

KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE - 638 052
(An Autonomous Institution affiliated to Anna University Chennai)

M.Tech. DEGREE IN FOOD TECHNOLOGY (FULL TIME)

CURRICULUM

(For the candidates admitted from academic year 2013 - 14 onwards)

SEMESTER – I

Course Code	Course Title	Hours / Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
11ED101	Applied Mathematics for Engineering and Technology	3	1	0	4	50	50	100
11MF101	Food Quality and Safety	3	1	0	4	50	50	100
11MF102	Fruits, Vegetables and Grains Processing Technology	3	0	0	3	50	50	100
11MF103	Food Additives, Nutraceuticals and Functional Foods	3	0	0	3	50	50	100
11MF104	Unit operations in Food Process Engineering (For Science Graduates)	3	0	0	3	50	50	100
11MF105	Food Chemistry and Microbiology (For Engineering Graduates)							
	Elective-I	3	0	0	3	50	50	100
	PRACTICAL							
11MF106	Food Analysis and Quality Control Laboratory	0	0	3	1	100	0	100
Total					21			

CA – Continuous Assessment, ESE – End Semester Examination

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SEMESTER – II

Course Code	Course Title	Hours / Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
11MF201	Refrigeration and Cold Chain Management	3	1	0	4	50	50	100
11MF202	Meat, Marine and Milk Processing Technology	3	0	0	3	50	50	100
11MF203	Food Processing Technology	3	1	0	4	50	50	100
11MF204	Food Legislation, Standards and Quality Management System	3	0	0	3	50	50	100
	Elective - II	3	0	0	3	50	50	100
	Elective - III	3	0	0	3	50	50	100
	PRACTICAL							
11MF205	Food Processing Technology Laboratory	0	0	3	1	100	0	100
Total					21			

CA – Continuous Assessment, ESE – End Semester Examination

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(For the candidates admitted from academic year 2013 - 14 onwards)

SEMESTER - III

Course Code	Course Title	Hours / Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
	Elective – IV	3	0	0	3	50	50	100
	Elective – V	3	0	0	3	50	50	100
	Elective – VI	3	0	0	3	50	50	100
	PRACTICAL							
11MF301	Project Work – Phase – I	0	0	12	6	50	50	100
Total					15			

CA – Continuous Assessment, ESE – End Semester Examination

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CURRICULUM

(For the candidates admitted from academic year 2013 - 14 onwards)

SEMESTER - IV

Course Code	Course Title	Hours / Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	PRACTICAL							
11MF401	Project Work – Phase – II	0	0	24	12	100	100	200
Total					12			

CA – Continuous Assessment, ESE – End Semester Examination

LIST OF ELECTIVES					
Course Code	Course Title	L	T	P	C
11MF011	Plantation Crops, Spices and Condiment Technology	3	0	0	3
11MF012	Food Process Equipment, Plant Layout Design and Process Economics	3	0	0	3
11MF013	Advanced Drying Technology	3	0	0	3
11MF014	Advanced Separation Techniques in Food Processing	3	0	0	3
11MF015	Heat and Mass Transfer operations	3	0	0	3
11MF016	Emerging Technologies in Food Processing	3	0	0	3
11MF017	Baking and Confectionery Technology	3	0	0	3
11MF018	Industrial Waste Management	3	0	0	3
11MF019	Transport Phenomena in Food Processing	3	0	0	3
11MF020	Operation Research Management	3	0	0	3
11MF021	Sensory Attributes of Foods	3	0	0	3
11MF022	Milk and Milk Products	3	0	0	3
11MF023	Instrumental Methods for Food Analysis	3	0	0	3
11MF024	Lipid Science and Technology	3	0	0	3
11MF025	Enzyme Technology	3	0	0	3
11MF026	Food Packaging and Storage Engineering	3	0	0	3
11MF027	Technology of Food Flavourants and Colourants	3	0	0	3
11MF028	Food Biotechnology	3	0	0	3

11ED101 APPLIED MATHEMATICS FOR ENGINEERING AND TECHNOLOGY
(Common to Engineering Design, CAD/CAM , Chemical Engineering & Food Technology
branches)

3 1 0 4

Objectives:

On completion of the course the students are expected

- To understand the concept of the variation problems.
- To understand the concept of linear and non linear equations and its solutions.
- To know the concept of numerical differentiation and integration.
- To understand the concept of boundary value problems and to find its solutions.
- To acquire knowledge about the partial differential equations and its solutions.

MODULE – I **15**

Calculus of variation: Functional –definition-Variational problem: Euler Lagrange equation- Solutions of Euler Lagrange equation – Variational problems involving one& Several unknown functions – Functionals dependent on higher order derivatives – Variational problems involving Several independent variables.

Solution of system of simultaneous equations: Linear equations: Direct methods – Gauss Elimination, Gauss Jordon, Iterative methods- Gauss Jacobi, Gauss Seidal method. Non-linear equations- Newton Raphson method.

