint). 2010.

11FP221 ENGINEERING PROPERTIES OF FOOD MATERIALS**Credits: 3:0:0****Course Objectives:**

- To study the various engineering properties of food materials under different conditions.
- To study about the different methods of determining the quality and properties of different foods

Course Outcome:

- On completion of the subject, the students will be able to design food processing equipments and gain knowledge on process development of new food products.

Unit I: Physical Properties and frictional properties of Foods

Methods of estimation of - Shape, size, volume, density, porosity, surface area, moisture content, equilibrium moisture content, water activity. Sorption Isotherm and its determination.

Friction, Static and kinetic friction, and angle of repose. Mechanical properties

Unit II: Rheological Properties of Foods

Rheological Classification and models, Viscosity – effect of temperature on viscosity, Newtonian and Non Newtonian fluids – two parameter model – evaluation of rheological parameters, measurement of viscosity – capillary tube viscometer – plate and cone viscometer – coaxial cylinder viscometer. Texture measuring instruments, Hardness and brittleness of food materials.

Unit III: Thermal Properties of Foods

Definitions - specific heat, enthalpy, conductivity and diffusivity, surface heat transfer coefficient. Measurement of thermal properties like specific heat, enthalpy, conductivity and diffusivity;

Unit IV: Aerodynamic and hydrodynamic properties of Foods

Drag and lift coefficient, friction drag, pressure drag, terminal velocity and their application in the handling and separation of foreign materials, pneumatic handling and transportation.

Unit V: Electrical properties of foods

Dielectric properties – resistance and capacitance, dielectric constant and loss factor, electric energy transmission properties, Electro-magnetic field effects, Dielectric measurements, Polar solvents, Ionic solutions.

Text Book

1. Rao, M.A. Rizvi, S.S.H., and Datta, A.K. Engineering Properties of Foods. Taylor and Francis, USA, 2005.

Reference Books

1. Serpil Sahin, and Sumnu. Physical properties of Foods. Springer Science + Business Media LLC, USA. 2006.
2. M.J.Lewis: Physical Properties of Foods and Food Processing Systems Woodhead Publishing Cambridge, UK (1990)

11FP222 ANALYSIS OF FOOD LAB – 1

Credits: 0:0:2

Course Objective:

- To learn about analysis of various food components.

Course Outcome:

- The students will develop practical skill in analyzing various food components available in various food materials.

List of experiments

1. Analysis of Honey for total and reducing sugars
2. Analysis of Milk – Lactose and Fructose content
3. Analysis of Fat content of edible oil seeds.
4. Analysis of Wheat flour
5. Analysis of Ghee & Butter – Reichert Meissel and Polenske Values
6. Analysis of Ghee & Butter – Baryta number
7. Analysis of caffeine in Coffee
8. Analysis of alcohol content in Beer
9. Analysis of instant premixes
10. Analysis of spices – Pepper & Ginger
11. Determination of Biological Oxygen Demand
12. Determination of chemical oxygen demand

11FP223 ANALYSIS OF FOOD LAB– 2

Credits: 0:0:2

Course Objective:

- To learn about analysis of various food components.

Course Outcome:

- The students will develop practical skill in analyzing various food components available in various food materials.

List of experiments (food additives)

1. Determination of moisture content in butter
2. Determination of sodium chloride in dried fish
3. Estimation of pectic substances in fruit based product

4. Estimation of total sugar and reducing sugar
5. Estimation of free fatty acid content in milk powder
6. Estimation of benzoic acid
7. Estimation of curcumin content in turmeric
8. Estimation of acid insoluble ash in cereal products
9. Estimation of salt in butter
10. Estimation of saccharin in beverages
11. Estimation of free sulphur di oxide in fruit products
12. Estimation of caffeine

11FP224 FOOD PRODUCT TECHNOLOGY LAB – 1

Credits: 0:0:2

Course Objective

- To study about the technology behind various food products.

Course Outcome

- On completion of the subject, the students will be able to develop new food products based on the knowledge gained.

Experiments

1. Preparation of RTS beverage
2. Preparation of squash
3. Preparation of cordial
4. Preparation of Jam and jellies
5. Preparation of marmalade
6. Preparation of ketchup
7. Preparation of basic bread
8. Preparation of French bread
9. Preparation of sweet atta biscuit
10. Preparation of butter scotch cookies
11. Preparation of sweet biscuits
12. Preparation of salt biscuits
13. Preparation of angel cake
14. Preparation of pound cake
15. Preparation of sponge cake
16. Preparation of rusks

11FP225 ENZYMOLOGY LAB

Credits: 0:0:2

Course Objective

- To study the characteristics of various enzymes applicable in food industries.

Course Outcome

- On completion of the subject, the students will be able to estimate the enzyme activity and to characterize the enzymes applicable in food industries.

List of experiments

Academic Information

1. Estimation of reducing sugars by dinitrosalicylic acid
2. Estimation of amylase activity
3. Effect of pH on amylase activity
4. Effect of temperature on amylase activity
5. Effect of substrate concentration on amylase activity
6. Effect of enzyme concentration on amylase activity
7. Determination of total and specific activity of amylase
8. Estimation of protein by Lowry's method
9. Estimation of protease activity
10. Effect of pH on protease activity
11. Effect of temperature on protease activity
12. Effect of substrate concentration on protease activity
13. Effect of enzyme concentration on protease activity
14. Determination of total and specific activity of protease

11FP226 ANALYSIS OF FOOD PRODUCTS OF PLANT ORIGIN LAB

Credits: 0:0:2

Course Objective

- To enable the students to develop practical skills to analyse various constituents in food products based on plants.

Course Outcome

- On completion of the subject, students will be able to analyse the biomolecules present in food products based on plants.

Experiments

1. Analysis of total sugars in jam
2. Analysis of reducing sugars in jam
3. Determination of acidity in fruit juices
4. Determination of total fruit solids in sauces
5. Determination of pectin content of jam
6. Determination of total ash in jaggery
7. Estimation of lycopene in tomato
8. Estimation of carotenes in a fruit
9. Estimation of anthocyanins and chlorophyll in a plant product
10. Estimation of saccharin and ascorbic acid in fruit beverage
11. Estimation of polyphenol in a plant product
12. Estimation of sulphur di oxide in fruit beverage
13. Estimation of iron and copper in a plant product
14. Analysis of tannins in black tea

11FP227 ANALYSIS OF FOOD PRODUCTS OF ANIMAL ORIGIN LAB

Credits: 0:0:2

Course Objective

Academic Information

- To enable the students to develop practical skills to analyse various constituents in food products based on animals.

Course Outcome

- On completion of the subject, students will be able to analyse the biomolecules present in food products based on animals.

Experiments

1. Estimation of fat in milk
2. Determination of alpha-amino acid content by Sorensons Formal titration
3. Estimation of curcumin in turmeric
4. Estimation of cholesterol
5. Estimation of salt in dried fish
6. Estimation of saponification value of an oil
7. Estimation of iodine value of butter
8. Determination of moisture content of spices
9. Determination of total volatile oil by Clavenger apparatus
10. Analysis of total extractives and ash content of tea
11. Determination of caffeine content of coffee
12. Determination of Scoville's index of capsaicin

11FP228 FOOD PRODUCT TECHNOLOGY LAB –II

Credits: 0:0:2

Course Objective

- To enable the students to understand the technology behind the manufacturing of various food products.

Course Outcome

- On completion of the subject, the students will be able to develop the food products based on their knowledge gained.

Experiments

1. Preparation of Rasagulla
2. Preparation of Sandesh
3. Preparation of Paneer
4. Preparation of Kalakhand
5. Preparation of Peda
6. Preparation of Gulab Jamun
7. Preparation of Bread and Butter Pickle
8. Preparation of Hot and Sour Tomato Pickle
9. Preparation of Chilly and Ginger Pickle
10. Preparation of Soanpapdi
11. Preparation of Mysorepak
12. Preparation of Gummies
13. Preparation of aerated confectionery

11FP229 FOOD REFRIGERATION AND COLD STORAGE CONSTRUCTION

Credits: 3:0:0

Objective

- To enable the students to understand the various concepts behind refrigeration and storage construction.

Course Outcome

- On completion of the subject, the students will be able to apply their knowledge on cold storage of perishable products.

Unit I Principles of Refrigeration

Refrigeration – Ton of refrigeration, refrigeration cycles, Vapour Compression and Vapour Absorption cycles, Refrigerants, characteristics of different refrigerants, net refrigerating effect - Components of a Refrigeration system: Compressor, condenser, Evaporator, Expansion valves piping and different controls. Atmospheric air and its properties, Psychometrics.

Unit II Cold Storage Design and Construction

Cold Room temperatures, Insulation, properties of insulating materials, air diffusion equipment, Doors and other openings. 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. Cold Storage practice, Stacking and handling of materials, Optimum temperatures of storage for different food materials.

Unit III Operation and maintenance - Controlled atmosphere and modified atmosphere storages

Operation and maintenance, Cleanliness, defrosting practices, preventive maintenance, safety Measures. Controlled atmosphere and Modified atmosphere storages. Principles and basics of their construction. Concept of cold chain supply.

Unit IV Chilling of Foods

Chilling equipment for liquid foods. Secondary refrigerants and direct expansion techniques in chilling. Chilled foods transport and display cabinets - Basics of Chilled foods microbiology, Packaging of Chilled foods - Hygienic design considerations for chillers and chilled Storages. Cool storages and their applications. Evaporative cooling and its applications

Unit V Freezing of foods

Freezing equipment, Freezing rates, growth rate of ice crystals, crystal size and its effect of texture and quality of foods, Freezer types, Blast freezers, Contact Plate Freezers, conveyORIZED quick freezers, Individual quick freezing. Cryogenic Freezing, Freezing practice as applied to marine foods, meat and poultry, fruits and vegetables.

Text Book

1. Clive D.J.Dellino: Cold and Chilled Storage Technology Publisher: Kluwer Academic Publishers (1997)

Reference Books

1. Colin Dennis and Michael Stringer: Chilled Foods – A Comprehensive Guide Ellis Horwood Publishing, New york (1992)
2. J.S.Pruthi: Quick Freezing Preservation of Foods (2 Volumes) Allied Publishers,

11FP230 RADIATION PRESERVATION AND PROCESSING OF FOOD PRODUCTS

Credit: 3:0:0

Course Objectives:

- To study the importance of non-thermal methods like irradiation as an alternative to the conventional methods of processing.
- To study the effect of radiation as a processing and preservation method
- To study the importance and safety issues of the irradiated foods

Course Outcome

- On completion of the subject, the students will gain knowledge about irradiation and safety measures to be followed and its application in food industries.

Unit I Basics of Radiation Chemistry

Electromagnetic energy, ionizing radiation, Concept of radiation, dielectric properties, ionization and excitation, Radiation chemistry basics - primary chemical effects and secondary effects on food, G value, irradiation parameters, instruments for measuring radiation, effect of food irradiation and potentialities for radiation processing of foods.

Unit II Radiation Chemistry of Food Components

Basics-carbohydrates, proteins, lipids, vitamins etc. Radiation effect on contaminating microorganisms like bacteria, viruses, yeasts and molds - Dosages of radiation for various plant foods and animal foods-meat and poultry, fruits, vegetables, spices, dairy products; Radiation equipment, salient features; Packaging of irradiated foods and safety issues.

Unit III Microwaves In Food Processing

Microwave heating, nature of energy, batch and continuous ovens, microwave generators, wave guides, brief description of oven construction, application of microwave radiation and safety measures.

Unit IV Infra red Radiation

Absorption and scattering characteristics of various food materials, Polarization characteristics of IR radiation, Propagation of IR radiation in food stuffs. IR generators, applications, Relative merits and demerits.

Unit V Radio Frequency Heating Principles

RF heating equipment, Advantages of Radio frequency heating of foods - Ultra violet radiation and its effect on microorganisms in foods - UV treatment application and equipment.

Text Book

1. Molins, R. Food Irradiation – Principles and Applications. John Wiley and Sons Inc., New York. 2001.

Reference Books

1. Welter M. Urbain: Food Irradiation Academic Press, New York (1986)
2. Wilkinson Guild: Food Irradiation – A Reference Guide Woodhead Publishing, Cambridge, UK (1996)

11FP231 EMERGING TECHNOLOGIES IN FOOD PROCESSING**Credits: 3:0:0****Course Objectives**

To enable the student to understand:

- Emerging / alternative technologies applied to food processing
- Relative advantages / disadvantages over existing technologies
- Economics and commercialization of newer technologies
- Strategies for applying the same to a wide range of food

Course Outcome

- On completion of the subject, the students will be able to apply their knowledge on high pressure processing, pulsed electric processing of food, irradiation and hurdle technology in various food industries

Unit I High pressure processing of Foods

Principles – applications to food systems – effect on quality – textural, nutritional and microbiological quality – factors affecting the quality – modeling of high pressure processes – High Pressure Freezing, Principles and Applications

Unit II Pulsed electric field processing of Foods

Principles – Mechanism of action – PEF treatment systems – Main processing parameters – PEF Technology – Equipments – Mechanism of microbial and enzyme inactivation- safety aspects– Processing of liquid foods using PEF – Process models – Comparison of High pressure processing and PEF – Enzymatic Inactivation by PEF, Examples – Microbiological and chemical safety of PEF foods

Unit III Osmotic dehydration of Foods

Principle – Mechanism of osmotic dehydration – Effect of process parameters on mass transfer – Methods to increase the rate of mass transfer – Applications – Limitations of osmotic dehydration – Management of osmotic solutions

Unit IV Ohmic and Ultrasound Processing of Foods

Principle of ultrasound – Fundamentals – Ultrasound as a processing and preservation aid – Effect on properties of foods
Basics of ohmic heating – Electrical conductivity - generic configurations- treatment of products

Unit V Hurdle technology

Basics of hurdle technology – Mechanism
Application to foods - Newer Chemical and Biochemical hurdles- organic acids – Plant derived antimicrobials – Antimicrobial enzymes – bacteriocins – chitin / chitosan (only one representative example for each group of chemical and biochemical hurdle)

Text Book

1. Nonthermal Preservation of Foods. Gustavo V. Barbosa-canovas, Usha R. Pothakamury, Enrique palou and barry G. Swanson. Published by Marcel Dekker, Inc.; 270 Madison Avenue, New York 10016; 1998.

Reference Books

1. Handbook of Food Preservation. M. Shafiur Rahman. Published by Marcel Dekker, Inc. NY. 2006
2. Emerging Technologies for Food Processing. Da-Wen Sun. Published by Elsevier Academic Press, UK.2005.

11FP232 ECONOMICS AND FOOD INDUSTRY MANAGEMENT

Credits: 4:0:0

Course Objective

- To enable the students to understand the concepts of economics and management activities of a food industry.

Course Outcome

- On completion of the subject, the students will be able to apply their knowledge to become a food industry entrepreneur.

Unit I Profiles of Food Processing Industries in India

Industrial production and growth rate in food processing sector, Opportunities and Threats; Entrepreneurship; Concept/Meaning, Need, Competencies/qualities of an entrepreneur; Entrepreneurial Support System; District Industry Centres (DICs), Commercial Banks, State Financial Corporations, Small Industries Service Institutes (SISIs), Small Industries Development Bank of India (SIDBI), National Bank for Agriculture and Rural Development (NABARD), National Small Industries Corporation (NSIC), Khadi Village and Industries Commission (KVIC), other relevant institutions /organizations/NGOs at State level

Market Survey and Opportunity Identification (Business Planning)

How to start a small scale industry, Procedures for registration of small scale industry, List of items reserved for exclusive manufacture in small scale industry, Assessment of demand and supply in potential areas of growth, Considerations in product selection, Data collection for setting up small ventures, Project Report Preparation , Preliminary Project Report, Techno-Economic feasibility report
Project Viability, Managerial Aspects of Small Business

Unit II Principles of Management

Definition, functions of management viz. planning, organization, coordination and control, Operational Aspects of Production, Inventory Management, Personnel Management, Importance of Communication in business Legal Aspects of Small Business, Elementary knowledge of Income Tax, Sales Tax, Patent Rules, Excise Rules

Unit III Factory Act and Payment of Wages Act

Environmental considerations, Concept of ecology and environment, Factors contributing to Air, Water, Noise pollution, Air, water and noise pollution standards and control; Personal Protection Equipment (PPEs) for safety at work places, Human relations and performance in organization, Industrial Relations and Disputes

Unit IV Preparation of Financial Statements

Classification of accounts, double book entry: Financial analysis, Significance and limitations of financial statements, Financial statement analysis, Ratio analysis, Profitability, Solvency and

activity ratios, Fund flow statements, Working capital and changes in working capital, preparation of cash flow statements, Significance of fund flow and cash flow statements.

Unit V Project and Product Costing

Elements of costing, preparation of cost sheets, Budgeting and budgetary controls, Product costing, Break even and sensitivity analysis, rates of returns. Capital costing, pay back periods, discounted cash flow analysis, Depreciation analysis. Related financial skills

Text Book

1. BS Rathore and Dr JS Saini Aapga (Editors): A Handbook of Entrepreneurship, Panchkula Publications, Haryana, 1999.

Reference Books

1. Reddy, P.N. and Appannaiah, H.R. Management Accounting. Himalaya Publishing House, Bombay, 1997.
2. Gupta, C.B. and Srinivasan, P. Entrepreneurship Development In India. Sultan Chand and Sons, New Delhi, 1997.

11FP301 MASS TRANSFER PROCESSES IN FOOD ENGINEERING

Credits : 4:0:0

Course Objective:

- To enable the student to understand the importance of mass transfer processes in food engineering applications.

Course Outcome

- On completion of the syllabus, the students will be able to apply their knowledge on distillation, evaporation, separation and super critical fluid extraction processes in various food industries.

Unit I: Basic Principles of separation processes

Basic principles of food processing SI system of basics units, Conservation of mass and materials balances, energy and heat units, conservation of energy and heat balances Units and dimensions of engineering parameters, dimensionless ratios, and calculations involving various physical parameters.

Unit II: Vapor liquid separation processes

Vapor- liquid equilibrium relations, single stage equilibrium contact for vapor liquid system, relative volatility of vapor liquid system Distillation , Steam distillation, applications and equipment, Mass transfer phenomenon applied to food systems

Unit III: Evaporation

Needs, basic principles, Single and multiple effect evaporation, Heat economy, Vapour recompression, Thermo and mechanical systems, boiling point elevation, Falling film, climbing film tubular evaporators, plate evaporators, thin film and scraped surface evaporators.

Unit IV: Gas liquid Separation Processes

Concentrations, Gas-liquid equilibria, Solid liquid equilibria, Equilibrium concentration relationships, operating conditions; Basics of Solid-liquid extraction processes, liquid-liquid extraction, with food application examples

Unit V: Extraction and Leaching

Mechanical extraction – Expellers, screw press, filter press.

Liquid-liquid extraction, liquid-solid extraction, phase diagram determination of extraction steps by McCabe-Thiele method.

Super critical Fluid extraction - Super critical Fluid State, Properties of Super critical CO₂ , Density, Viscosity, Volatility etc. Supercritical Phase Equilibria, Solubility, SCFE systems and components, Applications; extraction of Fatty acids, oleoresins and essential oils; Relative advantages, limitations and economics

Text Books

- 1 Christie John Geankoplis: Transport process and separation process principles-4th edition, PHI learning private limited New Delhi 2008.
- 2 McCabe, W.L., Smith, J.C., and Harriott, P. Unit operations of chemical engineering. 7th edn., 2005. McGrawhill Intl. Edition, Singapore.

Reference Books

1. J.M. Coulson, J.F. Richardson, J.H. Harker - Coulson & Richardson's Chemical Engineering – Vol. 2 Particle Technology and Separation Processes, Fifth Edition, 2002. Butterworth & Heinemann - Elsevier science Ltd.
2. H.S. Ramaswamy & M. Markotte: Food Processing Principles and Applications, CRC Press Ltd., 2006.

11FP302 SEPARATION PROCESSES IN FOOD ENGINEERING

Credits: 4:0:0

Course Objectives

- To enable the students to understand the concepts of separation of solids and liquids in the food engineering application.

Course Outcome:

- On completion of the subject, the students will be able to apply their knowledge on filtration technique, design of centrifuge, RO system in the food industries.

Unit I: Basic principles of fluid flow

Pressure head in fluids-devices to measure pressures- U tube manometer- Pitot tube, types of flow-laminar-turbulent, simple mass balance and continuity equation, pressure drop due to friction, drag coefficient, flow in packed beds.

Unit II: Mechanical Separations

Mechanical separation-screensers - sedimentation, gravity sedimentation, Sedimentation of solid particles in gas media, stokes law, Filtration, constant volume filtration, Constant pressure filtration, Industrial applications and equipments for Filtration and Sedimentation

Unit III : Separation by centrifuge

Centrifugal separation-Sedimentation, filtration centrifuges, Basic equations. Different types of centrifuges – Basket, Tubular Bowl, Decanting, Disk bowl, Desludging (Self Cleaning) Bowl

Centrifuges, Nozzle centrifuges. Importance of balancing of rotating masses, feed and discharge arrangement in each case. Specific characteristics, advantages and applications.

Unit IV: Filtration by membrane systems

Definitions; Reverse Osmosis (RO), Nano filtration (NF), Diafiltration, Ultra filtration (UF) and Micro filtration (MF), Molecular weight cut off in each case. Membranes and their characteristics, Cross flow filtration; Configuration of membranes, membrane materials, Pumps and other membrane equipment. Applications in food industry, relative advantages and limitations.

Unit V: Adsorption and Diffusion

Basics of adsorption, Diffusion of gases in liquid and solid foods, Moisture transfer in foods, Diffusion in porous foods, Inter-phase moisture transport. Diffusion of aroma components Applications of diffusion and migration in food packaging

Text Books

1. Christie John Geankoplis: Transport process and separation process principles-4th edition, PHI learning private limited New Delhi 2008.
2. McCabe, W.L., Smith, J.C., and Harriott, P. Unit operations of chemical engineering. 7th edn., 2005. McGrawhill Intl. Edition, Singapore.

Reference Books

1. J.M. Coulson, J.F. Richardson, J.H. Harker - Coulson & Richardson's Chemical Engineering - Vol 2 Particle Technology and Separation Processes, Fifth Edition, 2002. Butterworth & Heinemann - Elsevier science Ltd.
2. H.S. Ramaswamy & M. Markotte: Food Processing Principles and Applications, CRC Press Ltd.,2006.