MODULE – II **15**

Numerical Differentiation and Integration: Equal intervals – Newton’s forward and backward interpolation formula – unequal intervals – Newton’s divided difference formula. Newton-Cotes integration formulas, Trapezoidal rule, Simpson's rules, Gaussian quadrature.

Ordinary Differential Equations: Single step methods for Taylor series method – Euler method – Modified Euler method – Runge-Kutta Method of Fourth order .

MODULE- III **15**

Partial Differential Equations: Solving boundary value problems by finite difference method – Finite difference solution for one dimensional heat equation by Implicit and Explicit methods – One dimensional wave equation – Two dimensional Laplace and Poisson equations.

Lecture: 45, Tutorial: 15, TOTAL : 60

REFERENCE BOOKS

1. Gerald, Curtis F and Wheatley, Patrick O, "Applied Numerical Analysis", Pearson Education, New Delhi, 2002.
2. Jain, M.K. Iyengar, S.R.K and Jain R.K., “Numerical Methods for Scientific and Engineering Computation”, New Age International (P) Ltd., Publishers, 2008.
3. Venkataraman, M. K, “Numerical Methods”, National Publishing Company, Chennai, 2000.
4. Venkataraman. M.K, “Higher Mathematics for Engineering & Science”, National Publishing Company, 2006.

11MF101 FOOD QUALITY AND SAFETY

3 1 0 4

Objectives:

- To enhance the knowledge of the students about the various food safety norms and quality control techniques.
- To impart the students about the safety concerns in Food Processing.

MODULE – I

15

Food Safety and Risk: Introduction, Food safety- Principles and Need for quality control and safety - impact of food safety on world trade issues, Characterization of food hazards, Microbiological criteria for safety and quality- spoilage, food borne diseases and their control, sampling plans and criteria for microbial assessments in foods.

Food contaminant & Hazards- physical, biological and chemical contaminants - factors affecting toxicity of compounds - quality control and food safety. Food related hazards – biological hazards, chemical hazards & physical hazards.

MODULE – II

15

Conventional Processing Systems of Producing Safe Foods: Safety aspect during Pasteurization and Sterilization, Microwave Processing Mechanism - Microwave related dielectric properties, Drying Occurance and Control of mycotoxins and pathogenic bacteria in dried food products,

Food microbiology and refrigeration - Refrigerated storage and safety, Active and intelligent packaging, Sous Vide and Cook-chill Processing; Aseptic Processing and Packaging - Principles and applications, establishment, validation and regulations, Future trends. Systems –Monitoring of Safety, wholesomeness and nutritional quality of food.

MODULE - III

15

Integration of Food Process Engineering and Food Microbial Growth: Inactivation of microbial growth - high pressure processing, Food refrigeration. Process Dependent Microbial modeling, Integration of process and microbial growth modeling.

Contemporary Food Safety Strategies: - Strategy and criteria for food safety- Consumer lifestyle and demand- Food Production and economics- Issues in Food safety- Case study- Case against Food biotechnology, irradiation.

Lecture: 45, Tutorial: 15, TOTAL: 60

REFERENCE BOOKS

1. Da-Wen Sun., “Handbook of Food Safety Engineering”, John Wiley & Sons, New Jersey, 2011.
2. Ronald H. Schmidt, and Gary E. Rodrick., “Food Safety Handbook”, John Wiley & Sons, New Jersey, 2005.
3. Cynthia A. Roberts., “The Food Safety Information Handbook”, Greenwood Publishing Group, Westport, US, 2001.

11MF102 FRUITS VEGETABLES AND GRAINS PROCESSING TECHNOLOGY

3 0 0 3

Objectives:

- To acquire knowledge on Processing and preservation of plant food
- To understand the Milling and processing concepts of cereals and pulses
- To know international standards of quality of plant foods

MODULE – I

15

Processing of fruits and vegetables : Importance of post harvest technology –post harvest handling and physiological development– ripening mechanism –Spoilage of fruits and vegetables and their processed products –Deteriorative factors and their control – enzymatic changes, chemical changes, physical, changes and biological changes. Common machinery for operations like Peeling, Slicing/Dicing, Pulping, Grating and canning process.

Preservation of fruits and vegetables: Jam, Jelly and marmalade, pickles, vinegar, Juice and pulp extraction, Squashes, Puree, Ketchup, Sauces. Canning operations. 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 –Application of Spray Dryer and Drum Dryer.

MODULE – II

15

Milling of Cereals: Rice milling. Milling of wheat and wheat products. Milling of corn, barley, oat and coarse grains. Equipments used for cleaning and milling. Millets – major and minor. Traditional and improved processing methods.

Processing of Cereals: Cereal based animal feed, Rice based products. Wheat Germ and corn oil. Starch conversion into other value added products – Acid Hydrolysis, Enzyme Hydrolysis, Isomerization processes. Processing for Dextrose, Maltodextrin and other products. Millet based products.