DEPARTMENT OF FOOD PROCESSING AND ENGINEERING

LIST OF SUBJECTS AND SYLLABI

Sub. Code	Name of the Subject	Credits
12FP201	Principles of Food Process Engineering	3:1:0
12FP202	Thermodynamics	4:0:0
12FP203	Food Chemistry	3:0:0
12FP204	Fruit and Vegetable Processing Technology	3:0:0
12FP205	Food Microbiology	3:0:0
12FP206	Analysis of Food Lab	0:0:2
12FP207	Food Microbiology Lab	0:0:2
12FP208	Cereals and Pulses Technology	3:0:0
12FP209	Heat and Mass Transfer	4:0:0
12FP210	Food Biochemistry and Nutrition	3:0:0
12FP211	Fluid Mechanics and Heat Transfer Lab	0:0:2
12FP212	Food Biochemistry Lab	0:0:2
12FP213	Enzymology Lab	0:0:2
12FP214	Food Refrigeration and Cold Storage Construction	3:0:0
12FP215	Engineering Properties of Food Materials	3:0:0
12FP216	Unit Operations in Food Process Engineering – I	4:0:0
12FP217	Plantation Products and Spices Technology	3:0:0
12FP218	Dairy Engineering and Technology	3:0:0
12FP219	Unit Operations in Food Process Engineering and Grain Processing Lab	0:0:2
12FP220	Food Product Technology Lab – I	0:0:2
12FP221	Engineering Properties of Food Materials Lab	0:0:2
12FP222	Unit Operations in Food Process Engineering – II	4:0:0
12FP223	Food Safety Regulations	3:0:0
12FP224	Process Equipment Design	4:0:0
12FP225	Process Economics and Plant Layout Design	3:0:0
12FP226	Food Additives	3:0:0
12FP227	Food Engineering and Packaging Lab	0:0:2
12FP228	Analysis of Food Products of Plant Origin (Fruit & Vegetable) Lab	0:0:2
12FP229	Fat and Oil Processing Technology	3:0:0
12FP230	Technology of Meat, Poultry and Fish	3:0:0
12FP231	Food Preservation Principles	3:0:0
12FP232	Biochemical Engineering	3:0:0
12FP233	Bakery and Confectionery Technology	3:0:0
12FP234	Food Packaging Technology	3:0:0
12FP235	Storage Engineering	3:0:0
12FP236	Emerging Technologies in Food Process Engineering	3:0:0
12FP237	Functional Foods and Nutraceuticals	3:0:0
12FP238	Drying Technology	3:0:0
12FP239	Food Product Technology Lab-II	0:0:2
12FP240	Analysis of Food Products of Animal and Plantation Product Origin Lab	0:0:2
12FP241	Food Additives Lab	0:0:2

12FP242	Processing of Food Commodities	3:0:0
12FP243	Technology of Packaging	3:0:0
12FP301	Advances in Food Microbiology	4:0:0
12FP302	Separation Processes in Food Engineering	4:0:0
12FP303	Technology of Food Flavourants and Colorants	4:0:0
12FP304	Advances in Food Engineering	4:0:0
12FP305	Food Microbiology lab	0:0:2
12FP306	Food Engineering lab	0:0:2
12FP307	Kinetics of Food Systems	3:1:0
12FP308	Mass Transfer Processes in Food Engineering	4:0:0
12FP309	Emerging Trends in Food Process Engineering	4:0:0
12FP310	Food Packaging and Storage Engineering	4:0:0
12FP311	Food Analysis Lab	0:0:2
12FP312	Transport Processes in Food Engineering Lab	0:0:2
12FP313	Food Enzymology Lab	0:0:2
12FP314	Food Product Technology and Packaging Lab	0:0:2
12FP315	Food Safety Regulations and Control	4:0:0
12FP316	Instrumental Techniques of Food Analysis	4:0:0
12FP317	Engineering Properties of Food Materials	4:0:0
12FP318	Fruit and Vegetable Process Engineering	4:0:0
12FP319	Food Biochemistry and Nutrition	4:0:0
12FP320	Advances in Food and Water Microbiology	4:0:0
12FP321	Nutraceuticals and Functional Foods	4:0:0
12FP322	Research Methodology for Food Engineers	4:0:0
12FP323	Green Chemistry and Technology	4:0:0
12FP324	Advances in Food Packaging Technology	4:0:0

12FP201 PRINCIPLES OF FOOD PROCESS ENGINEERING

Credits: 3:1:0

Course Objective:

- To enable the students to solve problems in Food Engineering process of value addition and quality improvement.

Course Outcome:

- To utilize the principles in formulating solutions to solve problems in food industry.

Unit I

DIMENSIONS AND UNIT: Fundamental -derived units. Definitions of some basic physical quantities – Force, momentum, pressure, work and energy, power, heat and enthalpy. Dimensional analysis. Mole – atomical molar mass. Moisture content.-water activity

Unit II

GASES AND VAPORS: Behavior of Gases – Kinetic Theory of gases – Perfect Gas – Gas laws – Ideal gas laws – Real gas- Van der Waal's equation -pure component vapour pressure- partial pressure Dalton's law. Pure component volume-Amagat's law – psychrometry -humidity, relative humidity, saturation humidity –wet and dry bulb temperature-dew point –psychrometric chart reading.

Unit III

FLOW OF FLUIDS : Fluids-Properties, vapor pressure, surface tension, capillary effect, concept of viscosity-types of fluid. Bernoulli equation-fluid flow-laminar, turbulent ; pressure drop in pipes, valves and bends, Orifice meter, Venturimeter , Rotameter, Pitot tube –working principles.

Unit IV

MATERIAL BALANCE : Law of Conservation of mass- Process flow diagram-system boundaries -overall mass balance – component mass balance –basis and tie material-Continuous vs. Batch-Recycle and by pass-unsteady state -mass balance problems on concentration, dehydration, evaporation, crystallization, mixing –solvent extraction –multi stage process.

Unit V

ENERGY BALANCE : Heat capacity – gases – solids – liquids -Latent heat – sensible heat -energy balance for a closed system and open system -total energy balances. Energy balance problems in heat exchangers –Drying.

Text Books

1. Romeo T. Toledo. "Fundamentals of Food Process Engineering". Chapman & Hall, USA, CBS publications, New Delhi, 2000.
2. Smith, PG. "Introduction to Food Process Engineering ", Springer, 2004.

Reference Book

1. Paul Singh R, and Dennis R.Heldman ."Introduction to Food Engineering". Academic Press – Elsevier India Private Ltd. New Delhi, 2004.

12FP202 THERMODYNAMICS

Credits: 4:0:0

Course Objective:

- To enable the student to solve problems in Food engineering process of value addition and quality improvement.

Course Outcome:

- To utilize the principles in formulating a solution to a problem in food industry.

Unit I

ZEROTH LAW AND DEFINITIONS: Applications – Thermodynamics system and surroundings – closed, open and isolated system. Thermodynamics properties- specific volume – density – pressure – Thermodynamics state and equilibrium – properties- state and path function – Zeroth Law. Ideal gas concept of continuum – work and heat resources — Displacement work constant pressure and constant volume. Hyperbolic – polytropic -heat engine and heat pump

Unit II

FIRST LAW OF THERMODYNAMICS: Closed system – enthalpy- internal energy. First law for non flow process – for flow process – heat capacity – equation of state and its concept of ideal gas constant volume process – constant pressure process – constant temperature process – Adiabatic process – polytropic process

Unit III

SECOND LAW OF THERMODYNAMICS: Limiting first law of Thermodynamics – thermal efficiency— Kelvin Planck statement – refrigerators – heat pump – Air conditioners – Clausius statement – Equivalence of two laws – perpetual motion – reversible and irreversible processes. The Carnot cycle – Carnot engine Maxwell equations, Thermodynamic cycles- Carnot vapor power cycle, Ideal Rankine cycle, Rankine Reheat cycle, Air standard Otto cycle, Air standard Diesel cycle, Air-standard Brayton cycle, Vapor-compression refrigeration cycle.

Unit IV

ENTROPY : Clausius inequality -TS diagram- isentropic process – HS diagram-energy change for pure substances -solids and liquids – ideal gas. Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Unit V

PROPERTIES OF PURE SUBSTANCE : Phases of a pure substance -phase change – properties diagram – T- V diagram -PV diagram -solid phase on process diagram -PT diagram – PVT surface. equation of state and departure function, properties of mixtures: partial molar properties, fugacity, excess properties and activity coefficients; phase equilibria

Text Book

1. Radhakrishna E, “Fundamental Engineering Thermo Dynamics”, Printice Hall of India, New Delhi,2005

Reference Book

1. Khurmi R.S and J.K. Gupta, "A Text book of Thermal Engineering" S. Chand & Company Ltd, New Delhi, 2002.

12FP203 FOOD CHEMISTRY

Credits: 3:0:0

Course Objectives:

- To enable the students understand the chemistry and importance of water, carbohydrates, lipids, proteins and vitamins
- To impart knowledge on the methods of manufacture of oils and the methods of determining the quality of oils and fats
- To understand the role of vitamins in human nutrition and the effect of various processing methods in maintaining the vitamin content in foods.

Course Outcomes:

The students will be able to

- understand the importance of various food constituents, and their role in a food
- develop a basic idea in New Food Product development
- understand the importance of Packaging materials

Unit I

WATER AND ICE: Importance of water in foods. Structure of water & ice. Bound & free water, water activity (a_w) and their implications. Sorption Phenomena and Sorption isotherms, examples – Dispersed systems – some basic considerations

CHEMISTRY OF CARBOHYDRATES: Nomenclature Classification & structure of carbohydrates, Chemical reactions of carbohydrates. Physical & chemical properties of sugars

Unit II

CHEMISTRY OF POLYSACCHARIDES: Chemistry, properties of Pectins, gums. Starch and its hydrolytic products, maltodextrins, Cellulose, Cyclodextrins, dietary fiber – soluble and detergent fiber.

Unit III

CHEMISTRY OF LIPIDS: Definition & classification of lipids. Basic Structures, Chemistry of fatty acids & glycerides. Components of Fatty acids, Phospholipids and unsaponifiables, Auto oxidation and hydrolysis, Physical & chemical characteristics of fats & oils, hydrogenated fats, shortening agents, confectionary fats etc. Rancidity of fats & oils, and its prevention, antioxidants. Process flow sheet for the manufacture of edible oils (refined and hydrogenated)

Unit IV

CHEMISTRY OF PROTEINS: Importance of Proteins. Nomenclature, classification, structure and chemistry of amino acids, peptides & Proteins. Sources and distribution of Proteins. Isolation, identification & purity of Proteins. Denaturation, Physical & chemical characteristics of Proteins.

ENZYMES: Introduction, Nature, Function, classification & nomenclature of enzymes. Specificity. Amylases, Pectic Enzymes, Proteases, Immobilization of enzymes. Importance of enzymes in food industry.

Unit V

CHEMISTRY OF VITAMINS AND MINERALS: Fat soluble and water soluble vitamins – chemistry, their sources, functions, bioavailability. Reasons for loss of vitamins in food. **Minerals** – Essential Mineral elements – RDA – Bioavailability – Minerals of particular nutritional concern – Effect of processing - Chemical and functional properties of Calcium, Phosphates, Iron, Nickel and Copper.

Text Books

1. Belitz, H.D., Grosch, W., Schieberle, P. Food Chemistry. 4th and Revised and Extended Edition, Springer Verlag, Germany, ISBN 978-3-540-69933-0, 2009.
2. Damodaran S., Parkin K. and Fennema O.R., “Fennema’s Food Chemistry”, CRC Press, ISBN 0849392721, 9780849392726, 2008.

Reference Books

1. de Man J.M., “Principles of Food Chemistry”, Springer, 3rd Edn., ISBN 978-0-8342-1234-3, 2002.
2. Vaclavik V.A. and Christian E.W., “Essentials of Food Science”, Springer, 3rd Edn., ISBN 978-0-387-69939-4, 2008.

12FP204 FRUIT AND VEGETABLE PROCESSING TECHNOLOGY

Credits: 3:0:0

Course Objectives:

- To enable the students to understand the thermal processing of fruits and vegetables
- To impart technical know-how on the preparation of fruit juices
- To understand the methods of dehydration

Course Outcome:

- The students will get exposure to the processing of fruits and vegetables, preparation of juices and other products from fruits and vegetables

Unit I

INTRODUCTION: Production of Fruits and vegetables in India. Cause for heavy losses, Composition of each of the major fruits and vegetables produced in the country- Spoilage factors, Post harvest field operations, preservation treatments for freshly harvested fruits and vegetables, Packaging of whole fruits and vegetables for internal and export markets. General methods of preservation of whole fruits/Vegetables and processed fruits and vegetables. Processing and packaging of cut fruits and vegetables.

Unit II

CANNING OF FRUITS AND VEGETABLES: Washing, peeling, grating, slicing dicing, deseeding. Juice and pulp extraction and clarification. Bottled Products: Preparation of products like Jams, Jellies, Marmalades, Pickles, Puree, Ketchup, Sauce, Squashes etc. - FPO specifications. Bulk preparation and storage. Different filling, closing and sterilization

operations. Canning of Vegetables. Precautions - Blanching operations - Batch and Continuous Blanching. Concept of Hurdle technology as applied to fruit and vegetable preservation.

Unit III

PROCESSING OF FRUIT JUICES: Common machinery for operations like Peeling, Slicing/Dicing, Pulping, Grating, Hydraulic Pressing and Clarification. Preparation of specialty products like, Fruit juice concentrates, Fruit Bars and Fruit powders. Clarification of juices, Viscosity problems. Tomato products – Hot and Cold Break processes. Tomato Deseeding and clarification. Mango Pulp extraction and concentrations. Clarification centrifuges – Decanters and desludgers. Fruit juice aroma Recovery and its importance. Overview of Aroma Recovery equipment.

Unit IV

DEHYDRATION: Dehydration principles and equipment used for drying. Cross Flow Shelf Dryers, Vacuum Shelf Dryers, Freeze Dryers. Freeze drying Principles. Merits and demerits of Freeze Drying. Preparation of Fruit Powders. Working of Spray Dryer and Drum Dryer. Preparation of Fruit material for powder production. Packaging of Dried slices, Dices and powder. Intermediate Moisture Food.

Unit V

ASEPTIC AND OTHER METHODS OF PROCESSING: Aseptic processing and Bulk packing of Fruit juice concentrates, Pulps and Puree Brief information on Asepticity and how it is strictly maintained in the plant. Aseptic heat exchangers for sterilizing and concentrating the product. Aseptic fillers. Different system of filling practiced. Tetra pack for small quantities, Dole system and Scholle system for bulk storage in Bag and Boxes and Bag & Drums. Storage of Aseptically packed products. Minimal processing – Basic concepts, Reverse osmosis.

Text Book

1. Hui Y.H and Others, “Hand Book of Vegetable Preservation and Processing”, Marcel Dekker, New York, 2004

Reference Books

1. Chakraverty, A., Mujumdar A.S., Raghavan G.S.V and Ramaswamy H.S. “Handbook of Post-harvest Technology” Marcel Dekker Press, USA, 2001.
2. Srivastava, R.P. and Kumar S, “Fruit and Vegetable Preservation: Principles and Practices”, International Book Distributing Co. Lucknow (2nd Edition 1998).

12FP205 FOOD MICROBIOLOGY

Credits: 3:0:0

Course Objectives:

- To understand the isolation methodology of microorganisms.
- To know the methods of preservation of foods.
- To identify the microorganisms of food commodities of plant and animal origin.
- To learn about Food borne diseases and microorganisms.

Course Outcomes:

- To isolate microorganisms and how to utilize microorganism as sources of food.
- To utilize microorganism to produce fermented foods.
- To utilize microorganisms in food industries.

Unit I

INTRODUCTION, SCREENING AND ISOLATION OF MICROORGANISMS: Microorganisms associated with foods: Bacteria – Beneficial and Contaminants - Molds, Yeast and their importance – Viruses , Bacterial viruses and Fungal Viruses – Factors affecting the growth of bacteria – Growth curve of bacteria - antimicrobial barriers and constituents. General Microbiological Methods of enumeration and isolation of bacteria and fungi.

Unit II

CONVENTIONAL METHODS OF PRESERVATION: Thermal mode of preservation – Pasteurisation ,sterilization and appertization – Heat resistance of microorganisms and their spores –bacteria and their spores –fungi and their spores –yeast and their spores - spoilage of canned foods and types of spoiled cans – aseptic packaging - Low-temperature storage. Non-thermal methods of preservation : High pressure processing – Pascalisation - Irradiation – Brief account of microwave, UV and ionizing radiation - Use of chemical preservatives, Natural food preservatives.

Unit III

MICROBIOLOGY OF FERMENTED FOODS: Traditional vegetable fermentation – Sauerkraut - Lactic acid, citric acid, and mixed acid fermentations - Alcohol production – Fermentation of oriental food products.

Unit IV

MICROBIOLOGY OF WATER AND FOOD COMMODITIES: Microbiology of water and their importance of processing of foods in industries. MPN of coliforms Microbiology of milk – Hetero and homo fermentative Lactic acid bacteria – Yogurt and Cheese fermenting organisms –Aflatoxin producing organisms and their importance in canned foods.

Unit V

FOOD BORNE PATHOGENS: Food Poisoning and intoxication – food borne diseases – Symptoms of diseases caused by Bacillus spp., Clostridium botulinum, Escherichia coli, Salmonella, Staphylococcus aureus, Shigella spp., Hepatitis, Gastroenteritis viruses, Entamoeba histolytica and Entamoeba coli.

Text Book

1. Adams M.R and Moss M.O, “Food Microbiology”, Panima Publishing corporation, New Delhi, 2nd Edition, Third reprint, ISBN-13:9788122410143,978-8122410143, 2007.

Reference Books

1. Sivasankar B, “Food Processing and Preservation”, PHI Learning Private Limited, Eastern Economy Edition, 6th edition, ISBN- 97881203-2086-4, 2009.
2. William C Frazier and Dennis C. Westoff, “Food Microbiology”, Special Edition, Springer, The Mc Graw-Hill Companies, ISBN-9780070667181, 2008.

Credits: 0:0:2

List of Experiments

1. Estimation of Reducing sugars by Willstatter' Iodometric Titration
2. Estimation of Reducing sugars by Lane and Eynon's method
3. Estimation of Total sugars by Lane and Eynon's method
4. Estimation of Free Fatty Acids in Fats and Oils
5. Saponification Value of Fats and Oils
6. Peroxide Value of Fats and oils
7. Iodine Value of Fats and Oils
8. Estimation of α – Amino Nitrogen by Sorenson's Formol Titration
9. Estimation of Nitrogen by Kjeldhal's Method
10. Qualitative Analysis of Sugars
11. Qualitative Analysis of Amino Acids
12. Identification of Sugars by Paper Chromatography
13. Identification of Aminoacids by Paper Chromatography

12FP207 FOOD MICROBIOLOGY LAB

Credits: 0:0:2

List of Experiments

1. Study of morphology of bacteria and fungi
2. Methods of sterilization of a) Glass wares using hot air oven and b) culture media for microbiological work using autoclave and pressure cooker
3. Preparation of nutrient broth and nutrient agar
4. Monochrome staining
5. Differential staining-Gram staining
6. Negative staining, Lacto phenol cotton blue staining
7. Methods of pure culture techniques for bacteria
8. Hanging drop preparation to observe motility of bacteria
9. Enumeration and isolation of bacteria and fungi from water/milk
10. Enumeration and isolation of bacteria and fungi from any contaminated food
11. MPN Test for coliforms
12. IMVIC Tests
13. Methylene blue reduction test in milk

12FP208 CEREALS AND PULSES TECHNOLOGY

Credits: 3:0:0

Course Objectives:

- To create awareness about the processing of major cereals like paddy, maize etc.
- To study the storage and handling techniques of cereals.
- To gain knowledge on processing and milling of pulses.
- To study about the by products obtained during processing along with their uses.

Course Outcomes:

- To know about Paddy Processing and Rice milling equipment which will help them for developing entrepreneurial skills.

- To develop skills needed in the milling of pulses and in the processing and milling of maize which will promote gainful employment.
- To learn about the grain storage and handling processes including the spoilage and problems associated with different methods of storage, which will enable them to promote protective measures against rodents and pests.

Unit I

PADDY PROCESSING: Composition of paddy and Quality characteristics. Curing of Paddy –Parboiling Processes. Physico-chemical changes during parboiling – Cold Water soaking and Hot water soaking processes, Methods of grain drying- LSU Dryer, By Products of Paddy Processing - Paddy husk and its uses as husk ash, activated carbon, furfural and other by products. Production of Flattened and Puffed Rice from Paddy.

Unit II

RICE MILLING: Paddy Dehusking Processes. Rice Milling Flow Chart. Engelberg Huller Mills. Modern Rice Mills – their Components - Pre Cleaners, Shellers, Under Runner Shellers and Centrifugal Shellers, Paddy Separators – Satake and Schule Designs, Polishers - Cone polishers and other types, Bran and Broken separators. Rice Mill yields and loss due to broken at different stages of milling. Use of Rice Bran in Edible oil Industry.

Unit III

MILLING OF PULSES: Major Pulses grown in the country . Traditional milling process - merits and demerits. Drying of legumes - Sun and Traditional drying processes steps – Pre-cleaning, Pitting, Oil application, conditioning, dehusking and splitting - Machinery and equipment employed. Modern milling process - Process flow chart -Mechanical hot air drying and conditioning - merits and demerits, dehusking in Pulse Pearler, Water conditioning, splitting of pulses in Pulse splitter, Merits and demerits. Mini dhal mill - working principle - advantages and disadvantages. Grinding of split pulses, pulse flour products, their applications and equipments used.

Unit IV

MILLING AND PROCESSING OF MAIZE: Dry milling of maize, Storage and drying, Pre-cleaning, cleaning equipment, degermination and dehusking, Roller milling, Sifting, Purifying, Aspiration, Pneumatics in a maize mill. Products of milling - Flour, Semolina, Brewers' grits etc and their applications. Wet milling of Maize and corn: Modern methods of processing, Cleaning, Steeping, Degermination, Bran and Fibre separation, Gluten and Starch Separation,. Equipment needed for Degermination, Debraning and starch separation. Starch conversion into other value added products – Acid Hydrolysis, Enzyme Hydrolysis, Isomerization processes. Processing for Dextrose, Malto Dextrin and other products. Extraction and refining of Corn oil in brief.

Unit V

GRAIN STORAGE AND HANDLING: Bag Storage - Advantages and Disadvantages - Bag Storage structure design. Parameters of good storage structure, Cover Plinth Storage Structures, CAP storage (Ceiling and Plinth Storage), Plans for Bag storage, lay outs, Dunnage, Materials for Dunnage, Pallets, Protection against Rodents, Fungi, Pests and Mites. Fumigation Processes for bag storage piles. Bulk Storage in silos and large Bins - Problems of Silo storage, Relative merits and demerits of Silo storage to Bag Storage. Relative Costs of Silo and Bag Storage. Conveyors and Elevators for feeding and discharging into Silos. In silo Aeration and Drying, Problems of Dust Explosion in Grain Storages, Quality Changes of Grains during storages and remedial measures to prevent unwanted quality changes.

Text Books

1. Chakraverty, A.: Post Harvest Technology of Cereals, Pulses and Oilseeds. Oxford and IBH Publishing Co, Calcutta, 1995.
2. Samuel A .Matz: “The Chemistry and Technology of Cereals as Food and Feed”, Chapman and Hall, 1992.

Reference Books

1. Smartt J, “Tropical Pulses”, Longman Group Ltd. London, 1980.
2. Pomeranz Y, “Modern Cereal Science and Technology” VCH Publishing Inc. New York, 1987.
3. Cryde M. Christensen, “Storage of Cereal Grains and their Products”, American Association of Cereal Chemists inc., St. Paul, USA, 1982.
4. Bernard Godon and Claude Willm, “Primary Processing of Cereals” Berns and Noble Publishers, 1994.
5. Karel Kulp and Joseph P Pante, “Handbook of Cereal Science and Technology”, Mercel Dekkar, USA, 2000.

12FP209 HEAT AND MASS TRANSFER

Credits: 4:0:0

Course Objectives:

- To enable the student to understand the basics of fluid mechanics and thermal flow
- To understand the Importance of thermal fluid sciences in processing of food
- To develop processes with better heat efficiency and economics

Course Outcome:

- The students will be able to apply their knowledge on thermal fluid sciences in processing of food.

Unit I

HEAT TRANSFER – CONDUCTION: Modes of heat transfer – Conduction, Convection and Radiation. Fourier’s Law of Heat conduction-Thermal Conductivity for gases,liquids and solids-Thermal diffusivity- Thermal resistance-Steady heat conduction in simple geometries – Plane wall,hollow cylinder and hollow sphere through solids in series -plane wall and multilayer cylinder. Heat conduction through materials in parallel. Theory of insulation, critical radius of insulation .

Unit II

HEAT TRANSFER – CONVECTION: Convection heat transfer – forced and natural; Evaluation of convection heat transfer coefficient, Dimensionless numbers- Forced convection- Heat Transfer Coefficient for Laminar flow inside a tube -heat transfer coefficient for turbulent flow inside a pipe. –Heat Transfer outside various Geometries in Forced Convection – Flow parallel to flat plate - Natural convection from vertical planes and cylinders –boiling and condensation-mechanisms

Unit III

HEAT TRANSFER – RADIATION: Basics of Radiation heat transfer- Types of surfaces – Kirchhoff’s Law-radiation from a body and emissivity(Stephan Boltzman Law)--to a small object from surroundings –Planck’s Distribution law-Wein’s Displacement law-Lambert’s law-combined Radiation and Convection Heat Transfer.

Unit IV

HEAT EXCHANGERS: Types-Overall Heat Transfer Coefficient-Shell and Tube 1-1, 1-2, 2-4 passes –Plate Heat Exchanger-tubular heat exchanger-Parallel Flow and Counter Flow-Cross flow Types extended surfaces- Fin efficiency-Scraped surface exchangers-Compact Heat exchanger- Heat exchanger Analysis-Log mean Temperature Difference

Unit V

MASS TRANSFER : Physical origin-Mixture composition-classification-concentration-velocities and fluxes.Fick's law- general equation of mass transfer in stationary media- steady state diffusion-equimolar diffusion-diffusion of water vapour through air-mass transfer coefficient –convective mass transfer

Text Book

1. Rao, D. G, "Fundamentals of Food Engineering", PHI Learning Pvt. Ltd., New Delhi. 2010.

Reference Books

1. McCabe W.L., Smit J.C and Harriott P, "Unit Operations of Chemical Engineering", McGraw-Hill International Edition, 7th Edition New York, ISBN-007-424-740-6, 2005.
2. Ballaney, P.L. "Thermal Engineering", Khanna Publishers, New Delhi. 2002

12FP210 FOOD BIOCHEMISTRY AND NUTRITION

Credits: 3:0:0

Course Objectives:

- To understand about Biochemical cycles
- To impart basic knowledge about Biosynthesis of macromolecules
- To understand about Nutrition, its importance and anti-nutritional factors
- To know about specialized nutrition

Course Outcome:

- To get exposure about Nutrition and its importance, nutritive values of different food sources.

Unit I

CHEMICAL CONSTITUENTS OF LIFE: Biomolecules and the cell-nucleus, mitochondria, endoplasmic reticulum, golgi apparatus, lysosomes, peroxisomes. Nucleic acids- structure of nucleotides-purines, pyrimidines-bases in nucleic acids. Nucleoside di and triphosphate. Oxidative phosphorylation – ATP synthesis – Regulation of oxidative phosphorylation.

UNIT II

METABOLISM OF CARBOHYDRATES PROTEINS AND FATTY ACIDS: Glycolysis, Pentose phosphate shunt, TCA cycle, gluconeogenesis, Regulation of metabolic pathways, urea cycle. Biosynthesis and degradation of –fatty acids (saturated and unsaturated) and cholesterol. Aminoacids (tyrosine, cysteine). Peptides and proteins.

Unit III

CONCEPTS OF NUTRITION: Basic concept of nutrition-Importance of nutrition and dietetics. Assessment of nutritional status-energy values of carbohydrates, proteins and fats-determination of energy value-balanced diet-Recommended dietary intake-Acceptable dietary intake-protein efficiency ratio-Net protein utilization and their determinations- Malnutrition and its problems-Nutrient supplementation-fortification-Nutritional labeling and its importance-Effect of processing on protein quality, essential amino acids-Digestibility, carbohydrates in food and dietary fibre.

Unit IV

NUTRITIONAL DISORDERS: Inborn errors of carbohydrate, protein and fat metabolisms -Nutrition and disorders associated with organs such as liver and kidney - Naturally occurring anti-nutritional factors – Cyanogens, lectins, enzyme inhibitors, phytoalexins, and phytates.

Unit V

SPECIALIZED NUTRITION: Nutrition for specialized purposes – Pediatric nutrition – geriatric nutrition – Sports nutrition – Nutrition during pregnancy - Functional foods - Ageing – Theories of ageing – Nutrition and ageing – Cancer and its prevention - Age-related metabolic disorders – Nutrition in the treatment of age-related disorders like hypertension, diabetes, Alzheimer’s disease.

Text Books

1. Lehninger A.L., Nelson D.L, Cox, M.M, “Principles of Bio- Chemistry”, W.H. Freeman, 2005
2. Satyanarayana U. and Chakrapani U, “Biochemistry”, Uppala publishers, 2007

Reference books

1. Voet D and Voet G, “Biochemistry”, John Wiley and sons, 2004
2. Tymoczko, J.L., Berg, J.M., Stryer, L, “Biochemistry- A short course”, W,H., Freeman. 2009
3. Sunetra Roday., “Food Science and Nutrition”, Oxford., 2007

12FP211 FLUID MECHANICS AND HEAT TRANSFER LAB

Credits: 0:0:2

List of Experiments

1. Determination of pipe friction and pressure drop under sudden contraction and expansion during fluid flow
2. Determination of Equivalent Length of pipe fittings during fluid flow
3. Determination of Pressure drop in Helical coil
4. Determination of Pressure drop in annular pipes
5. Calibration of Venturi meter & Rotameter
6. Calibration of Orifice meter
7. Pressure drop across Packed-bed columns
8. Pressure drop across Fluidized bed columns
9. Heat transfer studies in a tubular heat exchanger (Parallel and counter flow)
10. Heat transfer studies in a plate heat exchanger (Parallel and counter flow)
11. Heat transfer studies of a shell and tube heat exchanger
12. Heat transfer through composite walls
13. Determination of particle size distribution using a gyratory sieve shaker

12FP212 FOOD BIOCHEMISTRY LAB

Credits: 0:0:2

List of Experiments

1. Estimation of sugars by DNS method
2. Estimation of crude fibre
3. Estimation of proteins by the Biuret method
4. Estimation of total free amino acid
5. Estimation of proteins by Lowry's method
6. Estimation of proteins by dye-binding method
7. Estimation of thiamine
8. Estimation of ascorbic acid
9. Estimation of riboflavin
10. Estimation of carotenoids
11. Estimation of cholesterol
12. Estimation of total carbohydrate by anthrone method
13. Qualitative tests for checking of milk and water

12FP213 ENZYMOLOGY LAB

Credits: 0:0:2

List of experiments

1. Estimation of reducing sugars by dinitrosalicylic acid
2. Estimation of amylase activity
3. Effect of pH on amylase activity
4. Effect of temperature on amylase activity
5. Effect of substrate concentration on amylase activity
6. Effect of enzyme concentration on amylase activity
7. Determination of total and specific activity of amylase
8. Estimation of protein by Lowry's method
9. Estimation of protease activity
10. Effect of pH on protease activity
11. Effect of temperature on protease activity
12. Effect of substrate concentration on protease activity
13. Effect of enzyme concentration on protease activity
14. Determination of total and specific activity of protease

12FP214 FOOD REFRIGERATION AND COLD STORAGE CONSTRUCTION

Credits: 3:0:0

Course Objective:

- To enable the students to understand the various concepts behind refrigeration and storage construction.

Course Outcome:

- The students will be able to apply their knowledge on cold storage of perishable products.

Unit I

PRINCIPLES OF REFRIGERATION: Refrigeration – Ton of refrigeration, refrigeration cycles, Vapour Compression and Vapour Absorption cycles, Refrigerants, characteristics of different refrigerants, net refrigerating effect -Components of a Refrigeration system: Compressor, condenser, Evaporator, Expansion valves piping and different controls. Atmospheric air and its properties, Psychrometrics.

Unit II

COLD STORAGE DESIGN AND CONSTRUCTION: Cold Room temperatures, Insulation, properties of insulating materials, air diffusion equipment, Doors and other openings. 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. Cold Storage practice, Stacking and handling of materials, Optimum temperatures of storage for different food materials.

Unit III

FREEZING OF FOODS: Freezing equipment, Freezing rates, growth rate of ice crystals, crystal size and its effect of texture and quality of foods, Freezer types, Blast freezers, Contact Plate Freezers, conveyORIZED quick freezers, Individual quick freezing. Cryogenic Freezing, Freezing practice as applied to marine foods, meat and poultry, fruits and vegetables.

Unit IV

CHILLING OF FOODS: Chilling equipment for liquid foods. Secondary refrigerants and direct expansion techniques in chilling. Chilled foods transport and display cabinets - Basics of Chilled foods microbiology, Packaging of Chilled foods - Hygienic design considerations for chillers and chilled Storages. Cool storages and their applications. Evaporative cooling and its applications

Unit V

COLD CHAIN MANAGEMENT: Supply chain system - Important Factors to consider- logistic supply- Protocols for Domestic, Sea and Airfreight- Traceability and barcode – Product Temperature and Moisture monitoring- Refrigeration systems and Refrigerant types during field chilling, transportation via land, air and sea ,At Grocery stores and display cases, Home refrigerators - Cooling chain summary - Storage and packaging

Text Book

1. Dellino, C.V.J “Cold and Chilled Storage Technology”, Chapman Hall India, ISBN-0751403911, 1997.

Reference Books

1. Colin Dennis and Michael Stringer: Chilled Foods – A Comprehensive Guide Brown.M WoodHead Publishing, New York, ISBN-1845692438, 9781845692438, 2008.
2. Pruthi. J.S, “Quick Freezing Preservation of Foods”, 2nd Volume, Allied Publishers,Mumbai,ISBN-817023963X ,1999.
3. Florkowski W.J, Shewfelt R.L, Brueckner B and Prussia S.E, “Post Harvest Handling and Sytems Approach”, Second edition, Academic Press, USA, ISBN-9780123741127, 2009.

Credits: 3:0:0

Course Objectives:

- To study about the different methods of determining the quality and properties of different foods
- To gain knowledge of engineering properties during processing, packing, storage and transport.

Course Outcome:

- To understand the relationship between physical and functional properties of raw, semi-finished and processed food to obtain products with desired shelf life and quality

Unit I

PHYSICAL PROPERTIES OF FOODS: Methods of estimation of Shape, Size, volume, density, porosity and surface area, sphericity, roundness, specific gravity. Frictional properties-coefficient of friction

Unit II

RHEOLOGICAL PROPERTIES OF FOODS: Definition – classification – Newton’s law of viscosity – momentum-diffusivity-kinematic viscosity – viscous fluids – Newtonian and Non Newtonian fluids- Viscosity Measurements-Viscometers of different types and their applications-Texture measuring instruments-Hardness and brittleness of Food materials.

Unit III

THERMAL PROPERTIES OF FOODS: Definitions of Heat capacity, specific heat, enthalpy, conductivity and diffusivity, surface heat transfer coefficient, Measurement of thermal properties like specific heat, enthalpy, conductivity and diffusivity

Unit IV

AERODYNAMIC AND HYDRODYNAMIC PROPERTIES OF FOODS: Drag and lift coefficient, terminal velocity and their application in the handling and separation of food materials. Water activity- measurement-vapor pressure method –freezing point depression method- Effect of temperature, and pressure on water activity-moisture sorption isotherms-models-Henderson, PET and GAB models.

Unit V

ELECTRICAL PROPERTIES OF FOODS: Dielectric properties-dielectric constants-, Dielectric measurements-Ionic Interaction-Dipolar rotation. Effect of moisture ,temperature and pressure on dielectric properties. Microwave heating-Infrared and Ohmic heating, Irradiation

Text Books

1. Serpil Sahin and Servet Gulum Sumnu “Physical Properties of Foods”, Springer,USA, 2006.
2. Nuri N. Mohsenin: “Thermal Properties of Food & Agricultural materials”, Gordon and Reach science publishers, 1970.

Reference Books

1. Rao, M.A and S.S.H. Rizvi: "Engineering Properties of Foods", Mercel Dekker inc. New York, 1998.
2. Lewis M.J, "Physical properties of foods and food processing systems" Woodhead publishing Cambridge, UK, 1990.
3. Reyonrd Jewitt and others: "Physical properties of foods "Allied science publishers, 1983.
4. Shafiur Rehman: Food Properties Hand book CRC press inc. New York, 1995.
5. Micha Peleg and Edward B. Bagley, "Physical Properties of Foods" AVI publishing company inc, Westport USA, 1983.
6. Kachru R.P.and R.K. Gupta, "Physico – Chemical Constituents and Engineering Properties of Food crops", Scientific publishers, Jodhpur.

12FP216 UNIT OPERATIONS IN FOOD PROCESS ENGINEERING - I

Credits: 4:0:0

Course Objective:

- To understand the engineering principles involved in the processing of food products.

Course Outcomes:

- To understand the operation of equipment
- To develop new food process equipment and modification of existing equipments.

Unit I

MIXING: Definitions and principles – Unit systems SI units – Basic equations standards. Evaluation of constants – work, energy and Power – Agitation and Mixing – Purpose of agitation – Agitated vessels – impellers – propellers – turbine – standard turbine design – High efficiency impellers – Impellers for high viscosity liquids. Draft tubers – Power number – mixing and blending of miscible liquids.

Unit II

EVAPORATION: Definition – liquid characteristics – Types of evaporators -single and multiple effect evaporators — once through and circulation evaporators – Agitated film evaporators. Performance – evaporator capacity – boiling point elevation and Duhuring's rule. Heat transfer coefficients – Evaporators economy – enthalpy balance of single effect evaporator – multiple effect evaporator – methods of feeding. Capacity and economy of multiple effect evaporator.

Unit III

DRYING AND DEHYDRATION: Moisture and its measurements - direct and indirect methods – Equilibrium moisture – methods of determination – EMC Models – Henderson ,Kelvin, PET and GAB models – importance of EMC- water activity – psychrometry — Drying theory – Drying rate – Mechanical Drying – hot air dryers – Types- fixed -fluidized bed – LSU drier-Spray drier- Osmotic dryer - vacuum shelf dryer – freeze dryer.

Unit IV

MECHANICAL SEPARATION: Filtration – Filter media types and requirement – constant rate filtration – constant pressure filtration – filter cake resistance – filtration equipments – filter press – rotary drum filters – sedimentation – gravitational sedimentation – Stoke's law –

sedimentation in cyclones. Centrifugal separations – rate of separation – centrifuge equipment.

Unit V

SIZE REDUCTION: Principles of comminuting – characteristics of comminuted products – particle size distribution in comminuted products – energy and power requirements – Rittinger's, Kick's and Bond's law – Size reduction equipments – crushers – hammer mill – attrition mills.

Text Books

1. Geankoplis CJ, "Transport Processes and Separation Processes Principles" .Printice Hall India, New Delhi, ISBN-978-81-203-2614-9, 2008
2. Warren,L McCabe, J.C. Smith and Peter Harriot,"Unit Operations of Chemical Engineering " McGraw Hill International Edition, Singapore, ISBN-007-424740-6, 2005

Reference Book

1. Earle, R.L, "Unit Operations in Food Processing". Pergamon Press,2nd Edition,UK, 2003

12FP217 PLANTATION PRODUCTS AND SPICES TECHNOLOGY

Credits: 3:0:0

Course Objectives:

- To understand about Coffee and its processing techniques, instant coffee, and quality grading
- To learn the Different types of tea and its manufacturing techniques, instant tea, quality parameters of tea
- To learn Cocoa and its processing, chocolate manufacturing technology
- To know the processing and chemistry of major and minor spices

Course Outcome:

- The students will be able to understand the processing steps involved for different plantation products and spices.

Unit I

CHEMISTRY AND TECHNOLOGY OF COFFEE: Coffee – Occurrence – chemical constituents – harvesting –fermentation of coffee beans – changes taking place during fermentation – drying – roasting – Process flow sheet for the manufacture of coffee powder – Instant coffee, technology – Chicory chemistry - Quality grading of coffee

Unit II

TEA – CHEMISTRY AND TECHNOLOGY: Occurrence – chemistry of constituents – harvesting – types of tea – green, oolong and CTC – Chemistry and technology of CTC tea – Manufacturing process – Green tea manufacture – Instant tea manufacture – Grading of tea

Unit III

CHEMISTRY AND TECHNOLOGY OF COCOA AND COCOA PRODUCTS: Occurrence – Chemistry of the cocoa bean – changes taking place during fermentation of

cocoa bean – Processing of cocoa bean – cocoa powder – cocoa liquor manufacture
Chocolates – Types – Chemistry and technology of chocolate manufacture – Quality control of chocolates

Unit IV

CHEMISTRY AND TECHNOLOGY OF MAJOR SPICES: Pepper, Cardamom, ginger, Chilli, mint, and turmeric – Oleoresins and essential oils – Method of manufacture – Chemistry of the volatiles –Enzymatic synthesis of flavor identicals - Quality control

Unit V

CHEMISTRY AND TECHNOLOGY OF MINOR SPICES: Cumin, Coriander, Cinnamon, fenugreek, Garlic, Clove and Vanilla - Oleoresins and essential oils – Method of manufacture – Chemistry of the volatiles – Quality control Synthesis of volatiles using micro-organisms, plant suspension cultures.

Text Book

1. Peter, K.V. “Hand book of herbs and spices”. Volume 2. Woodhead publishing Ltd.,2004.

Reference Books

1. Tainter, D.R. Grenis, A.T. Spices and Seasonings – A food technology hand book. 2nd edition. John Wiley and Sons, Inc., Canada. 2001.
2. Chakraverty, A., Mujumdar, A.S., Raghavan, G.S.V., Ramaswamy, H.S. Handbook of post harvest technology – cereals, fruits, vegetables, tea and spices. Marcel Dekker Inc., New York (Special Indian Reprint). 2010.

12FP218 DAIRY ENGINEERING AND TECHNOLOGY

Credits: 3:0:0

Course Objectives:

- To understand about milk, milk processing methodologies
- To provide knowledge about the processing equipments
- To provide technical know-how about the production of milk products (ice creams, fermented milk products)

Course Outcomes:

- The students will get exposure about milk and its processing methods.
- Gain knowledge of the various milk processing equipments.
- Gain knowledge on the production of various milk products.

Unit I

DAIRY CHEMISTRY AND MICROBIOLOGY: Introduction, Basic dairy terminology, milk as raw material, composition, food value, contaminants, milk reception in dairies and tests, Quality and Quantity tests at reception, Cell count and other tests, Milk transport and storage in dairy plants, Cholesterol, fatty acids and their relation to cardiovascular diseases – Dietary recommendations – Applications of enzymes in dairy industry

Unit II

DAIRY PROCESSING EQUIPMENTS: Milk processing terminology, Processing flow sheet, milk processing equipments and their selection, Pasteurisers – HTST, LTLT, UHT

methods, Plant piping, Pumps, Cream separating Centrifuges, Clarifiers, Homogenizers, Bottle and pouch fillers, Milk Chillers, Ice Cream Freezers. Vacuum Evaporators, Spray and Drum Dryers, Product instantizing equipment. Packaging of milk in bottles and sachets, Form – fill packs.

Unit III

MANUFACTURE OF DAIRY PRODUCTS: Manufacture of Butter, Ghee – Grading of butter Cheese – Types of cheese, Defects in cheese, Manufacture of paneer, Different types of processed milk, Khoa, Milk powder – Quality aspects. Equipments for manufacture of dairy products.

Unit IV

MANUFACTURE OF ICE CREAM AND OTHER DAIRY PRODUCTS: Manufacture of Ice cream, calculation of ice cream mixes – Chemistry and technology –Microbiology of ice cream - Quality aspects - Quality aspects Extraction of casein from milk, properties, composition and industrial uses, Production of lactose and whey, Equipments for manufacture of ice cream, butter and ghee. Storage Units

Unit V

FERMENTED DAIRY PRODUCTS: Fermented products – Yoghurt, Curd, acidophilus milk etc.- Concept of Probiotics and prebiotic foods, Energy use in Dairy plant, sources of energy, cost of energy, Control of energy losses and Energy conservation.

Text Book

1. Sukumar De, “Outlines of Dairy Technology”, Oxford University Press, New Delhi, 23rd impression, 2006.

Reference Books

1. Garret Smit G, “Dairy Processing”, Woodhead Publishing Limited, England. 2005.
2. Edger Spreer, “Milk and Dairy Product Technology” Marcel Dekkar Inc. New York, USA, 2005.

12FP219 UNIT OPERATIONS IN FOOD PROCESS ENGINEERING AND GRAIN PROCESSING LAB

Credits: 0:0:2

List of Experiments

1. Experiment on Cross flow drier
2. Experiment on Plate type pasteurizer
3. Experiment on Size reduction mill
4. Experiment on Screen analysis
5. Experiment on Centrifuge
6. Experiment on Mixer
7. Experiment on Fluid bed drier
8. Experiment on LSU drier
9. Experiment on Cleaner cum grader
10. Experiment on Rubber Roll Sheller
11. Experiment on Rice polishers
12. Experiment on Destoner
13. Experiment on Parboiling

12FP220 FOOD PRODUCT TECHNOLOGY LAB – I

Credits: 0:0:2

List of Experiments

1. Preparation of RTS beverage
2. Preparation of squash
3. Preparation of cordial
4. Preparation of Jam and jellies
5. Preparation of marmalade
6. Preparation of ketchup
7. Preparation of basic bread
8. Preparation of French bread
9. Preparation of sweet atta biscuit
10. Preparation of butter scotch cookies
11. Preparation of sweet biscuits
12. Preparation of salt biscuits
13. Preparation of angel cake
14. Preparation of pound cake
15. Preparation of sponge cake
16. Preparation of rusks

12FP221 ENGINEERING PROPERTIES OF FOOD MATERIALS LAB

Credits: 0:0:2

List of Experiments

1. Determination of viscosity of liquid food materials
2. Determination of surface area of grains by using planimeter.
3. Determination of porosity of food grains.
4. Determination of specific gravity, specific volume and density of foods.
5. Determination of friction.
6. Determination of sphericity, roundness of food grains.
7. Measurement of terminal velocity of food particles.
8. Measurement of angle of repose
9. Determination of hardness of grains.
10. Estimation of moisture content of food grains, fruits and vegetables.
11. Calculation of specific heat of food materials.
12. Calculation of thermal conductivity of food materials.
13. Determination of rehydration characteristics of dried foods.

12FP222 UNIT OPERATIONS IN FOOD PROCESS ENGINEERING – II

Credits: 4:0:0

Course Objective:

- To understand the various unit operations involved in food industry.

Course Outcome:

- To understand and improve the engineering operations that are critical to the food processing operations and industrial growth.

Unit I

DISTILLATION: Principles of diffusion and mass transfer -Fick's law – convective Mass transfer – Mass transfer for binary mixtures- definition of Distillation – Flash Distillation — continuous distillation with reflux – combined rectification and stripping. Material balances in plate columns – Advantages and limitations – distillation equipments – construction and operation – factors influencing the operation.

Unit II

LEACHING AND EXTRACTION: Definitions – Leaching equipment leaching by percolation through stationary solid- moving bed leaching –Dispersed solid – counter current leaching – number of ideal stages. Liquid extraction – Extraction equipment – mixer settlers – packed extraction towers – perforated plate towers – baffle towers – Agitated tower. Pulse column – centrifugal extractor.