MODULE - III

15

Milling and Processing of Pulses: Traditional Processing steps in Milling of pulses and legumes– Machinery and equipment employed, mass balance, losses during milling.

Modern milling process- merits and demerits. Mini dhal mill – working principle – advantages and disadvantages. Legume-based products, soy protein Isolate, Fermented and traditional products.

TOTAL : 45

REFERENCE BOOKS

1. Lal, G., Siddappa, G. and Tondon G.L., “Preservation of Fruits and Vegetables”, Indian Council of Agricultural Research, New Delhi, 1986.
2. Chakraverty.A., Mujumdar.A., Raghavan.G.S.V. and Ramaswamy.H.S., “Handbook of Post Harvest Technology : Cereals, Fruits, Vegetables, Tea and Spices”, CRC Press, 2003.
3. Owens.G, “Cereals Processing technology’, Woodhead Publishing Limited, 2001.

11MF103 FOOD ADDITIVES, NUTRACEUTICALS AND FUNCTIONAL FOODS

3 0 0 3

Objectives:

- To gain knowledge of additives that are relevant to processed food industry and to get an insight in newly emerging area of nutraceuticals with respect to the types, mechanisms of action, manufacture, product development and toxicity aspects.

MODULE – I

15

Food Additives: Introduction , classification and functions; Role of additives in foods - preservatives, antioxidants, sequestrants, emulsifiers, stabilizers and thickeners, leavening agents, pH control agents, anti-foaming agents.

Colourants and Flavourants: Food colourants and colour retention agents, sweeteners, humectants, flavourants and flavour enhancers, fat substitutes and replacers, bleaching and maturing agents, starch modifiers.

MODULE - II

15

Functional Foods and Nutraceuticals: Introduction and definition, difference between functional foods and nutraceuticals; Functional Food Ingredients - Introduction , classification and functions; Eye health ingredients – lutein, zeaxanthin, astaxanthin, beta-carotene, bilberry extracts; Heart health ingredients - omega-3, omega-6, omega-9, beta-glucan, soy protein, phytosterols

Health Ingredients: Digestive Health Ingredients – prebiotics, probiotics, synbiotics, digestive enzymes, zinc carnosine; Women health ingredients - Vitamin D, iron, calcium, soy isoflavones, folic acid, cranberry extract, lycopene; Bone and Joint health ingredients - prebiotic fiber, glucosamine, chondroitin, collagen peptide, hyaluronic acid, devils claw, olive polyphenols, Boswellia Serrata, horsetail extract.

MODULE - III

15

End User Market Products – Introduction to dietary supplements and functional food & beverages; Dietary supplements – Need for dietary supplements, supplements forms- tablets, capsules, powders, softgels, gelcaps, liquids.

Current Trends: Dietary supplements currently available in the market, regulation for dietary supplements; Functional food & beverages - products currently available in the market, regulatory scenario.

TOTAL : 45

REFERENCE BOOKS

1. Vaclavik, V.A. and Christian E. W ., “Essential of Food Science”, 2nd Edition, Springer, 2005
2. Wildman, Robert E.C., “Handbook of Nutraceuticals and Functional Foods”, CRC Press, New York, 2001.
3. Clydesdale, Fergus M., “Food Additives: Toxicology, Regulation, and Properties”, CRC Press, New York, 1996.
4. Lockwood, Brian, and Rapport Lisa, “Nutraceuticals: A Guide for Healthcare Professionals”, Pharmaceutical Press, 2007.

11MF104 UNIT OPERATIONS IN FOOD PROCESS ENGINEERING

3 0 0 3

Objectives:

- To impart Knowledge on fluid behavior and basic principles of unit operations used in Food Processing Industry.
- The aim of the course is to enable the students to understand the Unit Operation Principle and how to apply the concepts in industries.

MODULE- I

15

Principles of fluid flow: Basic engineering mathematics - units and dimension-conservation of mass and energy – principles of fluid flow – properties of liquids, fluid dynamics – mass and energy balance- potential energy, kinetic energy, pressure energy, friction loss, mechanical energy-Newtonian and non – Newtonian fluids-stream line and turbulent flow - flow measurement and measurement of viscosity.

Basic Equations of Fluid Flow: Kinematics of fluid flow, Concept of boundary layer, Basic equation of fluid flow: Equation of continuity and Bernoulli equation. Correction of Bernoulli equation for fluid friction. Application of Bernoulli equation for pump work.

MODULE-II

15

Mechanical Separation: Screening- screening equipment, effectiveness of screens , gravity settling, sedimentation- Thickening- clarifier- Flootation- filtration Principle- types of filtration - rate of filtration- batch and continuous filtration- equipments.

Heat Transfer: Concept of heat conduction - Fourier's law of heat conduction -one dimensional steady state heat conduction equation for flat plate- Concept of heat convection - Natural and forced convection –individual and overall heat transfer coefficient- Concept of radiations - Black body and grey body concept - Radiation Properties – Stefan Boltzmann's law, emissivity and absorptivity – Kirchhoff's Law.