Unit III

ABSORPTION AND ADSORPTION: Definition – rate of gas absorption – packing and packed tower for absorption – characteristics of packing- pressure drop and limiting flow rates – principles of absorption – mass balance. Adsorption – equipment – fixed bed adsorber - pressure swing adsorption – Adsorption from liquids.

Unit IV

CRYSTALLIZATION: Crystallization equilibrium -rate of crystal growth – stage of crystallization – magma- nucleation crystallization equipment. Variations in crystallizers – vacuum crystallizers. Draft tube, baffle crystallizers.

Unit V

MEMBRANE SEPARATION: Micro, Ultra and Nano filtration. Types of membranes. Permeate flux for ultrafiltration – concentration polarization – Application of ultrafiltration, diafiltration – membrane fouling – Separation of gases – porous membrane – Polymer membrane – Membrane structure -flow patterns. – Pervaporation – Reverse Osmosis

Text Books

1. Geankoplis, CJ, “Transport Processes and Separation Processes Principles” .Printice Hall India, New Delhi, ISBN-978-81-203-2614-9, 2008.
2. Warren,L McCabe, J.C. Smith and Peter Harriot.”Unit Operations of Chemical Engineering “ McGraw Hill International ,7thEdition ,Singapore, ISBN-007-424740-6, 2005.

Reference Book

1. Earle, R.L. “Unit Operations in Food Processing”. Pergamon Press,2nd Edition,UK, 2003.

12FP223 FOOD SAFETY REGULATIONS

Credits: 3:0:0

Course Objectives:

To enable the student to understand

- Importance of Food Safety
- Regulating authorities for food safety world over

Course Outcome

- On completion of the subject, the students will gain knowledge on regulations followed in various food industries.

UNIT 1

FOOD REGULATIONS: World Trade order – Functioning and responsibilities of the WTO - Codex Alimentarius –History, operations of Codex alimentarius, Responsibilities – Codex standards and Maximum residue limits – Current Issues under consideration – SPS (Sanitary and phytosanitary measures) agreement. World Health Organisation – History and mandate – Operations and responsibilities – ICGFI – Functions and responsibilities. Concept of Six Sigma

UNIT II

FOOD AUTHORITY IN INDIA: Food safety and Standards Act – organizational chart – role of individual authority –principles to be followed –Provisions as to articles of food – imported items – Responsibilities of the food business operator – Liability of manufacturers, packers, wholesalers, distributors and sellers –Enforcement of the act – Licensing and registration of food business – Food safety officer andtheir powers – Analysis of food – regulations regarding labs involved in food analysis – Offences and penalties – Adjudication and food safety appellate tribunal – Laws relating to Food Processing Industries in India - FPO, MMPO, PFA, AGMARK, Essential Commodities Act, BIS

UNIT III

FOOD LABELING : Need for labeling – Developing labeling standards at the world level – Limitations of labeling safety issues – Labeling regarding methods of processing – Irradiated products – Products derived from modern biotechnology – organic produce - Genetically modified foods – EU rules on nutritional labeling – US rules on nutritional labeling – Health claims – Approach of US and EU

UNIT IV

MICROBIOLOGICAL FOOD SAFETY : Concept of HACCP – Assembling the team – Product description – Describing the product’s intended use – Establishing a process flow diagram – on site confirmation - Listing potential hazards and control measures - Determination of critical points – decision tree for CCPs- Establishing monitoring procedures- establishing corrective actions – establishing verification Procedures

UNIT V

SAFETY ASPECTS OF WATER: Safety aspects of drinking water (microbiological and chemical) - the epidemiological triangle diseases caused by drinking of contaminated water , bottled water – setting of guideline values (microbiological and chemical) – risks and advantages of chlorination of water-Bottled water –origin of water- nutritional and physiological aspect – safety aspects – microbiological and chemical quality – Regulations for bottled water – EU, US and India

Text Books

1. Kees A. van der Heijden and Sanford Miller, “International Food Safety Handbook: Science, International Regulation, and Control”, Published by CRC Press, ISBN 0824793544, 9780824793548, 1999.

2. Guide to the Food Safety and Standards Act, Tax-mann Allied Services Pvt. Ltd., ISBN 10-8174968288, 2006.

Reference Book

1. Mehta R. and George J., "Food Safety Regulation Concerns And Trade- The Developing Country Perspective", Published by Macmillan India Ltd., New Delhi. ISBN 1403925046, 9781403925046, 2005.

12FP224 PROCESS EQUIPMENT DESIGN

Credits: 4:0:0

Course Objective:

- To enable the student to design and develop equipments used in Food Processing operations.

Course Outcome:

To gain technical know-how about the material requirements and design of various equipments needed in Food industries.

Unit I

MATERIALS : Metals and non metals, design of pressure vessels – cylindrical shell – internal and external pressure -under continued loadings. Numerical problem and design of pressure vessel.

Unit II

STORAGE VESSELS: Design of storage vessels – Rectangular Tank without stiffeners – with stiffeners – shell design – Numerical problem and design.

Unit III

REACTION VESSELS: Design of Reaction vessels – materials -classification – jackets- Design of vessel shell with half coil – Design of vessel shell with jacket – Numerical problem and design.

Unit IV

HEAT EXCHANGERS: Design of Heat exchangers – types – materials – Design pressure and temperature- shell design – tubes – Numerical problem.-Design of Equipment.

EVAPORATOR: Materials of concentration – types – design-consideration – Design of agitators – power requirements – Design based on Torque – critical speed.

Unit V

DRYERS: Types - General considerations – Design of Tray dryer , Rotary Dryer - Material Balance , Thermal energy Requirments , electrical energy Requirements, Performance Indices

Text Books

1. Maroulis Z.B. and Saravacos G.D. Food Process Design, Marcel Dekker Inc. ISBN-0824743113, 2003.

2. Joshi M.V, “Process Equipment Design”, Macmillan India Ltd.,1985

Reference Book

1. Coulson ,J.M. and Richardson,J.F. “Chemical Engineering “ Butterworth-Heinemann – Elsevier, ISBN-0750644451, 2002.

12FP225 PROCESS ECONOMICS AND PLANT LAYOUT DESIGN

Credits: 3:0:0

Course Objective:

- To enable the students understand the various concepts of economics, process development, design consideration and cost estimation in food industry.

Course Outcome:

- The students will be able to apply their knowledge to design projects for setting up a Food Processing Industry.

Unit I

FOOD PROCESS DESIGN DEVELOPMENT: Technical feasibility survey of Food Industry, process development, Food Process flow sheets – Hygienic food process design - equipment design and specifications – Computed-aided process design – Principles of spreadsheet aided process design (Basic concepts only)

Unit II

PLANT LAYOUT: Marketability of the product, availability of technology, raw materials, equipments, human resources, land and utilities, site characteristics, waste disposal, Government regulations and other legal restrictions, community factors and other factors affecting investment and production costs. Plant Layout based on process and product.

Unit III

PROJECT EVALUATION AND COST ESTIMATION: Capital investments – fixed capital investments including land, building, equipments and utilities, installation costs (including equipments, instrumentation, piping, electrical installation and other utilities), working capital investments. Manufacturing costs – Direct production costs(including raw materials, human resources, maintenance and repair, operating supplies, power and other utilities, royalties, etc.). – Process Profitability - Application to a Food Processing plant e.g. Tomato processing

Unit IV

PLANT OVERHEADS: Administration, safety and other auxiliary services, payroll overheads, warehouse and storage facilities etc

Unit V

PROFITABILITY ANALYSIS: Return on original investment, interest rate of return, accounting for uncertainty and variations and future developments. Optimization techniques – Linear and Dynamics programming, Optimization strategies.

Text Book

1. Peters and Timmerhaus, Plant design and Economics for Chemical Engineers, McGraw Hill 5th Edition, ISBN-007-124044-6, 2004 .

Reference Books

1. Maroulis Z.B. and Saravacos G.D. Food Process Design, Marcel Dekker Inc. ISBN-0824743113, 2003.
2. Rudd and Watson, Strategy of Process Engineering, Wiley and Sons, 1987

12FP226 FOOD ADDITIVES

Credits: 3:0:0

Course Objectives:

- To understand the importance of food additives in improving the overall quality of processed food
- To gain knowledge on their safety

Course Outcome:

- The students would be able to design newer products, with better quality using additives which are economical and safe

Unit I

INTRODUCTION: Food additives - definition and classification, food safety levels as per the specifications, safety evaluation of additives – determination of acute and chronic toxicity - NOEL, ADI, LD50 value, PFA regulations, GRAS status.

Unit II

ACIDULANTS: Types, chemical properties, levels of additions in individual products, toxicity data of Acidulants – Preservatives – Emulsifiers and gums - Antioxidants

Unit III

HUMECTANTS: Types, chemical properties, levels of additions in individual products, toxicity data of Dough conditioners - flour improvers – Humectants

Unit IV

FAT SUBSTITUTES AND REPLACERS: Types, chemical properties, levels of additions in individual products, toxicity data of Colourants – Natural and artificial, Flavourants, Flavour enhancers, Fat substitutes and replacers

Unit V

NUTRITIONAL ADDITIVES: Types, chemical properties, levels of additions in individual products, toxicity data of Sweeteners – Natural and synthetic, Chelating agents, antibrowning agents, Nutritional additives

Text Book

1. Food additives by Brannen A.L., Davidson P.M., Salminen S. and Thorngate J.H. Second Edition, Revised and Expanded. Marcel dekker Inc. USA, 2002.

Reference Book

1. Newton, D.E. Food Chemistry. An Imprint of Infobase Publications, New York. 2007

12FP227 FOOD ENGINEERING AND PACKAGING LAB**Credits: 0:0:2****List of Experiments:**

1. Characterization of Dehydrated Products- Extruded Products
2. Characterization of Dehydrated Products-Extruded Ready-To-Cook and flaked Products.
3. Determination of Particle Size-Sieve Analysis
4. Determination of The Overall Heat Transfer Coefficient Of Plate Heat Exchanger – Co-Current Flow
5. Determination of The Overall Heat Transfer Coefficient Of Plate Heat Exchanger - Counter Current Flow
6. Determination of efficiency of a distillation column
7. Kinetics of Anthocyanin extraction
8. Kinetics of Anthocyanin degradation
9. Determination of viscosity by Ostwald's viscometer
10. Determination of the migration characteristics of the given material – acid as stimulant
11. Determination of the migration characteristics of the given material – alcohol as stimulant
12. Determination of the Water Vapour Transmission rate of the given packaging material.

12FP228 ANALYSIS OF FOOD PRODUCTS OF PLANT ORIGIN (FRUITS AND VEGETABLES) LAB**Credits: 0:0:2****List of Experiments**

1. Analysis of reducing sugars in jam
2. Analysis of total sugars in jam
3. Determination of pectin content of jam
4. Determination of acidity in fruit juices
5. Determination of total fruit solids in sauces
6. Determination of salt content in pickles
7. Determination of calcium content of jaggery
8. Estimation of lycopene in sauces
9. Estimation of carotenoids in mango juices
10. Estimation of anthocyanins
11. Estimation of ascorbic acid in fruit beverage
12. Estimation of polyphenol in a plant product

12FP229 FAT AND OIL PROCESSING TECHNOLOGY

Credits: 3:0:0

Course Objectives:

- To understand the physical and chemical properties of fats and oils
- To study the extraction and refining processes
- To learn the packaging, quality standards of fats and oils.

Course Outcomes:

Students would be able to

- Appreciate the importance of fats and oils and their manufacture
- Develop technology for manufacture of designer fats
- Develop newer methods of analysis of oils and fats

Unit I

PHYSICAL AND CHEMICAL PROPERTIES: Fats and oils – formation – functions of oil in human body - fatty acids – double bonds and their position in oil – Geneva type classification - sources of vegetable oils – production status-oil content – coconut , palm, peanut , rice bran, sesame, mustard and sunflower seeds oil – physical and chemical properties of fats and oils - chemical reactions of oil – hydrolysis – hydrogenation, oxidation and polymerization.

Unit II

EXTRACTION METHODS: Oil extraction methods –mechanical expression – ghani , power ghani, rotary, hydraulic press, screw press, expellers, filter press - principle of operation and maintenance-solvent extraction process – steps involved, batch and continuous-continuous solvent extraction process for rice bran, soy bean and sunflower-oil extraction process for groundnut and cotton seed-production of special oils – palm oil, virgin coconut oil – extraction process.

Unit III

REFINING OF OILS: Refining of oils – objectives – characterization - degumming – Zeneath process – deacidification process – continuous acid refining-bleaching of oil – continuous bleaching process –decolourising agents-deodorization process winterization processes-hydrogenation of oil –selectivity – catalyst – batch type hydrogenation – regeneration of catalyst-vanaspati, ghee and margarine – production process-partial sterilization, emulsification, chilling, kneading and rolling, incorporation of salt, colouring substances-production of special fats – butter – types - production and storage.

Unit IV

PACKAGING OF EDIBLE OILS: Packaging of edible oils – requirements – types – tinplate, semi rigid, glass, Polyethylene Terephthalate, Poly Vinyl Chloride, flexible pouches – packaging for vanaspati and gheechanges during storage of oil –rancidity – causes – atmospheric oxidation and enzyme action – free fatty acid – colour-non edible oils – castor oil, linseed oil, vegetable waxes – production and processing.

Unit V

INDUSTRIAL APPLICATIONS AND QUALITY STANDARDS: Industrial applications of fats and oils – quality regulations - manufacture of soap, candle, paints and varnishes - ISI and Agmark standards – site selection for oil extraction plant- safety aspects- HACCP standards in oil industries.

Text books

1. Harry Lawson, "Food oils and Fats - Technology, Utilization and Nutrition", CBS Publishers and Distributors, New Delhi, 1997.
2. Gunstone F.D., "Oils and Fats in Food Industry", Blackwell Publishing, United Kingdom, ISBN – 13: 9781405171212, 2008.

Reference book

1. Gunstone F.D., "Vegetable Oils in Food Technology: Composition, Properties and Uses", 2nd Edition, Wiley - Blackwell Publishing Ltd., ISBN 9781444332681, 2011.

12FP230 TECHNOLOGY OF MEAT, POULTRY AND FISH

Credits: 3:0:0

Course Objectives:

- To understand about the composition, nutritive value of meat, poultry and fish
- To know about processing technology of meat, poultry and fish
- To learn the technology of meat products and eggs

Course Outcome:

- The student will be able to understand about how to process meat, poultry and fish, preparation of different types of products from meat, poultry and fish

Unit I

CHEMISTRY AND MICROBIOLOGY OF MEAT: Meat composition from different sources; Definitions and measurements, Explanation of muscle structure and compositions and its modifiers, White and Red Meat, Description of animal fat and its modifiers, description of bone and its modifiers; Post mortem muscle chemistry, Meat colour, flavors of meat products, meat microbiology and safety.

Unit II

SLAUGHTERING AND CARCASS PROCESSING: Modern abattoirs and some features, Ante mortem handling and welfare of animals, design of handling facilities, Hoisting rail and traveling pulley system, and stunning methods, stunning pen, slaughtering equipment, Washing area, Sticking, bleeding, dressing, Beef/Sheep and Pig Dressing operations, Offal handling and inspection, Inedible by products: Carcass processing equipment, Operational factors affecting meat quality, effects of processing on meat tenderization; meat processing equipment, electrical gadgets and manual gadgets; Typical lay outs.

Unit III

MEAT PRODUCTS: Canned meat, Frozen meat, Cooked and Refrigerated meat, Dried and preserved meat, Cured meat, Prepared meat products, Production methods for Intermediate moisture and dried meat products, Different kinds of sausages – Equipment used for all the process operations; Meat plant hygiene, Good manufacturing practice and HACCP.

Unit IV

PROCESSING OF POULTRY PRODUCTS: Poultry industry in India, measuring the yields and quality characteristics of poultry products, microbiology of poultry meat, spoilage factors; Plant sanitation; Poultry meat processing operations in detail along with equipment used – Defeathering, bleeding, Scalding etc.; Packaging of poultry products, refrigerated storage of poultry meat, by products – eggs, egg products, Whole egg powder, Egg yolk products, their manufacture, packaging and storage.

Unit V

FISH AND OTHER MARINE PRODUCTS PROCESSING: Commercially important marine products from India, Product export and its sustenance, Basic biochemistry, spoilage factors of fish, field refrigeration and icing practice, merits and demerits, Use of dry ice and liquid nitrogen as preservation elements, use of Refrigerated Sea Water (RSW) for preservation, Changes during storage in RSW and CSW; Freeze preservation; freezing of prawn and shrimp, weighing, filling and glazing, Individual quick freezing, in pack freezing, relative merits and demerits, Canning operations, Salting and drying of fish, pickling and preparation of fish protein concentrate, fish oil and other by products.

Text Book

1. Hui, Y.H., Nip, W.K., Rogers, R.W, “Meat Science and Applications”. Marcel Dekkar Inc. New York,2001.

Reference Books

1. Joseph Kerry, John Kerry and David Ledwood, “Meat Processing”, Woodhead Publishing Limited, CRC Press, 2002.
2. Balachandran, K.K, “Post Harvest Technology of Fish and Fish Products”, Daya Publishing House, New Delhi, 2001.
3. Mead G, “Poultry meat processing and quality”, Woodhead Publishing Limited, 2004.

12FP231 FOOD PRESERVATION PRINCIPLES

Credits: 3:0:0

Course Objectives:

- To understand the fundamentals of bio molecules
- To impart basic knowledge on the methods of analysis of fats and oils
- To know the food additives and microbes associated with food
- To learn about the food borne diseases , food poisoning and food preservation principle

Course Outcome:

- To gain knowledge and develop skills on various principles associated with food processing.

Unit I

FUNDAMENTALS OF FOOD CONSTITUENTS: Introduction to Proximate constituents of food -Carbohydrates – Classification – Simple & complex, mono-, di-, oligo- and polysaccharides; Important reaction of carbohydrates –Caramelisation, Maillard. Fats – classification – Analysis of Fats and oils – Saponification value, Iodine value, Acid value, Acetyl value, Peroxide value – Principles and Importance of the analytical methods, Vitamins – Fat and water-soluble – nutritional significance

Unit II

FOOD ADDITIVES: Introduction to food additives - Classification, intentional and non-intentional additives, functional role in food processing and preservation; food colourants – natural and artificial; food flavours; enzymes as food processing aids.

Unit III

MICROORGANISMS ASSOCIATED WITH FOOD: Bacteria, yeasts and molds – sources, types and species of importance in food processing and preservation; fermented foods and food chemicals, single cell protein.-examples and their applications

Unit IV

FOOD BORNE DISEASES: Classification – food infections – bacterial and other types; food intoxications and poisonings – bacterial and non-bacterial; food spoilage – factors responsible for spoilage, spoilage of vegetable, fruit, meat, poultry, beverage and other food products.

Unit V

FOOD PRESERVATION: Principles involved in the use of sterilization, pasteurization and blanching, thermal death point - methods of determination of thermal death time (Graphical, mathematical) – D, Z and F values – Importance of 12 D concept, Time – Temperature indicators - Canning; frozen storage-freezing methods, factors affecting quality of frozen foods; irradiation preservation of foods.

Text Books

1. Coultate T.P “Food – The Chemistry of its Components”, 2nd Edition. Royal Society, London, 1992.
2. Sivasanker, B, “Food Processing and Preservation”, Prentice-Hall of India Pvt. Ltd. New Delhi, ISBN-9788120320864, 2002.

Reference Books

1. Frazier W.C. and D.C. Westhoff, “Food Microbiology”, 4th Ed., McGraw-Hill Book Co., New York, ISBN_9780070667181,2008.
2. Jay J.M, “Modern Food Microbiology”, CBS Publishers, New Delhi, 1987.

12FP232 BIOCHEMICAL ENGINEERING

Credits: 3:0:0

Course Objective:

- To enable the student to understand the basic biological concepts in food engineering

Course Outcome:

- To adopt processing methods of biological materials and processing using biological agents.

Unit I

KINETICS OF ENZYME-CATALYZED REACTIONS: Kinetics of Enzymes as a catalyst – activation energy -cofactor – apoenzymes – holo enzymes -simple enzymes kinetics with one and two Substrates – Michaelis -Menten Kinetic equation – evaluation of parameters. Lineweaver- Burk plot and Eadie -Hofstee plot

Unit II

SUBSTRATE CONCENTRATION: Substrate activation and inhibition – Multiple substrates reacting on a single enzymes. Modulation and regulation of enzymes activity - other influences on enzymes activity – pH, temperature – fluid forces – chemical agents – enzymes reaction rates – enzymes deactivation.

Unit II

APPLIED ENZYMES CATALYSIS: Hydrolytic enzymes – Hydrolysis of starch and cellulose – enzyme immobilization – Industrial processes – ideal batch reactors. Ideal continuous flow stirred – tank reactor (CST)-Monod growth kinetics.

Unit IV

DESIGN AND ANALYSIS OF BIOLOGICAL REACTORS: Ideal bioreactors – Fed batch reactors – Enzymes catalyzed reactions in CSTR's – CSTR with recycle – plug flow reactor – Reactors with non- ideal mixing – Mixing Time – Residence time. Sterilization reactors – Batch and continuous. Types -Multiphase Bioreactors – packed bed – Bubble columns. Fluidized bed, Trickle bed -Fermentation technology.

Unit V

PRODUCT RECOVERY: Recovery of Particulates. Cells and solid particles – filtration centrifuge – sedimentation – product isolation -solvent extraction – precipitation chromatography – Membrane separations – Reverse Osmosis, Ultra filtration- Electrophoresis.

Text Book

1. James E. Bailey and David F.Ollis “Biochemical Engineering Fundamentals” McGraw – Hill Book Company, 3rd Reprint, Singapore, ISBN-0-07-003212-2, 1987.

Reference Book

1. Harvey W.Blanch and Douglas S.Clark.”Biochemical Engineering“ Marcel Dekker ,Inc, Chennai Micro Print (P)Ltd.Cennai, 2007

12FP233 BAKERY AND CONFECTIONERY TECHNOLOGY

Credits: 3:0:0

Course Objectives:

- To provide know how on the machinery and process involved in the baking process
- To understand the various types of sugar and its grades
- To know the confectionery product manufacture

Course Outcome:

- To gain knowledge on the ingredients, process and machinery involved in bakery and confectionery technology.

Unit I

BAKERY EQUIPMENTS AND TESTING OF FLOUR FOR BAKERY GOODS:

Laboratory testing of Wheat grain Quality, Moisture tests, Grain hardness testing. Testing, Visco graph, Amylograph, Ferinograph. Dough mixers, Dividers, rounders, Proofing, moulding, Ovens, Slicers, Packaging materials and equipment, Sanitation and safety.

Unit II

BAKED PRODUCTS: Materials of baking, Bread manufacturing process – Straight dough fermentation, Sponge and dough, Biscuit-Types of biscuit dough – Developed dough, short dough, semi-sweet, enzyme modified dough and batters- importance of the consistency of the dough- Cake – Flour specification – ingredients – manufacturing process – types of chemically aerated goods.

Unit III

SUGAR PRODUCTION PROCESS DETAILS: Energy and material balance of cane sugar process. Extraction of juice, extraction yields, drying and uses of Bagasse, Purification of juices-juice filtration and chemical purification, Clarification stages, Lime addition, pH control, Treatment of clarified juice, evaporation –multiple effect evaporators, Vacuum pans, Crystallization, Washing of sugar crystals and centrifugal separation/dewatering of sugar and other related processes. Sugar Refining, Sugar analysis, Sugar recovery –improvement, /Sugar balance, energy conservation, Sugar plant sanitation.