MODULE - III

15

Mass Transfer : Types of mass transfer operations -Fick's law- molecular and eddy diffusion in gas and liquids - steady state diffusion under stagnant and laminar flow conditions- diffusivity measurement - local and overall mass transfer coefficients.

Humidification: Humidity measurement, calculation of absolute humidity, moloal humidity, relative humidity and percentage humidity, use of psychrometric chart, cooling towers – principle and operations.

TOTAL: 45

REFERENCE BOOKS

1. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations of Chemical Engineering", Seventh Edition, McGraw-Hill, New York, 2005.
2. Dutta Binay K., "Heat Transfer: Principles and Applications", Prentice Hall of India, New Delhi, 2001.
3. Treybal. R.E., "Mass Transfer Operations", Third Edition, McGraw-Hill, New York, 1981.

11MF105 FOOD CHEMISTRY AND MICROBIOLOGY

3 0 0 3

Objectives:

- To provide an understanding of chemistry, function and properties of major food components.
- To provide the knowledge about the fundamentals of microorganisms present in the food.

MODULE- I

15

Water relationships in Food: Water activity and its relevance to deteriorative processes in foods. Glass transitions and molecular mobility, their relevance to quality and stability of foods.

Basic Concepts of Carbohydrates: Structure and properties of simple and complex food carbohydrates. Modified starch and cellulose. Manufacture of maltodextrins and corn syrup. Cyclodextrins- chemistry and food applications. Carbohydrates as fat substitutes.

Lipids: Classifications, Structures and roles of fatty acids. Processing of oils and fats – refining, hydrogenation, interesterification and winterization. Deterioration of oils – hydrolytic rancidity, oxidative rancidity and their prevention.

MODULE-II

15

Proteins: Protein structure & conformation; Properties & reactions of proteins in food systems: Dissociation, optical activity, solubility, hydration, swelling, foam formation & stabilization, gel formation, emulsifying effect. Denaturation of proteins. Food sources, functional role and uses in foods. Texturised Proteins.

Microbial growth: physical and chemical factors influencing destruction of microorganisms. Types of micro-organism normally associated with food-mold, yeast, and bacteria. Micro-organisms in natural food products and their control. Contaminants of foods-stuffs, vegetables, cereals, pulses, oilseeds, milk and meat during handling and processing. Biochemical changes caused by micro-organisms, deterioration of various types of food product. Food poisoning and microbial toxins, microbial food fermentation, standards for different foods. Food borne intoxicants and mycotoxins.

MODULE- III

15

Microbial Spoilage: Spoilage of foods – principles and types of spoilage – microbial spoilage of different types of foods, - spoilage of fruits and vegetables, fresh and processed meats, poultry, sea foods, cereals products, bakery products, dairy products, fermented foods and canned foods.

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 temperature, radiation, drying on microbes. Chemical preservatives. Perishability of food and general principles of preservation. Advances in preservation of Food by various biotechnological processes.

TOTAL : 45

REFERENCE BOOKS

1. Belitz, H. D., Grosch, W. and Schieberle P., “Food Chemistry”, Third Edition, Springer-Verley, Berlin, 2004.
2. Vaclavik, V.A. and Christian E.W., “Essential of Food Science”, 2nd Edition, Springer, 2005.
3. Frazier, W.C. and Westhoff, “Food Microbiology”, Fourth Edition, Tata McGraw-Hill, New Delhi, 2011.

11MF106 FOOD ANALYSIS AND QUALITY CONTROL LABORATORY

0 0 3 1

Objectives:

- To develop and understand the methodologies and instrumental techniques used in food analysis.

LIST OF EXPERIMENTS

1. Estimation of consistency, viscosity and Specific gravity for given food samples.
2. Detection and estimation of preservatives in food materials.
3. Extraction and estimation of fat content in fried food samples
4. Measurement and analysis of Cooking Quality Parameters
5. Estimation of total Polyphenols in tea/coffee extract
6. Estimation of total sugar content in fruits
7. Isolation and estimation of synthetic food colors
8. Flavour profile comparison of the given food materials by ranking scale method
9. Sensory analysis of food materials by overall difference test
10. Estimation of antioxidant and antimicrobial property in the given food sample
11. Quality analysis of raw materials used for bakery products
12. Study on estimation of food additives present in the given food sample

(Minimum 10 experiments has to be conducted)

REFERENCES / MANUALS/SOFTWARE:

1. Sadasivam, S., and Manickam, A., “Biochemical Methods”, Third Edition, New Age International, Delhi, 1996.
2. “Manual of methods for the Analysis of Foods”, Ministry of Health and Family Welfare, Government of India, New Delhi, 2005.
3. Morris B. Jacobs., “The chemical Analysis of Foods and Food products” Third edition, CBS publishers & distributors, New Delhi, 2005.

11MF201 REFRIGERATION AND COLD CHAIN MANAGEMENT

3 1 0 4

Objectives:

To acquaint the students with the aspects of refrigeration, cold storage and low temperature storage of foods.

MODULE – I

15

Principles of Refrigeration: Refrigeration, Single and multi-stage vapour compression system, vapour absorption system and air cycle refrigeration system, Refrigerants - characteristics of different refrigerants, ozone depletion potentials, use of non polluting refrigerants, estimation of cooling load, ton of refrigeration.

Components of a Refrigeration system: Compressor - positive displacement and roto-dynamic type and performance, Types of Evaporators and their functional aspects, Condensing units and cooling towers, expansion valves, piping and different controls.

MODULE - II

15

Cold Storage: Construction and operation of cold storage system - cold room temperatures, Insulation, properties of insulating materials, air diffusion equipment, Doors and other openings. Cold load estimation; Stacking and handling of material in and around cold rooms.

Low temperature storage of foods: Evaporative cooling and its applications. Freezing equipment, Freezing rates, growth rate of ice crystals, crystal size and its effect of texture and quality of foods, Freezer types, Individual quick freezing and Cryogenic Freezing.

MODULE – III

15

Cold Chain management: Scope and importance of cold chain in food processing industry and retail chain, components of cold chain and integration. Products in cold chain, their temperature and humidity requirements, packaging needs and their compatibility in cold chain.

Process: Flexibility storage systems cold chain transportation in land and export, retail & supermarket cold chain and display systems. Temperature recording devices used during transport, documentation and traceability.

Lecture:45, Tutorial:15 TOTAL : 60

REFERENCE BOOKS

1. Rajput, R.K., "Refrigeration and Air-conditioning" S. K. Kataria & Sons, Delhi, 2012.
2. Arora, C.P., "Refrigeration and Air Conditioning" Second edition, Tata McGraw-Hill Publishing Company Ltd, Delhi, 2008.
3. Agarwal D.K., "Supply Chain Management – Strategy, cases and Best Practices", Macmillan Publishers India Ltd, Bangalore, 2010
4. Dellino C.V.J., "Cold and Chilled Storage Technology", 2nd Edition, Springer, 2011.

11MF202 MEAT, MARINE AND MILK PROCESSING TECHNOLOGY

3 0 0 3

Objectives:

- To provide an understanding of the technology for handling, processing, preservation and bi-product utilization of meat, poultry and fish products processing.
- To acquaint with technologies and engineering aspects of milk processing.

MODULE - I

15

Meat: Meat and meat products in India. Chemical composition and structure of meat. Slaughtering of animals, Pre and post slaughter operations. Factors affecting post-mortem changes. Meat quality evaluation. Mechanical deboning, meat tenderization. Meat plant sanitation and safety, byproduct utilization. Preservation of meat.

Poultry: Types and characteristics of poultry products, composition, nutritive value of poultry products. Unit operation involved in poultry processing. Structure, composition, nutritive value and functional properties of eggs and its preservation by different methods. Processing of egg products. Measures of egg quality.

MODULE - II

15

Marine: Marine processing industries in India. Types of fish, composition, post-mortem changes in fish. Handling and transportation of fish. Freezing and Individual quick freezing. Seafood quality Assurance, Advances in fishery by products technology.

Fish products: Canning, smoking, freezing and dehydration of fish. Preparation of fish products, fish sausage and home makings. Productions of fish meal, fish protein concentrate, fish liver oil and fish sauce and other important byproducts. Radiation processing of fish and fish products. Quality control of processed fish. Sea wood: Benthic marine algae, Algae-red, brown and green.

MODULE - III

15

Milk processing: Milk processing – Filtration / clarification, Storage of milk, Standardization - simple problems in standardization, homogenization, pasteurization techniques. Manufacture of Cream, Butter, Ghee, Milk powder, Cheese, Yoghurt, curd, acidophilus milk and buttermilk.

Dairy plant equipments and sanitization: Centrifuges, Pasteurizers, Milk Chillers, Homogenizers, Bottle and pouch fillers, Spray and Drum Dryers. Cleaning in place technique, bottle and can washing, cleaning of tankers and silos. Energy use in Dairy plant – sources and cost of energy, Control of energy losses and energy conservation.

TOTAL : 45

REFERENCE BOOKS

1. Govindan. T.K., “Fish Processing Technology”, Oxford and IBH Publishers, New Delhi, 1985.
2. Lawrie, R.A., “Meat Science”, Second Edition, Pergamon Press, Oxford, UK, 1975.
3. Stadelmen, W.J. and Cotterill, O.J., “Egg Science and Technology”, Second Edition, AVI, Westport, 1977.
4. Sukumar De., “Outlines of Dairy Technology”, Oxford University Press, India, 1980.
5. Tufail Ahmad., “Dairy Plant Systems Engineering”, Kitab Mahal, Allahabad, India, 1985.