Unit IV

TECHNOLOGY OF BEVERAGES MANUFACTURE (ALCOHOLIC AND NON ALCOHOLIC): Manufacture of beer, wine and champagne - Quality characteristics, Manufacture of distilled beverages including whisky, brandy, rum and gin – Quality aspects
Manufacture of carbonated beverages – quality aspects – Manufacture of sugar-free, sugarless, carbonated beverages.

Unit V

CONFECTIONERY TECHNOLOGY: Types of Confectionery, raw materials and processing of toffee, chocolates, fruit drops, hard boiled candies. Additives for Confectioneries. Equipments used in Confectionery manufacture.

Text Book

1. Samuel A. Matz, “Bakery Technology and Engineering”, Chapman & Hall, 3rd Edition, 1992.

Reference Books

1. “Association of Operative Millers Cereal Millers Hand Book”, Burgess Publishing company, USA, 1963.
2. Pomeranz Y, “Modern Cereal science and Technology” MVCH Publications, NY, 1987.
3. Kent N.L., Evers A.D, “Technology of Cereals” Pergamon Press, Elsevier Publishers, 1994.
4. Samuel A. Matz, “Equipment for Bakers” Pan Tech International Publication, 1988.
5. Stanley P Cauvain, Linda S Young, “Technology of Bread making”, Aspen publication, 2nd Edition, 2007

12FP234 FOOD PACKAGING TECHNOLOGY

Credits: 3:0:0

Course Objective:

- To enable the students to understand about packaging and packaging materials, interaction of food items with packaging materials

Course Outcome:

- The students will get exposure about how to package the food items using different techniques, how to use cans and films for packaging and its properties, how food items are interacting with packaging materials.

Unit I

INTRODUCTION TO FOOD PACKAGING: Functions of packaging, Effect of environmental factors - light, Oxygen, Moisture, Temperature, mechanical forces and biological factors on quality of food. Estimation of shelf life. General Approach, analysis of storage requirement, accelerated storage studies: Vacuum and Inert Gas Packaging: Tests on packaging materials, Mechanical strength (Tension, notch and tearing strengths), Gas and water vapour transmission rates.

Unit II

METAL CANS AS PACKAGING: Metallic can types - Tin cans and Aluminum cans. Specialty of Open top sanitary cans, Lacquers and their use, Three piece cans and Two piece cans, Aerosol Cans, Basics of Canning operations – Can Reformer, Flanger, Seaming, Can closures. Glass jars and Bottles in food packaging, Design features and applications, Sterilization of bottles.

Unit III

FLEXIBLE FILMS PACKAGING: Formation of Films and pouches, Plastics used and their Specific applications - Polyethylene (LDPE and HDPE), Cellulose, Polypropylene (PP), Polyesters, Polyvinylidene Chloride (PVDC - Diofan, Ixan and Saran), Polyvinyl chloride, Copolymers their applications. Co-extruded films and Laminates. Rigid and Semi rigid plastic packaging – fabrication methods – Thermo forming, Blow moulding, Injection moulding, Extrusion – Retort pouch packaging. Laminated Paper board Cartons, Fibre Board and Corrugated Card Board packaging and their applications.

Unit IV

FILLING AND SEALING OPERATIONS FOR VARIOUS TYPES OF PACKAGES: Closing and sealing of Rigid plastic containers. Filling and sealing of Flexible plastic containers, Seal types-Bead seals, Lap Seals and Fin seals –Differences and advantages, Hot wire sealing, hot bar sealing and impulse sealing – differences and relative advantages, Form fill Seal equipment: Printing on packages, Bar codes, Nutrition labeling and legislative requirements. Filling and Sealing of pouches, pouch from fill seal machines.

Unit V

INTERACTION OF FOOD MATERIAL WITH PACKAGING MATERIAL: Active packaging, Moisture control, CO₂ and Oxygen scavenging, Modified atmosphere packaging – principles, applications. Permeability of gases in packs. Speciality packages.

Text Book

1. Coles, R., Dowell, D.M., Kirwan, J. "Food Packaging Technology". Black Well Publishing Ltd.ISBN-084939788X, 2003.

Reference Books

1. NIIR Board: Food Packaging Technology Handbook National Institute of Industrial Research, New Delhi (2004)
2. Pirenger O.G.and A.L.Baver: Plastic Packaging Materials for Food Wiley VCH, GmbH, Germany (2000)

12FP235 STORAGE ENGINEERING

Credits: 3:0:0

Course Objectives:

- To expose the students to the large scale handling and storage mechanism of grains.
- To make the students understand the engineering operations involved in control of physical, chemical and biological spoilage during storage of grains.

Course Outcome:

- To gain knowledge on the various aspects of storage of grains and storage structures.

Unit I

PHYSICO - CHEMICAL AND THERMAL PROPERTIES OF GRAINS: Grain dimensions, bulk density, true density, porosity, coefficient of friction, angle of repose, thermal conductivity and aerodynamic properties. Psychrometry: humidity, % relative humidity, humid heat, deterioration index, wet bulb temperature, use of psychrometric charts.

Unit II

GRAIN DRYING: Moisture content, equilibrium moisture content; free and bound water, rate of drying, constant and falling rate of drying rate; factors affecting rate of drying process, types of dryers used for drying of grains.

Unit III

GRAIN STORAGE: Principles, moisture movement during bulk storage of grains, pressure distribution in storage bins, methods of aeration, various theories, Physical, chemical, microbiological and sensory changes occurring during storage, Grain storage structures - location and material selection for storage building, Types - traditional, modern; temporary and permanent storage structures; design considerations.

Unit IV

INSECTS AND PESTS: Types, extent of losses during storage, causes and control measures, Insecticides- principles, scope of application in warehouses; requirements, group of active ingredients, choice, toxicity, resistance, application techniques, Fumigants - chemicals, areas of application, choice, toxicity, application rates, exposure time and resistance. Rodenticides - Types and effectiveness and limitations, important moulds and bacteria involved in spoilage of grains; effect on physico- chemical and sensory quality of grains; mycotoxins.

Unit V

CONTROLLED ATMOSPHERE STORAGE: Air tight, controlled atmosphere and modified atmospheric storage; differences, principles, optimization of storage gas composition, rate of supply, control systems for oxygen and carbon dioxide- their effect on microbes and limitations.

Text book

1. Sahay K.M and K.K.Singh. "Unit Operations of Agricultural Processing" Vikas Publications, New Delhi, ISBN-81-259-1142-1, 2007.

12FP236 EMERGING TECHNOLOGIES IN FOOD PROCESS ENGINEERING

Credits: 3:0:0

Course Objectives:

To enable the student to understand:

- Emerging / alternative technologies applied to food processing
- Relative advantages / disadvantages over existing technologies
- Economics and commercialization of newer technologies
- Strategies for applying the same to a wide range of food

Course Outcomes:

- The student understands different Emerging technology in Food Processing.
- To apply the knowledge in real time Food Processing Innovations

Unit I

HIGH PRESSURE PROCESSING OF FOODS : Principles – applications to food systems – effect on quality – textural, nutritional and Microbiological quality – factors affecting the quality – modeling of high pressure processes – High Pressure Freezing, Principles and Applications

Unit II

PULSED ELECTRIC FIELD PROCESSING OF FOODS : Principles – Mechanism of action – PEF treatment systems – Main processing parameters – PEF Technology – Equipments – Mechanism of microbial and enzyme inactivation- safety aspects– Processing of liquid foods using PEF – Process models – Comparison of High pressure processing and PEF – Enzymatic Inactivation by PEF, Examples – Microbiological and chemical safety of PEF foods

Unit III

OSMOTIC DEHYDRATION OF FOODS : Principle – Mechanism of osmotic dehydration – Effect of process parameters on mass transfer – Methods to increase the rate of mass transfer – Applications – Limitations of osmotic Dehydration – Management of osmotic solutions

Unit IV

OHMIC AND ULTRASOUND PROCESSING OF FOODS: Principle of ultrasound – Fundamentals – Ultrasound as a processing and preservation aid – Effect on properties of foods Basics of ohmic heating – Electrical conductivity - generic configurations- treatment of products

Unit V

PULSED LIGHT AND HURDLE TECHNOLOGY: Basics of hurdle technology – Mechanism Application to foods - Newer Chemical and Biochemical hurdles- organic acids – Plant derived antimicrobials – Antimicrobial enzymes – bacteriocins – chitin / chitosan (only one representative example for each group of chemical and biochemical hurdle)

Text Book

1. Da-wen Sun: Emerging Technologies for Food Processing, Elsevier Academic PressMarcel Dekker Inc. NY (1995)

Reference Books

1. Leistner L. and Gould G. Hurdle Technologies – Combination treatments for food stability safety and quality, Kluwer Academics / Plenum Publishers, New York,2002.
2. Novel Food Processing Technologies(Food Science and Technology Series) by Gustavo V. Barbosa-Canovas, Maria S. Tapia, M. Soledad Tapia, M. Pilar Cano,Publisher: CRC Press, November, ISBN-13: 9780824753337,2004.
3. Pulsed electric fields in food processing: Fundamental aspects and applications: a volume in the Food Preservation Technology series, Edited by G V Barbosa-Cánovas, Washington State University and Q H Zhang, Ohio State University, USA, Woodhead Publishing Limited, Abington Hall, Abington, Cambridge, CB1 6AH,England, 2001

12FP237 FUNCTIONAL FOODS AND NUTRACEUTICALS

Credits: 3:0:0

Course Objectives:

- To understand the basics of nutraceuticals and functional foods
- To study the significance of nutraceuticals and their role in disease prevention
- To identify new strategies for marketing of traditionally known nutraceuticals

Course Outcomes:

- To understand the importance of Functional food for preventive therapy
- To develop methods for extraction and identification of nutraceutically significant molecules.

Unit I

NUTRACEUTICALS: HISTORICAL, TECHNOLOGICAL ASPECTS AND CLASSIFICATIONS: Introduction – Historical Reviews - Teleology of nutraceuticals - Organization models for nutraceuticals – Classification of Nutraceuticals based on the sources– Animal, Plant and Microbial – Nutraceuticals in specific foods - Mechanism of Action - Chemical nature.

Unit II

FLAVANOIDS AND CAROTENOIDS AS ANTIOXIDANTS: General background on phytochemicals as antioxidants - Flavonoids and Lipoprotein oxidation - Evidence for specific Antioxidant mechanisms of Flavonoids - Dietary carotenoid and carotenoid absorption - Approaches to measurement of absorption - Metabolism of Carotenoids – Carotenoids as anticancer agents.

Unit III

OMEGA-3 FATTY ACIDS AND CLA: Introduction to Lipoprotein metabolism - PUFA and Cardiac Arrhythmias - Preventative role of n-3 fatty acids in cardiac arrhythmias - Mechanism of action on n-3 PUFA's - ω – 3 fish oils and their role in Glycemic control- ω – 3 fatty acids and rheumatoid arthritis - Chemistry and Nomenclature of CLA – Analysis of CLA in food and biological samples – CLA in food products and biological samples – Biological actions and potential health benefits of CLA – Mechanisms of CLA action – Potential adverse effects of CLA

Unit IV

LYCOPENE, GARLIC, OLIVE OIL, NUTS, PROBIOTICS AND PREBIOTICS:

Lycopene overview – lycopene and disease - Garlic – Chemistry – Implication in Health - Olive oil – CHD – Cancer - Nuts – Nutrient components and Composition - Nut Consumption and CHD epidemiological evidence, Human nutritional studies on nut consumption and serum lipid changes, Mechanism of action- Probiotics- criteria – products on market – probiotic products – Microbiology of the gastrointestinal tract - Prebiotics – future for probiotics and prebiotics.

Unit V

HERBS AS FUNCTIONAL FOODS, STABILITY, TESTING AND MARKETING ISSUES FOR NUTRACEUTICALS AND FUNCTIONAL FOODS:

Herbal medicine – Herbs as ingredients in functional foods – actions of herbal and evidence of efficacy - Kinetic modelling of chemical reactions – Accelerated shelf life testing - Evolution of marketing environment for Functional foods and nutraceuticals - Regulatory background - Introduction to consumer marketing issues for nutraceuticals - Potential product positioning.

Text Book

1. Wildman, R.E.C., “Handbook of Nutraceuticals and Functional Foods”, CRC Press LLC. ISBN-0849387345, 2001.

12FP238 DRYING TECHNOLOGY

Credits: 3:0:0

Course Objectives:

- To understand the basic theory of drying and its significance in food systems
- To understand the importance of drying as a method of food processing
- To learn about the relative advantages / disadvantages of each method of drying

Course Outcome:

- The students will be able to apply their knowledge on drying technology in various food industries.

Unit I

THEORY OF DRYING: Principles of drying – Fundamentals of air-water mixtures – Psychrometric chart – Problems based on psychrometry – Drying curves – constant and falling rate period - Heat and mass transfer in dryers – with and without recirculation. Water content in foods and its determination - Cabinet drying – Vacuum drying.

Unit II

DRUM DRYING, FOAM MAT DRYING AND OSMOTIC DEHYDRATION OF FOODS: Drum driers - Types of Drum Dryers - Principles of Operation of the Drum Dryer – Steam Consumption – Types of Feeding – Final product form. Foam Mat Drying- Principles- Equipments- Factors affecting Foam mat drying. Osmotic dehydration – Principles – Factors affecting osmosis- Equipment used. Rotary Dryer.

Unit III

SPRAY DRYING OF FOODS: Principles of Spray Drying Processes – Atomization - Drop Size and Size Distribution Wheel Atomizers - Pressure Nozzles - Pneumatic Nozzles - Chamber Design - Chamber Shape - Air-Droplet Contact Systems - Powder and Air

Discharge Systems - Ancillary Equipment - Fans -Powder Separators – Reconstitution of powders – Foam spray drying

UNIT IV

FREEZE DRYING AND MICROWAVE DRYING OF FOODS: Fundamentals of freeze drying – Freezing – Primary drying stage – secondary drying stage -Changes during freeze drying – Condensation, defrosting – Industrial freeze driers. Fundamentals of microwave and dielectric drying - Equipment for microwave and dielectric heating and drying.

Unit V

FLUIDIZED BED AND PNEUMATIC DRYING: Fluidized bed drying – Introduction – Effect of operating parameters – conventional and modified fluidized bed dryer – Pneumatic / Flash dryers - Basic Operation Principle and Applications of Flash Dryers - Design of Flash Dryers - Materials Dried in Flash Dryers.

Text Books

1. Arun S. Mujumdar, “Handbook of Industrial Drying”, CHIPS, 3rd Edition, 2006.
2. Paul Singh, R and Dennis R. Heldman.. Introduction to Food Engineering Academic Press, 2001

Reference Books

1. Hui Y. H.,”Food Drying Science and Technology, Microbiology, Chemistry, Application”, CHIPS, 2008.
2. Loesecke,H. W. V, “Drying & Dehydration of Foods”, Published by Agrobios, 2005.

12FP239 FOOD PRODUCT TECHNOLOGY LAB – II

Credits: 0:0:2

List of Experiments

1. Preparation of Rasagulla
2. Preparation of Sandesh
3. Preparation of Paneer
4. Preparation of Kalakhand
5. Preparation of Peda
6. Preparation of Gulab Jamun
7. Preparation of Bread and Butter Pickle
8. Preparation of Hot and Sour Tomato Pickle
9. Preparation of Chilly and Ginger Pickle
10. Preparation of Soanpapdi
11. Preparation of Mysorepak
12. Preparation of Gummies
13. Preparation of aerated confectionery

12FP240 ANALYSIS OF FOOD PRODUCTS OF ANIMAL AND PLANTATION PRODUCTS ORIGIN LAB

Credits: 0:0:2

List of Experiments

1. Estimation of fat in milk by Gerber’s method

2. Estimation of curcumin in turmeric
3. Estimation of cholesterol in egg.
4. Estimation of salt in dried fish
5. Estimation of iodine value of butter
6. Determination of moisture content of spices
7. Determination of total volatile oil by Clavenger apparatus
8. Determination of Scoville's index of capsaicin
9. Analysis of total extractives and ash content of tea
10. Determination of tannins in tea.
11. Determination of cocoa butter content of chocolates
12. Determination of caffeine content of coffee
13. Analysis of Food Samples by HPLC, GC.

12FP241 FOOD ADDITIVES LAB

Credits: 0:0:2

List of Experiments

1. Estimation of Sulphur-Di-Oxide
2. Estimation of Sodium Benzoate
3. Estimation of Sorbic Acid
4. Estimation of Butylated hydroxyl toluene
5. Estimation of Propyl Gallate
6. Estimation of Ascorbic Acid
7. Estimation of Carotenoid
8. Estimation of Chlorophyll
9. Estimation of Anthocyanin
10. Estimation of Iron
11. Estimation of Copper
12. Determination of Saccharin
13. Estimation of Salt in Iodised salt

12FP242 PROCESSING OF FOOD COMMODITIES

Credits: 3:0:0

Course Objectives:

- To study various processing methods for various food materials like fruits & vegetables, dairy products, cereals, meat, poultry, fish and bakery products .
- To study various innovative food processing techniques

Course Outcomes:

- Students to acquire knowledge on the basics of food processing
- Students will have a know-how on the various processing technologies involving fruits and vegetables, dairy, cereals, meat, fish, egg and plantation products

- Students to acquire basic knowledge on microbiology of food products
- Students will have an overview of the possible arena of entrepreneurial activity related to food products.

Unit I

CEREAL, PULSES AND OIL SEEDS TECHNOLOGY: Rice milling, Pulse milling, Wheat milling - Oil extraction - Methods of manufacture of Bread - different processes of manufacture - types of breads - buns, biscuits, cakes and cookies -Pasta products -Tortilla - Method of manufacture

Unit II

FRUITS AND VEGETABLE PROCESSING: Production of Fruits and vegetables in India, Cause for heavy losses, preservation treatments - Basics of Canning, Minimal processing and Hurdle technology as applied to Vegetable and Fruit processing, Processing of fruit juices, Dehydration, Aseptic processing

Unit III

DAIRY PROCESSING : Basic dairy terminology, composition, General tests at reception, Dairy Processing - Method of manufacture of Standardised, toned and double toned milk, milk powder - Equipments - Pasteurizers, homogenisers and pumps - Method of manufacture of dairy products - Icecream, Cheese, Paneer, Yoghurt - Pasteurisation and microorganisms involved in spoilage of milk.

Unit IV

MEAT, POULTRY AND FISH PROCESSING: Meat composition from different sources, Definitions and measurements, Carcass Processing, Meat Products, Processing of Poultry Products, Fish and other Marine Products Processing

Unit V

PLANTATION PRODUCT TECHNOLOGY: Processing of Tea, Coffee and Cocoa - Outline of the methods of manufacture of - green tea, black tea, instant tea, Instant coffee, Cocoa and Chocolate. Outline of the methods of processing of Pepper, cardamom, ginger, vanilla and turmeric

Text Books

1. Srivastava, R.P. and Kumar, S.: Fruit and Vegetable Preservation: Principles and Practices. International Book Distributing Co. Lucknow (2nd Edition 1998).
2. Chakraverty, A., Mujumdar A.S., Raghavan G.S.V and Ramaswamy H.S. Handbook of Post-harvest Technology: Marcel Dekker Press, USA (2001)
3. James Harper W. and Carl W. Hall: Dairy Technology and Engineering AVI Publishing, Westport, USA (1976)
4. Karel Kulp and Joseph P Pante:Hand Book Of Cereal Science and Technology Mercel Dekkar USA (2000)
5. Samuel Matz: The Chemistry and Technology of Cereals as Food and Feed, Chapman & Hall (1992)

12FP243 TECHNOLOGY OF PACKAGING

Credits: 3:0:0

Course Objectives:

- To provide knowledge on packaging and packaging materials.
- To understand the working various packaging methods.
- To enable the students to understand the interaction of food items with packaging materials.

Course Outcome:

- The students will get exposure about packaging, packaging materials and packaging methods.

Unit I

INTRODUCTION TO FOOD PACKAGING: Definition of basic functions of packaging – Packaging strategy – Packaging design and development framework – Product needs – Distribution needs – Consumer needs – Environmental effects of packaging – Key properties of main packaging media – Paper and paperboard, Tin and aluminum, Glass, and plastics - Effect of environmental factors - light, Oxygen, Moisture, Temperature, mechanical forces and biological factors on quality of products. Vacuum and Inert Gas Packaging.

Unit II

METAL CANS AS PACKAGING: Metallic can types - Tin cans and Aluminum cans. Specialty of open top sanitary cans, lacquers and their use, Three piece cans and Two piece cans, Aerosol Cans, Basics of Canning operations – Can Reformer, Flanger, Seaming, Can closures. Glass jars and Bottles in food packaging, Sterilization of bottles.

Unit III

FLEXIBLE FILMS PACKAGING: Formation of Films and pouches, Plastics used and their Specific applications - Polyethylene (LDPE and HDPE), Cellulose, Polypropylene (PP), Polyesters, Polyvinylidene Chloride (PVDC - Diofan, Ixan and Saran), Polyvinyl chloride, Copolymers their applications. Co-extruded films and Laminates. Rigid and Semi rigid plastic packaging, Retort pouch packaging. Laminated Paper board Cartons, Fibre Board and Corrugated Card Board packaging and their applications.

Unit IV

FILLING AND SEALING OPERATIONS FOR VARIOUS TYPES OF PACKAGES: Closing and sealing of rigid plastic containers. Filling and sealing of flexible plastic containers, Seal types-Bead seals, Lap Seals and Fin seals –Differences and advantages, Hot wire sealing, hot bar sealing and impulse sealing – differences and relative advantages, Form fill Seal equipment - Filling and Sealing of pouches, pouch from fill seal machines.

Unit V

INTERACTION OF FOOD MATERIAL WITH PACKAGING MATERIAL: Active packaging, moisture control, CO₂ and Oxygen scavenging, Modified atmosphere packaging – principles, applications. Permeability of gases in packs. Speciality packages. Tests on packaging materials, Mechanical strength (Tension, notch and tearing strengths), Gas and water vapour transmission rates.

Text Book

1. Coles, R., Dowell, D.M., Kirwan, J. “Food Packaging Technology”. Black Well Publishing Ltd., ISBN-084939788X, 2003.

Reference Books

1. NIIR Board, "Food Packaging Technology Handbook" National Institute of Industrial Research, New Delhi, 2004.
2. Pirenger O.G and A.L.Baver, "Plastic Packaging Materials for Food" Wiley VCH, GmbH, Germany, 2000.

12FP301 ADVANCES IN FOOD MICROBIOLOGY

Credits: 4:0:0

Course Objectives:

To enable the student to understand:

- The interaction between food and microbes
- The uses of microbes in the development of food products
- Importance of microbiology in relation to sanitation.

Course Outcomes:

On completion of the course, the student will gain knowledge and exposed to

- Various microorganisms involved in food and food product spoilage
- The multifarious role in different types of food fermentations
- Preservation techniques and control measures employed in the promotion and production of microbiologically safe food

Unit I

FOOD AND MICROORGANISMS: Factors affecting growth of microorganisms – pH, water activity, oxidation – reduction potential, nutrient content, inhibitory substances and biological structure – combined effects of factors affecting growth.

Unit II

MICROBIOLOGY OF PRESERVATION: General concepts about molds, bacteria and yeasts. Effect of high temperature on microbes – TDT, D value, Z value, 12D concept, calculation of process time. Effect of low temperature, radiation, drying on microbes.

Unit III

FOOD FERMENTATION: Manufacture, spoilage and defects of Bread, malt beverages, wines, vinegar, fermented vegetables, fermented dairy products, oriental fermented foods.

Unit IV

FOODS AND ENZYMES FROM MICROORGANISMS: General principles of culture maintenance and preparation for food fermentation – Single cell protein – Fats from microbes – production of amino acids - production of other substances added to food - production of enzymes.

Unit V

MICROBIOLOGY IN FOOD SANITATION: Bacteriology of water supplies - Sewage and waste treatment and disposal – Microbiology of the food product - Good Manufacturing Practices (GMP) – Hazard Analysis and Critical Control Points (HACCP).

Text Book

1. William C Frazier and Dennis C. Westhoff, "Food Microbiology", Tata McGraw – Hill Ltd., New Delhi, Fourth edition, ISBN-9780070667181, 2008

Reference Book

1. Adams, M.R. and Moss, M.O., "Food Microbiology", RSC Publication, Cambridge, U.K. ISBN-13:9788122410143,97-88122410143 2007.

12FP302 SEPARATION PROCESSES IN FOOD ENGINEERING**Credits: 4:0:0****Course Objective:**

- To enable the students understand the concepts of separation of solids and liquids in food engineering application.

Course Outcome:

- On completion of the subject, the students will be able to apply their knowledge on filtration technique, design of centrifuge, RO system in the food industries.

Unit I

BASIC PRINCIPLES OF FLUID FLOW: Pressure head in fluids-devices to measure pressures- U tube manometer- Pitot tube, types of flow-laminar-turbulent, simple mass balance and continuity equation, pressure drop due to friction, drag coefficient, flow in packed beds.

Unit II

MECHANICAL SEPARATIONS: Mechanical separation-screens - sedimentation, gravity sedimentation, Sedimentation of solid particles in gas media, stokes law. Filtration, constant volume filtration, Constant pressure filtration, Industrial applications and equipments for Filtration and Sedimentation.

Unit III

SEPARATION BY CENTRIFUGATION: Centrifugal separation-Sedimentation, filtration centrifuges, Basic equations. Different types of centrifuges – Basket, Tubular Bowl, Decanting, Disk bowl, Desludging (Self Cleaning) Bowl Centrifuges, Nozzle centrifuges. Importance of balancing of rotating masses, feed and discharge arrangement in each case. Specific characteristics - advantages and applications.

Unit IV

FILTRATION BY MEMBRANE SYSTEMS: Definitions; Reverse Osmosis (RO), Nano filtration (NF), Diafiltration, Ultra filtration (UF) and Micro filtration (MF), Molecular weight cut off in each case. Membranes and their characteristics, Cross flow filtration; Configuration of membranes, membrane materials, Pumps and other membrane equipment. Applications in food industry, relative advantages and limitations.

Unit V

ABSORPTION AND DIFFUSION: Basics of absorption, Diffusion of gases in liquid and solid foods, Moisture transfer in foods, Diffusion in porous foods, Inter-phase moisture transport. Diffusion of aroma components Applications of diffusion and migration in food packaging

Text Books

1. Geankoplis C.J., "Transport process and separation process principles", PHI learning private limited, New Delhi, 4th edition, ISBN-978-81-203-2614-9, 2008.
2. McCabe, W.L., Smith, J.C., and Harriott, P., "Unit operations of chemical engineering". McGrawhill Intl. Edition, Singapore, 7th edn. ISBN-007-424740-6, 2005.

Reference Books

1. Coulson J.M., Richardson J.F., Bachurst J.R., and J.H. Harker – "Coulson & Richardson's Chemical Engineering – Vol. 2 Particle Technology and Separation Processes", Butterworth & Heinemann - Elsevier science Ltd., Fifth Edition, ISBN 0750644451, 2002.
2. Ramaswamy H.S. and Markotte M., "Food Processing Principles and Applications", CRC Press Ltd. ISBN-1-58716-008-0, 2006.

12FP303 TECHNOLOGY OF FOOD FLAVOURANTS & COLOURANTS

Credits: 4:0:0

Course Objectives:

To enable the student to understand

- Basics of foods flavors and colours
- Chemistry & technology of natural flavours, pigments

Course Outcomes:

On completion of the course the student would be able

- To develop methods for stabilization of natural colorants
- To develop aroma chemicals
- To develop techniques for analysis of colorants and aroma chemicals

Unit I

BASICS OF FLAVOURS AND COLOURS: Olfactory perception of flavour and taste – Theories of olfaction - Molecular structure and activity relationships of taste – Sweet, bitter, acid and salt, Chemicals causing pungency, astringency, cooling effect – properties. Classification of flavours – Natural, Nature identical and synthetic – Flavor potentiators. Basics of colour – Hue, chroma, brightness. Regulations regarding additions – Toxicology and safety aspects

Unit II

TECHNOLOGY OF NATURAL FLAVOURS: Classification – Alliaceous flavours – Bittering agents, Coffee and Cocoa, Fruit flavours. Evolution of flavours during processing – enzymatic development, effect of roasting, cooking frying on flavour developments- Essential oils and oleoresins –Extraction – Super critical fluid extraction - Continuous and semi-continuous methods- Effect of types of solvents used. Liquid and dry flavour production - Staling of flavours. Microbial and cell suspensions in the synthesis of flavours

Unit III

CHLOROPHYLL & CAROTENOIDS: Chlorophyll and chlorophyll derivatives, Haems and bilins, Carotenoids, annatto, saffron, turmeric- Stability to pH, temperature and other processing conditions - Technology for the production of dried colourants - Caramel colour. Microbial and cell suspensions in the synthesis of colours.

Unit IV

ANTHOCYANINS & FLAVANOIDS: Anthocyanins and betalains, Less common colourants – Acylated β -ring substituted anthocyanins, Monascus, cochineal and related pigments, Stability to pH, temperature and other processing conditions. Technology for the production of dried colourants.

Unit V

ANALYSIS OF FLAVOURS AND COLOURS: Total component analysis– Basics and methods – Recent developments. Head space analysis – static and dynamic methods – basic principles – method and developments - Solid phase micro extraction of aroma components - E nose technology. Tristimulus colorimetry – Basics and application to foods

Text Books

1. Reineccius G. and Heath H.B., “Flavor Chemistry and Technology” , Taylor and Francis group, CRC Press, II Edition, 2006.
2. Socaciu C., “Food Colorants - Chemical and Functional Properties”, CRC Press, Taylor and Francis group, LLC, ISBN No. 9780849393570, 2008.

Reference Books

1. Rowe D.J., “Chemistry and Technology of Flavors and Fragrances”, Blackwell Publishing Ltd., U.K., ISBN No. 1405114509, 2005.
2. Marsili R., “Techniques for Analyzing Food Aroma”, Marcel Dekker Inc., 1997
3. Francisco D-V and Octavio P-L., “Natural Colorants for Food and Nutraceutical Uses”, CRC Press LLC, 2003.
4. Lauro G.J., “Natural Food Colorants”, Marcel Dekker Inc., 2000.

12FP304 ADVANCES IN FOOD ENGINEERING

Credits: 4:0:0

Course Objectives:

To enable the students to study & understand the

- Heat preservation methods.
- Aseptic Packaging of processed foods

Course Outcomes:

- The knowledge on Food Engineering will help to conserve and minimize the losses of food produced.
- The primary goal on food security can be achieved.

Unit I

PRESERVATION ASPECTS: Heat preservation of foods -thermo bacteriology, process calculation and selection – low temperature preservation - microbiological aspects, cooling

and cold storage - physical methods of preservation - freeze concentration - membrane process -ultrafiltration, Reverse osmosis

Unit II

MINIMAL PROCESSING: Minimal Processing of Foods with thermal methods and non thermal methods- safety criteria in minimally processed foods- Minimal processing in practice- fruits & vegetables-seafood- effect on enzymatic and texture property- quality changes- packaging and storage conditions- Future developments

Unit III

OSMOTIC, HEAT PUMP & FREEZE DRYING: Application of light pulses in sterilization of foods and packaging materials- Foam mat drying - osmotic dehydration –heat pump drying - freeze drying - recent advances in freeze drying

Unit IV

SPRAY DRYING: Recent developments on design and practice of spray drying - drying behavior of droplets – flash evaporation - extraction and distillation process – energy calculation process – energy requirements in different methods of dehydration - super critical fluid extraction

Unit V

ASEPTIC PACKAGING & EXTRUSION: Advances in aseptic processing and packaging - processes, design of process, decontamination of packaging - extrusion cooking - recent developments, methods, equipment, and design criteria of extruders.

Text Books

1. Sun D-W, “Emerging Technologies for Food Processing”, Published by Academic Press, 2005.
2. Ohlsson T. and Bengtsson N., “Minimal Processing Technologies in the Food Industry”, Published by Woodhead Publishing Ltd.,ISBN No. 0849312078, England, 2002.

Reference Books

1. Guy R. “Extrusion cooking – Technologies and Applications” Woodhead Publishing Ltd., CRC Press LLC, England, 2000.
2. Asiedu, J.J., “Processing tropical crops - a technological approach”, MacMillan Publishers, ISBN No. 033344857X, 1989.
3. Gould G.W., “New Methods Of Food Preservation”, Aspen Publishers, Great Britain, ISBN No. 0834213419, 1999.

12FP305 FOOD MICROBIOLOGY LAB

Credits: 0:0:2

List of Experiments

1. Experiment on Microscopy
2. Experiment on sterilization and disinfection
3. Experiment on isolation of microorganisms by pure culture technique
4. Experiment on monochrome staining & gram staining
5. Experiment on negative staining & spore staining
6. Experiment on Hanging drop technique

7. Experiment on isolation of MO from spoiled food
8. Experiment on isolation of MO from air
9. Experiment on water quality analysis
10. Experiment on Lactophenol cotton blue staining
11. Experiment on methylene blue reduction test, phosphate test for milk samples
12. Experiment on biochemical test (TSI, catalase, oxidase, hydrogen peroxide)
13. Experiment on production of wine
14. Experiment on production on enzyme amylase
15. Experiment on phenol coefficient test.

12FP306 FOOD ENGINEERING LAB

Credits: 0:0:2

List of Experiments

1. Experiment on Vacuum shelf drier.
2. Experiment on plate pasteurizer.
3. Experiment on tubular pasteurizer.
4. Experiment on vibro fluidizer.
5. Experiment on Fluidized bed drier.
6. Experiment on Spray drier.
7. Experiment on Freeze drier.
8. Experiment on canning of vegetables.
9. Experiment on canning of fruits.
10. Experiment on twin screw extruder.
11. Experiment on Sigma mixer.
12. Experiment on retort pouch sterilizing unit.
13. Experiment on bottling of fruit juices.
14. Experiment on bottling of vegetable products.
15. Experiment on vacuum packaging

12FP307 KINETICS OF FOOD SYSTEMS

Credits: 3:1:0

Course Objectives:

- To enable students understand the physical chemistry and kinetics of food systems
- To make the students understand the interaction of food constituents in maintaining the texture and structure of a food

Course Outcomes:

Students would be able

- To develop new products which are nutritional and cost effective
- To predict their behavior during storage
- To develop cheaper sources of raw materials for a product

Unit I

GLASS TRANSITIONS IN FOODS: Basics of theory of glass transitions – crystalline and amorphous polymers, - difference, Glass transition temperature, crystallite melting point,

Crystal melting point – Key elements of the food polymer science approach –Fringed micelle structural model – the dynamics map – Effect of molecular weight on Tg – Plasticizer – water as a plasticizer - Crystallisation – gelation mechanism – Polymer crystallization kinetics theory - Importance in food systems

Unit II

PHYSICAL CHEMISTRY OF FOOD GELS AND GELLING: Nature of the gel state – Mechanism of gel formation in food systems – point cross linking, extended junction zone formation, particle association and spinodal decomposition – gel network types. Basic Theories of gelation – Flory –Stockmayer theory – percolation theory, diffusion –limited aggregation model – mechanical properties of cured gels – Small deformation studies – differentiation between strong and weak gels - frequency dependence, strain dependence and temperature dependence of visco-elastic modulus – Large deformation studies – failure envelopes

Unit III

GENERATION OF ENGINEERED GEL STRUCTURES: Foods as composite materials – Characteristics of composite materials – solid foams and sponges – Fibrous structures – Reinforcement by solid particles and fibers – Mixed dairy gels – filled dairy gels – Cellular structures of fruits and vegetables

Unit IV

STRUCTURES & PROPERTIES OF FOOD EMULSIONS: General aspects of emulsions – Types of food emulsions – Oil in water, water in oil, water in oil in water- Measurement of particle size and size distributions in emulsions - Factors affecting stability of emulsions – Structures of adsorbed layers on the surfaces of emulsion droplets - Importance of interfacial layer – Protein stabilized emulsions and foams

Unit V

KINETICS OF NON-ENZYMATIC BROWNING: Introduction –Mechanism of Maillard Reaction – Factors influencing Maillard reaction – Type of amino acid, pH, type of sugar, solvent state, sugar – amine ratio, temperature, Fluorescence (pHand Temperature interactions) – Kinetics of Maillard browning

Text Books

1. Schwartzberg H.G., and Hartel R.W., “Physical Chemistry of Foods”, Marcel Dekker Inc., New York, ISBN No. 0824786939, 1992.
2. Friberg S., Larsson K. and Sjoblom S. “Food Emulsions” Marcel Dekker Inc., Fourth Edition, ISBN No. 0824746961, 2004.

Reference Books

1. Damodaran S., Parkin K. and Fennema O.R.,“Fennema’s Food Chemistry”, CRC Press, ISBN No. 0849392721, 9780849392726, 2008.
2. Belitz H-D., Grosch W.and Schieberle P., “Food Chemistry”- Springer Verlag, Berlin Heidelberg, Germany, III Revised Edition, ISBN No. 3540408177, 2004.

12FP308 MASS TRANSFER PROCESSES IN FOOD ENGINEERING

Credits: 4:0:0

Course Objective:

- To enable the student to understand the importance of mass transfer processes in Food Engineering applications.

Course Outcome:

- On completion of the syllabus, the students will be able to apply their knowledge on distillation, evaporation, separation and super critical fluid extraction processes in various food industries.

Unit I

BASIC PRINCIPLES OF SEPARATION PROCESSES: Basic principles of food processing SI system of basics units, Conservation of mass and materials balances, energy and heat units, conservation of energy and heat balances Units and dimensions of engineering parameters, dimensionless ratios, and calculations involving various physical parameters.

Unit II

VAPOR LIQUID SEPARATION PROCESSES: Vapor- liquid equilibrium relations, single stage equilibrium contact for vapor liquid system, relative volatility of vapor liquid system Distillation - Steam distillation, applications and equipment, Mass transfer phenomenon applied to food systems

Unit III

EVAPORATION: Needs, basic principles, Single and multiple effect evaporation, Heat economy, Vapour recompression, Thermo and mechanical systems, boiling point elevation, Falling film, climbing film tubular evaporators, plate evaporators, thin film and scraped surface evaporators.

Unit IV

GAS LIQUID SEPARATION PROCESSES: Concentrations, Gas-liquid equilibria, Solid liquid equilibria, Equilibrium concentration relationships, operating conditions; Basics of Solid-liquid extraction processes, liquid-liquid extraction, with food application examples.

Unit V

EXTRACTION AND LEACHING: Mechanical extraction – Expellers, screw press, filter press. Liquid-liquid extraction, liquid-solid extraction, phase diagram determination of extraction steps by McCabe-Thiele method. Super critical Fluid extraction - Super critical Fluid State, Properties of Super critical CO₂, Density, Viscosity, Volatility etc. Supercritical Phase Equilibria, Solubility, SCFE systems and components, Applications; extraction of Fatty acids, oleoresins and essential oils; Relative advantages, limitations and economics

Text Books

1. Geankoplis C.J., “Transport process and separation process principles”, PHI learning private limited, New Delhi, 4th edition, ISBN-978:81-203-2614-9, 2008.
2. McCabe, W.L., Smith, J.C., and Harriott, P., “Unit operations of chemical engineering”. McGrawhill Intl. Edition, Singapore, 7th edn. ISBN-007-424740-6, 2005.

Reference Books

1. Coulson J.M., Richardson J.F., Bachurst J.R., and J.H. Harker – “Coulson & Richardson's Chemical Engineering – Vol. 2 Particle Technology and Separation Processes”, Butterworth & Heinemann - Elsevier science Ltd., Fifth Edition, ISBN 0750644451, 2002.

2. Ramaswamy H.S. and Markotte M., "Food Processing Principles and Applications", CRC Press Ltd. ISBN-1-58716-008-0, 2006.

12FP309 EMERGING TRENDS IN FOOD PROCESS ENGINEERING

Credits: 4:0:0

Course Objectives:

To enable the student to understand

- High Intensity Pulse Techniques, Light Pulses,
- Food irradiation, high pressure processing and biocatalysts

Course Outcome:

- Students are updated of the recent technological advancements in the field of Food Technology.
- Students are appraised of the alternate technologies in Thermal Processing of foods.

Unit I

HURDLE TECHNOLOGY: Hurdle technology - principles and applications -hurdle effect in fermented food, shelf stable products, and intermediate moisture foods- total quality of foods - optimal range of hurdles and potential safety -application of hurdle technology – fruit preservation, dairy products and meat

Unit II

LIGHT PULSE TECHNIQUE: High-intensity pulse technique- Processing systems- design of static chambers- continuous chambers- other chamber designs- generation of different voltage waveforms-oscillation magnetic fields for food processing- generation of magnetic fields -mechanisms of inactivation of microorganisms in food preservation.

Unit III

OHMIC HEATING: Application of heat and ultrasound - inactivation of microorganisms and enzymes –electrical resistance heating of food - ohmic heating, heating models-treatment of products - high voltage pulse technique - Elsteril process, influence on microorganisms, food ingredients - decontamination of packaging - decontamination of microorganisms by surface treatment.

Unit IV

FOOD IRRADIATION & HIGH PRESSURE PROCESSING: Food irradiation - advantages and applications, microwave processing - interaction with food materials, material properties, effect of microorganisms, microwave equipment – high pressure processing – Principles -equipment, processing and effect on microorganisms.

Unit V

BIOCATALYSTS: Biocatalysts- Sources-Types- Processes in Food Industry- Enzymatic Synthesis of Food Additives – Biocatalysis using enzymes-flavours & fragrance – Biosensors types- application of biosensors to food industry requirements- Development of Biosensors

Text Books

1. Gustavo V. Barbosa-Cánovas, Tapia M.S. and ,Pilar Cano M., "Novel Food Processing Technologies", CRC Press, ISBN No. 082475333X , 2005.
2. Gustavo V. Barbosa-Cánovas, "Nonthermal Preservation of Foods", Marcel Dekker, Inc., New York, ISBN No. 0824799798, 1998.

3. Scott A.O., "Biosensors for food analysis", RSC Publication, Great Britain, ISBN NO. 0854047506 1998.

Reference Book

1. Lozano E.J., "Trends in Food Engineering", Ed. Lozano E.J., Technomic Pub., ISBN No. 1566769914, 2000.

12FP310 FOOD PACKAGING AND STORAGE ENGINEERING

Credits: 4:0:0

Course Objectives:

To enable the students to understand

- Different packaging techniques
- Different Storage techniques

Course Outcomes:

- Students will attain knowledge about the testing of various packaging materials and also suitability of packaging materials with respect to the products.
- Students will help to understand the designing of various storage structures and theories related to it.

Unit I

PACKAGING – IMPORTANCE & MATERIALS: Importance of packaging & packaging materials, form and testing – paper boards- tensile, tearing, bursting, water absorption, plastic films & laminates - test for tensile strength, bursting strength, tear strength, permeability (water vapor & gas), stretch, metals, glasses & retort pouches.

Unit II

SELECTION OF PACKAGES: Migration characteristics, Package for different individual groups of foods like dehydrated, liquid, frozen & processed foods–vacuum packaging of fruits & vegetables–equipment & method– packaging equipment for solid, semi–solid & liquid food. Types of filling machines – glass bottle, pouches.

Unit III

PACKAGING METHODS: Form filling- form filling & sealing equipment, labeling- methods-, capping & closures. Metallic containers- Basic canning operations-reforming, seaming, -Testing of cans for seaming and vacuum - Glass packaging- cartons- Manufacture & ply rating – shrink wrapping.

Unit IV

STORAGE ENGINEERING: Storage of grains–biochemical changes during storage–production, distribution and storage capacity estimate models–storage capacity models–ecology, storage factors affecting losses, storage requirements, bag and bulk storage–pressure distribution– theories–rodent control– method of stacking– preventive method, bio-engineering properties of stored products–function structural and thermal design of structures.

Unit V

COLD, MA & CA STORAGE: Cold storage controlled and modified atmosphere storage – effects of nitrogen, oxygen, and carbon-di-oxide on storage of durable and perishable commodities – storage of dehydrated products – food spoilage and prevention.

Text Books

1. Kirwan M.J., Derek McDowell D., and Coles R., “Food Packaging Technology”, Blackwell Publication, ISBN No. 084939788X, 2003.
2. Robertson G.L., “Food packaging: Principles and practice”, Taylor & Francis/CRC Press, ISBN No. 0849337755, 2006

Reference Books

1. Ahvenainen R., “Novel Food Packaging Techniques”, Woodhead Publishing, ISBN No. 1855736756, 2003.
2. Morris S.A., “Food and Package Engineering”, Wiley - Blackwell, ISBN No. 1119949777, 2011

12FP311 FOOD ANALYSIS LAB

Credits: 0:0:2

List of Experiments

1. Analysis of Jam – Moisture and Total sugars.
2. Analysis of milk – Determination of fat content by Gerber’s method
3. Analysis of Coffee – Estimation of total extractives
4. Analysis of Coffee – Determination of caffeine content
5. Analysis of tea – Total extractives in tea
6. Analysis of tea – Tannin content of tea
7. Estimation of salt in pickles / spice pastes.
8. Kinetics of bi-phasic (solid-liquid) extraction of natural colours
9. Kinetics of degradation of colours
10. Column chromatographic separation of colours
11. Kinetics of Maillard browning
12. Sensory analysis
13. Estimation of iron content
14. Estimation of copper

12FP312 TRANSPORT PROCESSES IN FOOD ENGINEERING LAB

Credits: 0:0:2

List of Experiments

1. Drying studies using through flow dryer – drying rate and drying curve.
2. Determination of overall heat-transfer co-efficient of a tubular pasteurizer.
3. Determination of crushing efficiency of sugar cane crusher.
4. Performance evaluation of an extruder.
5. Calibration of rota meter.
6. Determination of heat transfer through composite walls.
7. Determination of pressure losses in pipes due to sudden enlargement and contraction..
8. Calibration of venturi meter and orifice meter.
9. Determination of friction coefficient in annular pipe.
10. Determination of overall heat transfer coefficient in shell and tube heat exchanger.
11. Determination of aerodynamic properties using fluidised bed column.