11MF203 FOOD PROCESSING TECHNOLOGY

3 1 0 4

Objectives:

- To educate the students about the principle, equipments and the application of important food process operations like size reduction, mechanical separation, crystallization and extrusion and develop awareness about various material handling equipments.

MODULE – I

15

Properties of Food materials: Physical properties, Thermal properties, Mechanical properties, Rheological properties, Aero and Hydrodynamic properties. Moisture content – free moisture, bound moisture, Equilibrium moisture content, EMC determination methods, EMC Models, hysteresis effect.

Post Harvest Processing: Post harvest losses in field crops – Cleaning, Wet and dry cleaning, Peeling– Grading and Sorting – Principles, types, equipments – Disk separator, Indented Cylinder Separator, Spiral separator, Specific gravity separator, Destoner, Inclined draper, Velvet roll separator, Magnetic separator, and Color separator.

MODULE - II

15

Material handling and size reduction: Material handling equipments- screw conveyor, bucket elevator, belt conveyor, chain conveyor, pneumatic conveyor. Size reduction - energy and power requirements - Rittinger's, Bond's and Kick's laws – principles of Size reducing equipments – Crushers, hammer mill, ball mill, Disc mill, Edge runner mill, Roller mill - Cryogenic grinding and its application – homogenization principles,

Mixing and Thermal Processing: Mixing – liquid mixing – solid mixing – applications – Mixing equipments. Thermal processing of food- Blanching, pasteurization, sterilization, aseptic sterilization, Process time calculations.

MODULE – III

15

Drying: Theory and mechanism of drying, drying characteristics of materials, Types of dryers-Spray dryer, freeze dryer, vacuum dryer, rotary dryer; fluidized bed dryer, spouted bed dryer, Microwave dryers, dehumidify dryer, Heat pump drying, Di-electric drying, Impingement drying, Flash drying.

Extrusion & Crystallization: Theory and mechanism, Single & twin screw system. Crystallization Equilibrium – Nucleation – Meta stable region – Seed Crystals – Heat of Crystallization – Rate of crystal growth – Stage equilibrium crystallization – Equipments.

Lecture: 45, Tutorial: 15, TOTAL: 60

REFERENCE BOOKS

1. Paul Singh R. and Dennis R. Heldman., “Introduction to Food Engineering” 4th Edition, Academic Press, 2009
2. Fellows P., “Food Processing Technology- Principles and practice”, CRC Press, 2009.
3. Earle.R.L. “Unit Operations in Food Processing, 2nd Edition, Pergamon, 1983.

11MF204 FOOD LEGISLATION, STANDARDS AND QUALITY MANAGEMENT SYSTEM

3 0 0 3

Objectives:

- To make the students to understand and correlate the regional standards with international standards.
- To equip the students to maintain the food quality standards in order to ensure the food safety in industry.

MODULE – I

15

International Agencies- World Trade Organisation (WTO), Food and Agricultural Organisation (FAO) and Codex Alimentarius Commission (CAC). World Health Organization (WHO), United States Food and Drug Administration (USFDA), Global Food Safety Initiative (GFSI), International Consultative Group On Food Irradiation (ICGFI), European Food Safety Authority (EFSA), British Retail Consortium (BRC) global standards, Food Standards Australia New Zealand (FSANZ), Food Regulations in the Middle East.

FSSAI- Functions, duties & responsibilities of food safety regulators, Food safety and standards for various food products, Implementation of food safety regulation – FSS Act 2006 – Regulation (2011), Advances in Food Safety & Quality Management, Food Safety Audit.

MODULE - II

15

Quality Practices- Good Agricultural Practices (GAP), Good Manufacturing Practices (GMP), Good Hygienic Practices (GHP), Good Laboratory Practices (GLP), Sanitary and Phyto-Sanitary measures (SPS), Plant Quarantine Act, Life cycle Assessment (LCA); Environmental Impact Assessment (EIA). **Certification-** Organic Certification. SSOP, HACCP, HALAL, Nutritional labeling and packaging laws.

MODULE - III

15

ISO Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing. PDSA Cycle, 5S, Kaizen, FMEA, ISO 9000:2008, ISO 14000, ISO 18000, ISO 20000, ISO 22000. FSSC 22000

TS 16949 - Concept, Requirements and Benefits, QS-9000 – Concept, Requirements and Benefits.

TOTAL : 45

REFERENCE BOOKS

1. Mehta, Rajesh and George J., “Food Safety Regulations Concerns and Trade: The Developing Country Perspective”, McMillan, New Delhi, 2005.
2. Dale H. Besterfield., “Total Quality Management”, Third edition, Pearson Education, 2008
3. FSSAI., “Manual of Food Safety Management System”, FSS Act, 2006, Ministry of the Health and Family Welfare, New Delhi, 2006.
4. FSSAI., “Food Safety and Standards Regulations – 2011”, Ministry of the Health and family Welfare, New Delhi, 2011.

11MF205 FOOD PROCESSING TECHNOLOGY LABORATORY

0 0 3 1

Objective:

- To provide hands on training on various food processing operations to give practical exposure.