12. Determination of mixing index of a mixer – sigma, ribbon, planetary mixers.
13. Determination of mass transfer coefficient using Fick's law.
14. Determination of enthalpy balances in single effect evaporator.
15. Determination of mass transfer rate in leaching / extraction

12FP313 FOOD ENZYMOLOGY LAB

Credits: 0:0:2

List of Experiments

1. Estimation of reducing sugars by dinitrosalicylic acid method.
2. Estimation of proteins by the hartree-lowry method.
3. Amylases - optimisation of ph & temperature.
4. Optimisation of enzyme-substrate ratio and determination of michaelis-menten kinetic.
5. Time study / enzyme kinetics of amylases.
6. Optimisation of ph and temperature of protease.
7. Optimisation of enzyme-substrate ratio and determination of michaelis-menten kinetics – protease.
8. Time study / enzyme kinetics of protease.
9. Characterisation of activity of crude amylase.
10. Characterisation of activity of crude protease.
11. Techniques of enzyme immobilization.
12. Michaelis – menten kinetics and half-life of immobilized enzymes.
13. Qualitative tests for presence of enzymes – catalase, peroxidase and urease.
14. Tests for cellulase activity.
15. Test for phosphatase activity in milk

12FP314 FOOD PRODUCT TECHNOLOGY AND PACKAGING LAB

Credits: 0:0:2

List of Experiments

1. Preparation and calculation of material balance of on *khoa*- and *chhana* – based traditional dairy products.
2. Preparation of traditional aerated confectionery.
3. Preparation of traditional products from legumes.
4. Determination of quality parameters of premixes.
5. Determination of water vapour transmission rate of the given packaging material – polythene.
6. Estimation of water vapour transmission rate of the given packaging material – polypropylene.
7. Determination of migration characteristics of packaging materials using different simulants -alcohol as a stimulant.
8. Determination of continuity of tin coating in cans by thiocyanate test for porosity.
9. Estimation of thermal shock resistance of glass bottles.
10. Determination of grease resistance of papers used in food industry – butter paper & toffee wraps.
11. Determination of half value (hvp) of products stored in ldpe (low density polyethylene) films by direct weighing method & break down method.

12. Estimation of half value (hvp) of products stored in hdpe (high density polyethylene) films by direct weighing method & break down method.
13. Determination of bacterial counts of polymer – packed foods during storage.
14. Determination of coliforms and fungal counts of polymer – packed foods during storage.

12FP315 FOOD SAFETY REGULATIONS AND CONTROL

Credit: 4:0:0

Course Objectives:

- To enable the students to understand the basics of food safety and regulations governing the same, the world over.
- To make the students to understand the role of individual personnel of the regulatory authority

Course Outcomes:

Students will be able to develop

- Protocols based on GMP for Food Processing Industries
- Develop new innovative norms and
- Ensure implementation of adequate safety regulations and control.

Unit I

STRUCTURE, ORGANIZATION AND PRACTICAL OPERATION OF INTERNATIONAL INTERGOVERNMENTAL FOOD REGULATION BODIES:

World Trade order – Functioning and responsibilities of the WTO - Codex Alimentarius – History, operations of Codex alimentarius, Responsibilities – Codex standards and Maximum residue limits – Current Issues under consideration – SPS (Sanitary and phytosanitary measures) agreement. World Health Organization – History and mandate – Operations and responsibilities – ICGFI– Functions and responsibilities. Concept of Six Sigma.

Unit II

REGULATING AUTHORITY OF FOOD SAFETY IN INDIA AND ITS ROLE: Food safety and Standards Act – organizational chart – role of individual authority – principles to be followed –Provisions as to articles of food –imported items – Responsibilities of the food business operator – Liability of manufacturers, packers, wholesalers, distributors and sellers – Enforcement of the act – Licensing and registration of food business – Food safety officer and their powers – Analysis of food – regulations regarding labs involved in food analysis – Offences and penalties – Adjudication and food safety appellate tribunal – Laws relating to Food Processing Industries in India - FPO, MMPO, PFA, AGMARK, Essential Commodities Act, BIS.

Unit III

FOOD LABELING – REGULATIONS: Need for labeling – Developing labeling standards at the world level – Limitations of labeling- safety issues – Labeling regarding methods of processing – Irradiated products – Products derived from modern biotechnology – organic produce - Genetically modified foods – EU rules on nutritional labeling – US rules on nutritional labeling – Health claims – Approach of US and EU.

Unit IV

GENERAL ASPECTS OF FOOD SAFETY: Concept of HACCP – Assembling the team – Product description – Describing the product's intended use – Establishing a process flow diagram – on site confirmation - Listing potential hazards and control measures - Determination of critical points – decision tree for CCPs- Establishing monitoring procedures- establishing corrective actions – establishing verification procedures.

Unit V

ISO 22000 REGULATIONS: Basics and differences with HACCP. Implementing HACCP & ISO 22000 for foods of Animal origin – Dairy Foods, Meat & Meat Products and Poultry. Safety aspects of drinking water (microbiological and chemical) - risks and advantages of chlorination of water. Bottled water – origin of water- safety aspects – microbiological and chemical quality – Regulations for bottled water – EU, US and India.

Text Books

1. Kees A. van der Heijden and Sanford Miller- International Food Safety Handbook: Science, International Regulation, and Control. Published by CRC Press. ISBN 0824793544, 9780824793548. 1999.
2. Guide to the Food Safety and Standards Act. Tax-mann allied Services Pvt. Ltd., ISBN – 10 – 8174968288. 2006.

Reference Book

1. Rajesh Mehta and J. George - Food Safety Regulation Concerns and Trade- The Developing Country Perspective. Published by Macmillan India Ltd., New Delhi. 2005

12FP316 INSTRUMENTAL TECHNIQUES OF FOOD ANALYSIS

Credit: 4:0:0

Course Objectives:

- To enable the students to understand the basics of various techniques available for the analysis of a food commodity.
- To make the students appreciate the instruments for analysis and their advancements till date

Course Outcomes:

Students will be able to

- Apply the instrumental techniques learnt towards the analysis of food materials and
- Develop / improve methods of analysis with improved sensitivity and reproducibility

Unit I

BASIC CONCEPTS IN CHROMATOGRAPHY: Chromatogram, distribution coefficient, retention volume, capacity factor, Gaussian profile, theoretical plates, selectivity, resolution, kinetic processes – Physical forces and interactions – Ionic interactions, van der Waals forces, hydrogen bonding, charge transfer – Modes of separation – Adsorption, Partition, Ion exchange, size-exclusion

High performance liquid chromatography: Basic principles – Mobile phase – Instrumentation – Injector, Column, Pump, detector, Types of detector – advantages of HPLC over other techniques – Applications of HPLC to food analysis

Unit II

GAS CHROMATOGRAPHY AND FTIR SPECTROSCOPY: Principles – Definitions, terms relating to Retention of analytes, column efficiency, sample component separation-Theory of Gas chromatography – Instrumentation – Carrier gas source, inlet system, columns, types of detectors – FID, TCD, ECD, MSD – application of GC to food analysis

FTIR Spectroscopy: Principles of Infrared spectroscopy – Instrumentation- Data handling Techniques, Spectral rationing, co-adding, Baseline correction, peak measurements, measurement of overlapping bands, smoothing and interpolation, spectral subtraction – quantitative analysis- Sampling methods , transmission cells, attenuated total reflectance – Applications in foods

Unit III

ATOMIC ABSORPTION SPECTROSCOPY: Introduction to AAS – Components of an AA spectrometer – Overview, Light sources, Nebuliser / Atomiser assemblies, Nebulisers, flames, optics, detectors, support gases, AAS measurements- approaches to improving the S/N ratio – Interferences – Chemical, Physical, Ionisation, Background and spectral – Calibration techniques – External standards and Standard additions – Minimising uncertainties – Atomisation techniques

Atomic emission spectrometry (AES): ICP – Mass spectrometry - **Atomic Fluorescence Spectrometry (AFS)** : Trace metal determinations in Biological samples

Unit IV

NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY: Electromagnetic spectrum – The NMR Phenomenon – Types of information provided by NMR spectra – Instrumental and Experimental Considerations – Solid state NMR – application of NMR to Food analysis

Unit V

MASS SPECTROMETRY: Process – Ionization techniques – Instrumentation – Linked scanning techniques – application of MS in Food Science – application of GC/MS, LC/MS / FAB/MS / MS/MS and linked scan techniques

Capillary electrophoresis: Instrumentation and components – Modes of CE – Capillary zone electrophoresis, Micellar electrokinetic chromatography (MECK), Capillary gel electrophoresis (CGE), Capillary isoelectric focusing (CIEF), Capillary Isotachophoresis (CITP) – Applications of CE in analysis of food substances

Text book

1. Pare J.R.J. and Belanger J.M.R.. “Instrumental Methods of Food Analysis”, Elsevier Science B.V. The Netherlands. ISBN: 0-444-81868-5. 1997

Reference Books

1. Rouessac F. and Rouessac A., “Chemical Analysis: Modern Instrumentation Methods and Techniques”, 2nd Edition, John Wiley and Sons. Ltd. England. ISBN: 978-0-470-85903-2 2007.
2. David L. B. Wetzel, George Charalambous. “Instrumental Methods of Food and Beverage Analysis”, Elsevier Science BV. 1998

12FP317 ENGINEERING PROPERTIES OF FOOD MATERIALS

Credit: 4:0:0

Course Objectives:

- To enable students to understand the different engineering properties of food materials.
- To make the students to acquire knowledge of engineering properties in the designing of food processing systems.

Course Outcome:

- The course will help to understand the relationship between Engineering and Functional properties of raw, semi finished and processed food to obtain products with desired shelf life and quality.

Unit I

PHYSICAL PROPERTIES: Engineering properties - physical, thermal, aerodynamic and dielectric properties – importance and applications in the crop processing design - factors affecting the properties. Physical characteristics - grains, fruits and vegetables - shape - size - description. Volume – determination - platform scale method - bulk density and particle density – porosity - air comparison pycnometer. Surface area – importance – determination - projection method - tracing method. Friction - concept - laws of friction - measurement of static and kinetic friction - effect of normal load, sliding velocity, surface, moisture and environment - rolling resistance - angle of internal friction and angle of repose - determination. Flow of bulk granular materials - in bins and hoppers, through orifices, chutes and flow of solids.

Unit II

RHEOLOGICAL PROPERTIES: Rheology - definition - various types of materials - Hook's law – classic ideal material. Stress – strain - density relationship - Rheological models - Maxwell model - creep behaviour of materials - uses - elastic - plastic materials – generalised Maxwell model. Kelvin model – stress relaxation behaviour of materials - generalised Kelvin model. Four elements Burger's model. Viscometry - Newtonian and Non-Newtonian fluids - flow behaviour equations – mechanics of flow in rotational and capillary viscometers. Yield stress and power law equations for Newtonian and Non-Newtonian fluids.

Unit III

TEXTURAL PROPERTIES: Texture of food materials - subjective and objective methods - imitative and empirical tests -dynamic test. Firmness and Hardness - different methods of measurements on various produce and foods - dynamic hardness. Mechanical damage on food - causes - biological and chemical reactions following mechanical damage - Detection and evaluation - static and dynamic resistance to mechanical damage – comparison. Impact damage - damage under dead load. Vibration damage - stress cracking.

Unit IV

THERMAL PROPERTIES: Thermal properties - specific heat - determination - methods for solids and powders. Determination of thermal conductivity - steady state and unsteady state methods. Thermal diffusivity - determination - relationship among specific heat, thermal conductivity, bulk density and thermal diffusivity - effect of moisture content on thermal properties.

Unit V

ELECTRICAL AND AERODYNAMIC PROPERTIES: Electrical properties - resistance, capacitance - uses - Dielectric loss factor - method of determination. A.C. conductivity and dielectric constant - determination - Q meter. Effect of moisture content on electrical properties - energy absorption from high frequency electric field. Aerodynamic properties - lift and drag - drag coefficient - friction drag - pressure drag – terminal velocity - importance

- spherical bodies and non-spherical bodies - drag coefficient - Reynold's number relationship - separation of foreign materials - pneumatic handling and transportation - applications.

Text Books

1. Mohesenin. N.N. Thermal properties of Foods and Agricultural Materials. Gordon and Breach Science Publishers, New York, ISBN-1980.
2. Mohesenin. N.N. Physical properties of Plant and Animal Materials. Gordon and Breach Science Publishers, New York, ISBN-0677213700, 1980.

Reference Books

1. Rao, M.A and S.S.H.Rizvi (eds) . Engineering Properties of Foods. Marcel Dekker Inc. New York, ISBN- (10):0-8247-5328-3, ISBN- (13): 970-0-8247-5328-3, 1986.
2. Singhal,O.P. and Samuel,D.V.K. . Engineering Properties of Biological Materials. SarojPrakasan, Allahabad, 2003.
3. Peleg, M.and E.B.Bagelay. Physical properties of foods. AVI publishing Co. USA,1983.

12FP318 FRUIT AND VEGETABLE PROCESS ENGINEERING

Credit: 4:0:0

Course Objectives:

To enable the student to know about

- Post harvest technology of fruits and vegetables.
- Processing & preservation techniques of fruits and vegetables

Course Outcomes:

- To identify suitable equipments for fruit and vegetable processing
- To apply the knowledge of processing methods of fruits and vegetables in food industries.

Unit I

CONCEPTS OF FRUIT AND VEGETABLE PROCESSING: Importance of post harvest technology of fruits and vegetables -post harvest handling and physiology of fruits and vegetables -Fruit ripening – changes during ripening-recommended ripening conditions for fruits – sources of ethylene for ripening – ethylene reactions with O₂ and CO₂-Spoilage of fruits and vegetables and their processed products -Deteriorative factors and their control – enzymatic changes, chemical changes, physical, changes and biological changes

Unit II

PRESERVATION TECHNIQUES: Biochemistry of fruits-implication on processing-Principles and methods of preservation of fruits and vegetables-Pre-treatments- blanching – methods-Commercial canning of fruits and vegetables-Minimal processing of fruits and vegetables-merits and demerits-Hurdle technology – applications Thermal and non-thermal preservation of fruits and vegetables - Quick freezing preservation of fruits and vegetables – principle – advantages

Unit III

DRYING AND DEHYDRATION: Dehydration of fruits and vegetables –methods – tunnel drier, cabinet Tray drier, drum drier, spray drier, fluidized bed drier – components and working-Osmotic dehydration of fruits and vegetables – principle - Merits and demerits-Foam mat drying of fruits and vegetables – principle – advantages and disadvantages-Freeze drying – principle- application – heat and mass transfer in freeze drying - heat of -sublimation – methods

Unit IV

EMERGING PRESERVATION TECHNIQUES: Microwave heating – principle – absorption of microwave energy –applications in fruits –and vegetables-Radiation preservation of fruits and vegetables –application of radiation – irradiation sources-Intermediate moisture foods – types- applications- advantages and disadvantages-Ohmic heating – principle - advantages over conventional heating-High pressure processing of fruits and vegetables –principle- application -Sensory evaluation of fruits, vegetables and their products

Unit V

PACKAGING AND STORAGE: Packaging technology of fruits, vegetables and their products – packaging materials-Aseptic packaging – principle – applications –Merits-General principles of quality control quality attributes – tests--Storage systems of fruits and vegetables and their products – recommended storage -conditions for selected fruits and vegetables-Cold storage of fruits and vegetables –cooling load calculation – design of cold storage – cost economics of cold storage Modified and Control Atmosphere Storage of fruits and vegetables.

Text Books

1. Verma, L.R and Joshi, V.K. Post harvest technology of fruits & vegetables (Vol I & II). Indus publishing company, New Delhi.2000.
2. Srivastava, R.P. and Sanjeev kumar. Fruit and vegetable preservation. Principles and practices. International book Distributing Co., Lucknow. 1994.

Reference Books

1. Shafiur Rahman. Handbook of Food Preservation. Replika Press Pvt. Ltd. India.2006.
2. The Completer Technology Book on Processing, Dehydration, canning, Preservation of Fruits. & Vegetables by NIIR Board, New Delhi.
3. Loesecke. Drying and dehydration of foods. Agrobios (India), Jodhpur. 2001.

12FP319 FOOD BIOCHEMISTRY AND NUTRITION

Credit: 4:0:0

Course Objectives:

- To enable students understand the basics of food biochemistry and nutrition.
- To make the students appreciate the importance of nutrition and enable them to develop new products of high nutritive value

Course Outcome:

- Students will be able to apply their knowledge in Food Biochemistry and nutrition in designing new range of products with improved nutritional characteristics (Nutraceuticals, probiotics etc.)

Unit I

CARBOHYDRATE METABOLISM: Electron transport chain - glycolysis, TCA cycle, gluconeogenesis, Pentose phosphate shunt, Embden Meyerhof Pathway (EMP), urea cycle, interconnection of pathways, Metabolic regulation, Bioenergetics: Respiratory chain ATP cycle, energy rich compounds

Unit II

AMINOACID AND LIPID METABOLISM: Biosyntheses and degradation of fatty acids, and cholesterol - Biosyntheses and degradation of amino acids (one example each for sulphur containing, aliphatic, aromatic, heterocyclic, basic and acidic amino acids), peptides and proteins; Biosynthesis and degradation of purines, pyrimidines and nucleic acids.

Unit III

BASIC CONCEPTS OF NUTRITION: Basic concept of nutrition – Importance of nutrition and dietetics - Assessment of nutritional status – energy value of carbohydrates, proteins and fats – determination of energy value – balanced diet – Recommended dietary intake – Acceptable dietary intake – Protein efficiency ratio – Net protein utilisation and their determinations – Malnutrition and its problems – Nutrient supplementation – fortification - Nutritional labeling and its importance - Effect of processing on protein quality, essential amino acids - Digestibility, carbohydrates in food and dietary fibre

Unit IV

INBORN ERRORS OF CARBOHYDRATE, PROTEIN AND FAT METABOLISM: Inborn errors of carbohydrate, protein and fat metabolisms - Nutrition and disorders associated with organs such as liver and kidney - Naturally occurring anti-nutritional factors – Cyanogens, lectins, enzyme inhibitors, phytoalexins, phytates

Unit V

NUTRITION FOR SPECIALIZED PURPOSES: Nutrition for specialized purposes – Paediatric nutrition – geriatric nutrition – Sports nutrition – Nutrition during pregnancy - Functional foods Ageing –Theories of ageing – Nutrition and ageing – Cancer and its prevention - Age-related metabolic disorders – Nutrition in the treatment of age-related disorders like hypertension, diabetes, Alzheimer's disease

Text Books

1. Voet D, Voet G, Principles of Biochemistry, Third Edition, John Wiley and Sons, ISBN-13: 9780470233962, 978-0470233962.2008.
2. Martin Eastwood. Principles of Human nutrition – Second Edition, Ed. Wiley - Blackwell Publishing, ISBN: 978-0-632-05811-2, 2003.

Reference Books

1. Ronald Ross Watson, Functional foods and Nutraceuticals in Cancer Prevention, Ed. Wiley – Blackwell, ISBN-13: 978-0813818542, 2003.
2. Lehninger A.L, Nelson D.L. and Cox M.M., Principles of Biochemistry, W.H. Freeman and Company Publications, ISBN - 071677108X, 2008.

12FP320 ADVANCES IN FOOD AND WATER MICROBIOLOGY

Credit: 4:0:0

Course Objectives:

- To enable students to understand the basics of microbiology and its importance in food and water.
- To study their impact on health and diseases transmitted.
- To recycle waste and appreciate the importance of anaerobic digestion in relation to energy

Course Outcomes:

Students demonstrate their ability to

- Identify and solve problems related to Food and Water Microbiology and
- Develop ways for ensuring a microbially safe product in Food Industries

Unit I

FOOD AND MICROORGANISMS: General concepts about bacteria, molds and yeasts - Factors affecting the growth of microorganisms – pH, water activity, oxidation – reduction potential, nutrient content, inhibitory substances and biological structure – combined effects of factors affecting growth

Unit II

MICROBIOLOGY OF WATER: Soft and hard water – its implications in Food processing industry- Definition of potable water, contaminated water and polluted water – Diseases transmitted through water – cholera, typhoid, dysentery (Amoebic / Bacillary) – coliforms and its importance – MPN count of coliforms – Permissible limits in drinking water – Advantages and disadvantages of chlorination of water

Unit III

FOOD SPOILAGE AND DEFECTS: Classification- Food infections – bacterial and other types; Food intoxications and poisonings – bacterial and non-bacterial; food spoilage – factors responsible for food spoilage – spoilage of canned foods

Unit IV

FOODS AND ENZYMES FROM MICROORGANISMS: General principles of culture maintenance and preparation for food fermentation – single cell protein – fats from microbes – production of amino acids – production of other substances added to food – production of enzymes

Unit V

MICROBIOLOGY IN FOOD SANITATION: Bacteriology of water supplies – sewage and waste treatment and disposal – Anaerobic digestion pathways in relation to biogas output – Good Manufacturing Practices (GMP) – Hazard Analysis and Critical Control Points (HACCP)

Text Books

1. B. Sivasanker, Food Processing and preservation– Prentice Hall India Pvt. Ltd., New Delhi.2002.
2. Frazier, W.C and Westhoff, D. C., “Food Microbiology”, McGraw- Hill Education India Ltd.4th Edition, ISBN – 9780070667181, 2008.

Reference Book

1. Adams M.R. and Moss M.O., “Food Microbiology”, New Age International Ltd. Publication. ISBN-13: 9788122410143, 978-8122410143, 2007.

12FP321 NUTRACEUTICALS AND FUNCTIONAL FOODS

Credit: 4:0:0

Course Objectives:

- To understand the basics of nutraceuticals and functional foods
- To study the significance of nutraceuticals and their role in disease prevention
- To identify new strategies for marketing of traditionally known nutraceuticals

Course Outcomes:

- The student will be able to develop strategies for isolation and purification of nutraceutically important components.
- Design processes for large scale production of nutraceuticals.
- Develop important analytical techniques for identification of same.

Unit I

NUTRACEUTICALS: HISTORICAL, TELEOLOGICAL ASPECTS AND CLASSIFICATION: Introduction – Historical Reviews - Teleology of nutraceuticals - Organization models for nutraceuticals – Classification of Nutraceuticals based on the sources– Animal, Plant and Microbial – Nutraceuticals in specific foods - Mechanism of Action - Chemical nature

Unit II

FLAVONOIDS AND CAROTENOIDS AS ANTIOXIDANTS: General background on phytochemicals as antioxidants - Flavonoids and Lipoprotein oxidation - Evidence for specific Antioxidant mechanisms of Flavonoids – Anticancer and Cholesterol-lowering effect of citrus flavonoids - Dietary carotenoid and carotenoid absorption - Approaches to measurement of absorption - Metabolism of Carotenoids – Carotenoids as anticancer agents.

Unit III

OMEGA – 3 FATTY ACIDS AND CLA: Introduction to Lipoprotein metabolism - PUFA and Cardiac Arrhythmias - Preventative role of n-3 fatty acids in cardiac arrhythmias - Mechanism of action on n-3 PUFA's - ω – 3 fish oils and their role in Glycemic control- ω – 3 fatty acids and rheumatoid arthritis - Chemistry and Nomenclature of CLA – Analysis of CLA in food and biological samples – CLA in food products and biological samples – Biological actions and potential health benefits of CLA – Mechanisms of CLA action – Potential adverse effects of CLA

Unit IV

LYCOPENE, GARLIC, OLIVE OIL, NUTS, PROBIOTICS AND PREBIOTICS: Lycopene overview – lycopene and disease - Garlic – Chemistry – Implication in Health - Olive oil – CHD – Cancer - Nuts – Nutrient components and Composition - Nut Consumption and CHD epidemiological evidence, Human nutritional studies on nut consumption and serum lipid changes, Mechanism of action- Probiotics- criteria – products on market – probiotic products – Microbiology of the gastrointestinal tract - Prebiotics – future for probiotics and prebiotics

Unit V

HERBS AS FUNCTIONAL FOODS, STABILITY TESTING AND MARKETING ISSUES FOR NUTRACEUTICALS AND FUNCTIONAL FOODS: Herbal medicine – Herbs as ingredients in functional foods – actions of herbal and evidence of efficacy - Kinetic modelling of chemical reactions – Accelerated shelf life testing – Cruciferous vegetables and cancer prevention – Dietary fiber and coronary heart disease - Evolution of marketing environment for Functional foods and nutraceuticals - Regulatory background - Introduction to consumer marketing issues for nutraceuticals - Potential product positioning

Text Book

1. Robert E.C Wildman. Handbook of Nutraceuticals and Functional Foods, Ed., Robert E.C. Wildman, CRC Press LLC. ISBN – 0849387345, 2001.