LIST OF EXPERIMENTS /EXERCISES

1. Determination of Physical Properties of grains.
2. Determination of angle of repose for given food grains at various moisture content
3. Determination of co-efficient of friction for given grains at various base.
4. Determination of fineness modulus using Hammer mill and ball mill.
5. Determination of shelling efficiency of paddy dehusker.
6. Experiment on drying characteristics of food material using tray dryer.
7. Experiment on spray drier.
8. Studies on efficiency of Butter churner.
9. Studies on Minimal Processing of fruits and vegetables.
10. Experiment on osmotic dehydration characteristics of food materials.
11. Preparation of Cookies.
12. Preparation of Cake.

(Minimum 10 experiments has to be conducted)

REFERENCES / MANUALS/SOFTWARE:

1. Kavitha Marwaha., “Food Process Engineering: Theory & Laboratory Experiments”, Gene Tech Books, 2010.
2. Girdhari Lal, Siddappa G.S. and Tandon G.L., “Preservation of Fruits and Vegetables’, Indian Council of Agriculture Research, New Delhi.1986
3. Sukumar De. R.”Outlines of Dairy Technology”, Royal, Oxford University, Press, Delhi. 1983
4. Tufali Ahmed, “Dairy Plant Engineering and management”, CBS Publishers and Distributions, New Delhi.2001

11MF011 PLANTATION CROPS, SPICES AND CONDIMENT TECHNOLOGY

3 0 0 3

Objectives:

This course provides knowledge about the different methods of processing and value added products made from cereals and legumes and an ability to know about the effective ways to process and preserve agricultural crops.

- To develop an awareness of various processing procedure and processed cereal products
- To learn about processing and product development of plantation crops, spices and tuber crops.

MODULE – I

15

Plantation Crops: Description of various types of Plantation crops, viz., coconut, arecanut, coffee, tea, cocoa etc. Processing and preservation methods. Value-added products shelf-stable products and shelf life studies. Description of various types of leafy vegetables-composition, nutritive value, health benefits. Preservation methods and packaging techniques.

Oil seed processing -gingelly,groundnut and sunflower. **Processing of tea** – black tea, Green tea, Oolong tea, flavored tea. Coffee processing – instant coffee. Processing of cocoa, cashew nut, coconut, oil palm, areca nut. Processing of tuber crops – tapioca, sago. Processing of potatoes-processed potato products.

MODULE – II

15

Spices & Condiments: Description of various types of spices and condiments, their composition, functional properties, flavouring agents. Nutritive value of spices and their health benefits. Intermediate Moisture Products – Intermediate Moisture Products viz., ginger paste, ginger – garlic paste, tamarind paste, tamarind concentrate. Their importance in culinary preparations. Flavour retention and packaging methods.

Spices- importance, culinary preparation ,grinding and packaging methods for powders like chilli powder, turmeric powder, ginger powder, garlic powder; and Masala Powders for chicken masala, meat masala, biryani masala, chat masala. Processing of spices – Pepper, Chilly, turmeric, Cardamom, nutmug, cinnamon. Importance of Cryogenic grinding of spices. Spice Oils – Concept and importance of spice oils from spices like and condiments like clove, cardamom, cinnamum. Their application in food processing, and extraction methods of spice oils by various techniques, viz., solvent extraction, steam distillation etc.

MODULE- III

15

Herbs & Flavour Description of various types of herbs, viz., Basil, Chives, Cilantro, Dill, Coriander, Mint, Oregano, Parsley, Chives, Borage and Avocada leaves, Rose marry, Saga, Tarragon, Thyme, Winter savory and bolbo leaves, Papalo, Pipicha and Safflower. Their nutritive value & health benefits, their processing and Post harvest handling. Packaging methods for processed products.

Flavoring materials of natural origin: Natural flavors, sources of natural flavoring materials – Herbs and spices, standards of purity and sensory assessment of herbs and spices, classification of herbs and spices, Spice processing-milling, Microbiology of spices, gas sterilization of spices, gamma irradiation, Heat treatment, Distillation or Extraction. Distillation of volatile oils, Spice essential oils, Application of spice essential oils, Essential oil content of spices. Oleoresins-Extraction, Quality and, Application of oleoresins.

TOTAL: 45

REFERENCE BOOKS

1. Minifie Bernard W., “Chocolate, Cocoa and Confectionery Technology”, Third Edition, Aspen Publication, 1999.
2. “Handbook on Spices”, National Institute of Industrial Research (NIIR) Board, Asia Pacific Business Press Inc, New Delhi, 2004.
3. Kader, A. A., “Post Harvest Technology of Horticultural Crops”, Second Edition, Division of Agriculture and National Resources, California University, 1992.