12FP322 RESEARCH METHODOLOGY FOR FOOD ENGINEERS

Credits: 4:0:0

Course Objective:

- To impart the knowledge about the method by which the research has to be carried out.

Course Outcomes:

The students will be able to

- Choose the ideal experimental design based in the given problem
- Apply statistical methods for effectively conducting the experiments
- Prepare research reports in conformance with standards

Unit I

INTRODUCTION TO RESEARCH: Definition of Research - Objectives of Research - Types of Research- Research and Scientific Method – Research Process - Criteria of Good Research - Problem's Encountered by Researcher's in India; Research problem: Defining the Problem – Selecting the Problem – Necessity of Defining the Problem - Techniques involved in Defining the Problem; Research Design – Need for Research Design - Important Concepts Relating to Research Design, Different Research Design.

Unit II

DATA COLLECTION, SAMPLING DESIGN AND LITERATURE REVIEW: Sources of Data: Primary Data - Secondary Data – Collection of Data through Questionnaire and Schedules - Difference between Questionnaires and Schedules; Sampling Design: Steps in Sample Design – Procedure – Characteristics – Types of Sample Design; Difference between Survey and Experiment; Proceedings for reviewing the Literature: Search for existing Literature – Review the Literature selected – Develop a Theoretical Framework – Develop a Conceptual Framework.

Unit III

STATISTICAL ANALYSIS AND APPLICATIONS: Introduction to Statistics: Probability Theories - Poisson Distribution, Binomial Distribution and Properties of Normal Distributions; Hypothesis Tests, One Sample Tests – Two Sample Tests / Chi – Square Test, Association of Attributes – t - test - Standard Deviation – Co – efficient of Variations –Time Series Analysis, Decision Tree.

Correlation and Regression Analysis – Analysis of Variance, Completely Randomized Design, Randomized Block Design, Latin Square Design. ANOVA – One way and two way.

Unit IV

PROFESSIONAL ETHICS FOR ENGINEERS: Fundamentals of Engineering Ethics – Preamble – Responsibilities – Orientation – Implementation – Conclusion; Code of Ethics for Engineers – Preamble – Fundamental Canons– Guidelines for use the Fundamental Canons for Ethics – Role of Practice – Professional Obligations; Ethical Decision Making; Research Ethics: Ethical Distinction – Ethical Approach – Research Misconduct - Plagiarism; Regulations and Guidelines regarding Authorship; Helsinki Declaration on Bio-Ethics.

Unit V

INTERPRETATION AND RESEARCH REPORTS: Interpretation: Defining of Interpretation - Technique of Interpretation- Precautions in Interpretation. Research Reports: Significance of Report Writing, Different Steps in Report Writing, Structure and Components of Research Report, Types of Reports – Technical Report – Popular Report, Precautions for writing Research Reports.

Text Books

1. Panneerselvam, R., Research Methodology, Prentice Hall of India, New Delhi, ISBN – 8120324528, ISBN -13: 978812034527, 978 – 8120324527, 2011.
2. Kothari, C.R., Research Methodology, ISBN (10): 81 – 224 – 1522 – 9; ISBN (13): 978 – 81 – 224 – 1522 – 3, 2004.

Reference Books

1. Kumar and Ranjit, Research Methodology-A Step-by-Step Guide for Beginners, (2nd.ed.),Singapore, Pearson Education, 2005
2. Dawson and Catherine, Practical Research Methods, New Delhi, UBS Publishers Distributors, 2002.

12FP323 GREEN CHEMISTRY AND TECHNOLOGY

Credits: 4:0:0

Course Objectives:

To enable the students understand

- the basics of Green chemistry
- the importance of eco-friendly methods of manufacture of various products

Course Outcomes:

On completion of the course, the students will be able to

- choose an eco-friendly and cost-effective method of manufacture of products
- Improve existing methods for improved efficiency and economics
- Develop novel methods for improved efficiency and economics

Unit I

INTRODUCTION AND PRINCIPLES OF SUSTAINABLE AND GREEN CHEMISTRY: Chemistry Past, Present and Future – The Costs of Waste – The Greening of Chemistry – Green chemistry and Industry – Waste Minimization and Atom Economy – Atom Economy, Some Inherently atom economic reactions and Some Inherently Atom

Uneconomic reaction - Reduction of energy requirement – Some energy efficiency improvements and Alternate energy sources - Chemistry of Atmosphere – Chemistry of oceans

Unit II

SUSTAINABILITY AND LCA: Concept of Sustainability – Green Chemistry and Sustainability parameters – LCA methodology – Methodological Framework – Applications of LCA – Product Oriented LCA – Process Oriented LCA

Unit III

SOLID ACID CATALYSTS AND MICELLE TEMPLATED SILICAS AS CATALYSTS: Concepts in Acidity and Solid Acid Catalysts – Industrial Applications of Solid Acid Catalysts – Zeolite based Solid Acid Catalyst, HeteroPolyacid based Solid Acid Catalyst, Sulphated Zirconia, Ion Exchange Resins and Acidic Pillared Clays - Recent Developments in Catalytic Materials and processes – Structured Mesoporous Materials – Synthesis of Micelle Templated Materials, Post Functionalisation of Micelle Templated Materials and Direct Preparation of Organically Modified Micelle Templated Silicas - Catalytic Applications

Unit IV

BIOCATALYSIS AND GREEN CATALYSTS FOR INDUSTRY: Chemical production by Biocatalysts – Bulk chemicals, Pharmaceuticals, Flavour and Fragrance Compounds, Carbohydrates and Polymers - Green Biocatalytic processes – Biocatalysis in Supercritical Carbon dioxide, Biocatalysis in Waste treatment and Biodesulfurisation - Supported Reagents – Envirocats – Advantages – Activation – General methods for using Envirocats - Commercial Applications of Envirocats – Benzoylations, Olefin Alkylation, Sulfonylation, Esterifications and Aerobic oxidation

Unit V

PROCESS INTENSIFICATION FOR GREEN CHEMISTRY AND EXTRACTION OF NATURAL PRODUCTS WITH SUPERHEATED WATER: Relevance to Green Chemistry – Spinning Disc reactor – Microreactors – Intensified Cross-Corrugated Multifunctional Membranes - Properties of Superheated water – Extraction of materials other than natural products – Chromatography with Superheated Water – Extraction of Rosemary – Extraction of other plant materials

Text Book

1. James Clark and Duncan Macquarrie, “Handbook of Green Chemistry and Technology”, Blackwell Publishing, First Edition, ISBN – 0632057157, 2002.

12FP324 ADVANCES IN FOOD PACKAGING TECHNOLOGY

Credits 4:0:0

Course Objectives:

To enable the student to know about

- Novel food packaging technology
- Active and Intelligent food packaging for preservation of food materials.

Course Outcomes:

- To identify suitable techniques for Novel food packaging.

- To apply the knowledge of Active and Intelligent Packaging in Food packaging industries.

Unit I

ACTIVE AND INTELLIGENT PACKAGING: Role of packaging in the food chain - Active packaging techniques - Intelligent packaging techniques- Current use of Novel packaging techniques – Current research - The legislative context – Consumers and Novel packaging – sources of future information and advice - Materials used in active and intelligent packaging - oxygen scavenging technology- Selecting the right type of oxygen scavenger - Ethylene scavenging technology – Carbon-di-oxide and scavengers- Future trends.

Unit II

ANTIMICROBIAL FOOD PACKAGING AND FLAVOUR - PACKAGING INTERACTIONS: Antimicrobial agents - Constructing an antimicrobial packaging system- factors affecting the effectiveness of antimicrobial packaging – Non-migratory bioactive polymers in food packaging – advantages, limitations and applications - Accelerated shelf life testing – Interaction of Food and packaging contents – Factors affecting product / package interactions with examples

Unit III

TIME-TEMPERATURE AND FRESHNESS INDICATORS USED IN PACKAGING: Time-temperature indicator(TTIs) – Defining and classifying TTIs - Requirement for TTIs - development of TTIs-current TTI systems - Maximising the effectiveness of TTIs - using TTIs to monitor shelf life during distribution- Optimise distribution and stock rotation - Compounds indicating the quality of packaged food product- Freshness indicators – Pathogen indicators – other methods for spoilage detection – Future trends.

Unit IV

NOVEL MAP APPLICATIONS FOR FRESH PREPARED PRODUCTS: Novel MAP gases- testing novel MAP applications- applying high oxygen – Carbon dioxide as an antimicrobial gas – Microbial safety of MAP – Effect of MAP on the nutrition quality of respiring and non respiring food product – Vitamin-C, Carotenoids, Phenolic compounds and glucosinolates- Colour changes and stability in fruit and vegetables - Colour measurement-processes of colour change- colour stability and MAP - Combined low oxygen high carbon dioxide and other gases- MAP performance.

Unit V

GREEN PACKAGING AND THE ROLE OF PACKAGING IN SUPPLY CHAIN MANAGEMENT OF PERISHABLE FOOD: Problem of plastics packaging waste – The range of biopolymers- Developing novel biodegradable materials – Legislative issue – current applications – The supply chain for perishable foods - Role of packaging in the supply chain – creating integrated packaging ; Storage and distribution – Traceability – New packaging techniques and the consumer- Special problem in testing responses to new packaging consumers and the future active and intelligent packaging - Future trends.

Text Books

1. Ahvenainen.R., “Novel Food Packaging Techniques” Woodhead publishing limited New York England.ISBN-0849317894, 2003.
2. Charles L.Wilson “Intelligent and Active packaging for fruits and vegetables”, Taylor and Francis group,Boston , New York.ISBN-0849391660 , 2007.

Reference Book

1. Richard Coles; Mark J.Kirwan Food packaging technology Blackwell Publishing ,library of Congress. ISBN-1841272213. 2003.

Karunya University

LIST OF SUBJECTS

Sub. Code	Name of the Subjects	Credits
12FP325	Biocatalysis	4:0:0
12FP326	Nanotechnology in Food Systems	4:0:0
12FP327	Advances In Drying Technology	4:0:0
13FP301	Food Plant Layout and Design	3:0:0
13FP302	Food Engineering Lab	0:0:2

12FP325 BIOCATALYSIS

Credits: 4:0:0

Objective:

- To enable the students understand the nature of various enzymes and methods of production, purification and formulation
- To make the students understand the kinetics of enzyme inhibition and modes of operation of enzyme reactors
- To make the students understand the application of enzymes in synthesis of novel compounds

Outcome:

Students would be able

- To isolate new enzymes which are cost effective
- To predict their nature and accordingly modify the system for optimum activity
- To design various types of reactions using enzymes that are eco-friendly

Unit I

Introduction: The discovery of enzymes- catalysis and bio- catalysis - enzymes as catalysts, structure- functionality relationships- Classification of enzymes - commercial importance of enzymes in biosynthesis- the concept and determination of enzyme activity- enzyme production- enzyme sources- enzyme synthesis- enzyme recovery- enzyme purification- enzyme formulation

Unit II

Enzyme Kinetics: Kinetics of enzymatic reactions- enzyme immobilization- methods of immobilization- evaluation of immobilization- partition effects- diffusional restriction- external and internal restriction- combined effects of external and internal restriction- environmental variables in enzyme kinetics

Unit III

Enzyme Reactors And Non-Enzymatic Biological Catalysis: Types of reactors- modes of operation- design fundamentals- design of enzyme reactors under ideal conditions, batch reactor, continuous stirred tank reactor- continuous packed bed reactor under plug flow regime- non enzymatic biological catalysis- catalytic RNA- synthetic enzyme models. Isomerases- cofactor – independent racemases and epimerases – allylic isomerases

Unit IV

Proteases And Lipases: Proteases- chemical synthesis of peptides- proteases as catalysts for peptide synthesis- enzymatic synthesis of peptides- process considerations for synthesis of peptides- sources and production of lipases - structure and functionality of lipases- improvement of lipases by medium and biocatalyst engg- application of lipases

Unit V

Oxidoreductases And Aldolases: Oxidoreductase as powerful biocatalysts for green chemistry- mild and selective oxidations catalyzed by oxidases- redox biotransformation catalysed by dehydrogenases- immobilization and stabilization of dehydrogenases- reactor engineering- use of aldolases for asymmetric synthesis- definition and classifications- preparation of aldolase biocatalysts- applications

Text Book:

1. Andres Illanes “Enzyme Biocatalysis- Principles and Applications” Springer Science Business Media Publication. ISBN: 978-1-4020-8360-0, e- ISBN: 978-1-4020-8361-7, 2008

Reference Book:

1. T.D.H Bugg “Introduction to Enzyme and Coenzyme Chemistry” Blackwell publishing, Second Edition, ISBN: 1-4051-1452-5, 2004

12FP326 NANOTECHNOLOGY IN FOOD SYSTEMS

Credits: 4:0:0

Objective:

- To enable students understand the importance of nanotechnology in food applications
- To make the students understand the role of nanotechnology in food ingredients, additives, supplements and food packaging
- To enable the student understand the structures of naturally occurring food nano substances and ethical issues of nanotechnology in food

Outcome:

- Students will attain knowledge about the designing of food nano substances, food nano packaging materials, nano-sized food ingredients and additives
- Students would be able to develop nanosensors for testing the quality of the foods

Unit I

Basics of Nanotechnology and Nanostructures in Food: Background-Evolution of new technologies in the food sector-Public perception of nanotechnology food products-Properties of nanomaterials-Nanomaterials for food applications-Nano-sized food ingredients and additives in relation to digestion of food-Natural nanostructures in food-Naturally occurring food nano substances and nanostructure-Designing food nanostructures-The status of natural nanostructures in food

Unit II

Nanoparticles in Food Diagnostics and Supramolecular Structures: Introduction-Sensors-Biosensors-Enzyme biosensors and diagnostics-DNA-based biosensors and diagnostics-RFID-Integrated nanosensor networks, detection and response-Nanosensors for food quality-Transduction principles-Examples of biosensors with nanoparticles-Future prospective-Supramolecular structures-Self assembly-Plant cells-Organized self assembled structures

Unit III

Nanotechnology in Food Packaging: Introduction-Reasons to package food products-Physical properties of packaging materials-Antimicrobial functionality-Visual indicators-Improvement of mechanical properties through nanocomposites-Improvement of the barrier properties, nanocomposites, nano-structured coatings-Improvement of the performance of bio-based polymers-Surface biocides-Active packaging materials-Intelligent packaging concepts-Potential migration of nano-particles from food contact materials

Unit IV

Nanotechnology and Food Allergy, Nano-Ethics: Introduction-Molecules in foods involved in triggering allergies-Plant food allergens-Animal food allergens-Food structure processing and food allergy-Impact of nanoscale structures on allergic potential of foods-Nano-ethics-Historical background-Identifying and avoiding unethical nanotechnological products-Ensuring ethical nanotechnological research, innovation and production-Nano-ethics as the question of the good nanotechnological society

Unit V

Food Functionality and The Physics of Bionanotechnology: Risk Governance: Introduction-Physics and structures in food bionanotechnology-Fibrillar structures-Plate-like structures-Spherically symmetric structures-Biocontinuous structures in protein-polysaccharide systems-Gastronomy and nanodomain: Molecular gastronomy-Guiding principles for risk governance-Nanofoods knowns and unknowns-New for old-A nanovision for the future food

Text Book:

1. Qasim Chaudhry, Lawrence Castle and Richard Watkins, "Nanotechnologies in Food" published by Royal Society of Chemistry, ISBN: 9780854041695, ISSN: 17577136, 2010.

Reference Book

1. Lynn J. Frewer, Willem, Norde, Arnout Fischer, and Frans Kampers, "Nanotechnology in Agri-Food Sector" Published by Wiley-VCH Verlag GmbH & co. KGaA Hoeschst. ISBN: 978-3-527-33060-7, 2011.

12FP327 ADVANCES IN DRYING TECHNOLOGY

Credits: 4:0:0

Objective:

- To enable the students understand the concepts of different drying models
- To make the students understand the processing parameters and drying rates of product
- To enable the students to design and develop various dryers used in food processing operations

Outcome:

- The knowledge on drying technology will help to conserve and minimize the losses of food produced
- Student would be able to predict the drying curves for a product
- Students would be able to design eco-friendly dryers with cost effective

Unit-I

Principles, Classification And Selection Of Dryers: Introduction-External conditions (process I)-Vapour liquid equilibrium and enthalpy-Vapor-gas mixture-Unsaturated vapour –gas mixture-Enthalpy humidity charts-Types of psychrometric representation-Internal condition (process II)-Models for predicting water activity - Moisture isotherms-Models for predicting sorption isotherms - Determination of sorption isotherm-Mechanism of drying-Classification and selection of dryer-Energy costs, Safety and Environment factors-Design of dryers-Guidelines for dryer selection-Drying kinetics

Unit-II

Basic Process Calculations And Simulations In Drying: Basic classes of models and generic dryer types-General rules for a dryer model formulation-Mass and energy balances-Constitutive equations-Auxiliary relationships-Property databases-General remarks on solving models-Basic models of dryers in steady state-Distributed parameter models for the solid-Models for batch dryers-Models for semi-continuous dryers-Shortcut methods for dryer calculation-Software tools for dryer calculations

Unit-III

Transport Properties In Drying Of Solids: Moisture diffusivity-Thermal conductivity-Inter phase heat and mass transfer coefficient- Drying constant-Equilibrium moisture content-Definition, experimental methods, data compilation, factors affecting and theoretical estimation-Heat and mass transport properties from drying experiments-Principle of estimation-Experimental drying apparatus-Regression analysis- Drying model-Applications-Transport properties of foods

Unit IV

Industrial Dryers: Fluidized bed dryer, parameters of fluidized bed dryer, types of fluidized bed dryer, Spray drying systems - principle, atomized chamber design, new development in spray drying, -Freeze drying process-Microwave freeze drying-Freezing drying plant equipment-Industrial freeze dryer- Microwave and dielectric heating-equipment and industrial application for microwave and dielectric heating and drying- Spouted bed drying - experimental device and

procedure spouted bed drying-drying results- basic operation and application of flash dryer- design of flash dryer- basic principle on infrared drying-industrial infrared drying application.

Unit V

Newer methods of drying and Process control: Heat recovery methods-Some new drying techniques-Low pressure Super heated steam drying – Basic principles – Mathematical modeling of LPSSD of food materials - Heat pump assisted drying – Heat and mass transfer mechanisms – Innovative heat pump drying systems – Impingement drying - Introduction and design- Food drier process control - Environmental problems-Examples of applications of some energy saving method

Text Book:

1. Xiao Dong Chen and Arun S. Mujumdar. “Drying Technologies in Food Processing”, Blackwell Publishing Ltd., ISBN-13: 978-1-4051-5763-6, 2008.

Reference Book:

1. Arun S. Mujumdar 'Handbook of Industrial Drying' CRC Publications, ISBN: 1574446681, Third edition, 2006.

13FP301 FOOD PLANT LAYOUT AND DESIGN

Credits: 3:0:0

Objective:

To enable the student to understand:

- The importance of Food plant layout and design.
- The various factors involved in the site selection and design of food plant layout.
- The concept of preparing cost estimate and economics.
- The importance HACCP and food safety laws governing food industries.
- The environmental pollution control in food industries.

Outcome:

On completion of the course, the student will gain knowledge and exposed to

- Design and setting up of new food processing plant as Entrepreneur and/or consultant.
- Prepare cost estimate and economic analysis of food industry.
- Implement the food safety standards in food industries.
- Help to minimize the food industry losses and maximize the processed food production

Unit - I

SITE SELECTION: Site selection - Factors - Case Study: Site Selection - Product Capacity and quality – Storage of Raw materials and Product - Waste Disposal, Utilities – Requirements for water, electricity, labor, transportation facilities, refrigeration, boiler- laboratory - Plans for Future Expansion- Hours of Operation- Completion Date- Safety

Unit - II

PLANT DESIGN, SAFETY, POLLUTION AND ITS ABATEMENT: Manufacturing Plant Design – Building design – Legal aspects – Building bylaws, Expansion – Plant Location – The structure – Facilities Lay-out Office, toilet, laboratory- Problem of pollution - Determining Pollution Standards- Meeting Pollution Standards- Air and Water Pollution Abatement Methods- BOD and COD

Unit- III

CLEANING AND SANITATION: Goals of cleaning and sanitizing – Types of soil – Cleaning criteria and measurement – The cleaning process – Environmental aspects – Cleaning Kinetics – Hygienic design – Cleanability test methods – Water treatment

Unit - IV

LAYOUT AND COST ESTIMATION: New Plant Layout- Product and process layout - Expansion and Improvements of Existing Facilities- Case Study: Layout and Warehouse Requirements – Inventory control - Cost Indexes - Capacity vis-a-vis Costs - Factored Cost Estimate – Break – even point - Improvements– Module Cost Estimation - Unit Operations Estimate- Detailed Cost Estimate- Accuracy of Estimates- Case Study: Capital Cost Estimation.

Unit - V

ECONOMICS: Cost of Producing a Product- Capital - Elementary Profitability Measures- Time Value of Money- Compound Interest- Net Present Value- Rate of Return- Comparison of Net

Present Value and Rate of Return Methods- Proper Interest Rates - Expected Return on the Investment- Economic Evaluation – Depreciation – Amortization- Depletion Allowance- Investment Credit- Special Tax Rules - Problems.

Text Books:

1. William D. Baasel. “Preliminary chemical engineering plant design”, Second edition Van Nostrand Reinhold, 1990.
2. Dennis R. Heldman and Daryl B. Lund. “Hand Book of Food Engineering”, Second edition, CRC Press, Taylor and Francis Group, 2007.

Reference books:

1. R.K. Sinnott. “Coulson and Richardsons Chemical Engineering” Vo. 6., 4th Edition, Elsevier Publication. 2005.
2. Max S. Peters and Klaus D. Timmerhaus and Ronald West. “Plant Design And Economics For Chemical Engineers”, 5th Edition, Tata Mc-Graw Hill Education. 2003.
3. T.C. Robberts. “Food Plant Engineering Systems”. CRC Press. 2002.

13FP302 FOOD ENGINEERING LAB

Credits : 0:0:2

Objective:

To enable the students to have the practical experience on

- Various Unit Operations
- Use of Instrumentation In Food Analysis
- Engineering Property measurements
- Efficiency of Food Processing Machineries

Outcome:

- The student can use this understanding /knowledge for the design ,development operation and maintenance of food processing machines thereby increasing the processing production rates.
- The mechanization will reduce the labour requirement, time and cost of production

The faculty conducting the Laboratory will prepare a list of experiments [10/5 for 2/1 credit] and get the approval of HoD and notify it at the beginning of each semester.