11MF012 FOOD PROCESS EQUIPMENT, PLANT LAYOUT DESIGN AND PROCESS ECONOMICS

3 0 0 3

Objectives:

- To horn the fundamental knowledge on of equipment design product and layout design, and process economics.
- To make the students to think and design new product and process equipment based on indigenous.
- To make the students to prepare project report for new establishment based on economic analysis.

MODULE – I

15

Introduction to material selection- Material of construction, Mechanical properties. Design basis: Design code; Design pressure, welding efficiency, types of corrosion, corrosion allowance and factor of safety.

Hygiene design- Design of pipe and pipe fittings, process vessels, double pipe heat exchanger; Shell & Tube Heat Exchanger, Evaporator, dryer, design of supports and closures.

MODULE - II

15

Product selection and development- introduction of new product-stages of product development considerations in product development.

Plant layout- Objectives of plant layout, Plant Location, Location Analysis, Selection criteria, Significance. Essentials of plant layout. Types of layout: Factors influencing layout, Dynamics of plant layout and Applicability of plant layout.

MODULE - III

15

Sales forecasting-techniques, approach to pre casting, economy studies for investment and concept of present value-various criteria for comparing investment and replacement analysis and material management.

Inventory control-relevant costs-economic lot size-economic order quantity, Break even analysis, cost estimation. Rate of return, Return on investment and payback period. Preparation of project report. Formulation-project appraisal implementation.

TOTAL : 45

REFERENCE BOOKS

1. Lalat Chander., “Textbook of Dairy Plant Layout and Design”, Directorate of Information and Publications of Agriculture, ICAR, 2010.
2. Khanna, O.P., “Industrial Engineering and Management”, Dhanpatrai & Sons, New Delhi, 1995

11MF013 ADVANCED DRYING TECHNOLOGY

3 0 0 3

Objectives:

- To provides a general discussion of the need for advanced drying technologies and various advanced drying techniques.

MODULE– I

15

Theory and mechanism of drying - Drying characteristics of materials – Intensification of Drying Rates – Multistage Dryers – Classification and Selection Criteria – Development of Improved Drying Technologies

Drying on Inert Particles – Introduction- Drying Mechanism and Process Considerations – Impinging Stream Drying – Basic Features – Hydrodynamics and Heat Transfer – Fry Drying.

MODULE– II

15

Heat Pump Drying – Introduction – Principle of Heat Pump Operation- Low-Temperature Heat Pump Drying – Chemical Heat Pump Drying – New Developments and Trends in Heat Pump Drying – Freeze drying- principle – types – Freeze drying with heat input by microwaves – changes in food material – industrial developments.

Superheated Steam Drying – Introduction – Basic Principles of Superheated Steam Drying – Classification and Selection of Superheated Steam Dryers – Superheated Steam Drying of Selected Products – Utilization of Exhaust Steam – Spray drying – principle of operation – mechanism of atomization.

MODULE– III

15

Novel dehydration techniques – radio frequency drying – Infra red drying – flash drying principle – working. Use of sonic and ultrasonic energy in dehydration – Ecal process of dehydration.

Microwave–Convective Drying with Cogeneration – Microwave–Vacuum Drying – Filtermat Drying – Spray-Fluid Bed–Vibrated Fluid Bed Dryer.

TOTAL : 45

REFERENCE BOOKS

1. Kudra, T and Majumdar, A.S., “Advanced Drying Technologies”, Taylor & Francis Inc, 2009.
2. Arun S. Mujumdar., “Hand Book of Industrial Drying”, 3rd Edition, CRC Press, 2012.
3. Dennis.R.Heldman, Daryl B. Lund, “Handbook of Food Engineering”.2nd Edition, CRC Press,2007

11MF014 ADVANCED SEPARATION TECHNIQUES IN FOOD PROCESSING

3 0 0 3

Objectives:

- To acquire knowledge on advanced separation techniques and adsorption
- To know about various membrane and solid separation methods
- To expose with ionic separations and effluent treatment

MODULE – I

15

Recent Advancements in Separation Techniques: Recent advances in separation techniques based on size, surface properties, ionic properties and other special characteristics of substances. Process concept, theory and equipment used in cross flow filtration, cross flow electro filtration and dual functional filter. Surface based solid – liquid separations involving a second liquid, Sirofloc filter.

Adsorption based Processes: Types and choice of adsorbents, Mechanisms of Affinity chromatography and immuno chromatography. Application of adsorption process in food processing industry.

MODULE - II

15

Solid Separation Process: Concept of size, Shape, Magnetic separation, Eddy-current separation, , Ballistic separation, Color separation, Wet Separation Process, liquid-solid and liquid- liquid separation by hydrocyclones, Surface velocity classifier, Elutriators, Impingement separator, Electrostatic precipitation membrane.

Separation Technology: Mechanism and equipments employed for micro-filtration, Ultrafiltration, Nanofiltration, Reverse osmosis, Concentration polarization, Operation layout of the modules, Pervaporation and Application of membrane technology in food industry.

MODULE - III

15

Ionic Separation Processes : Working principle, controlling factors, equipment employed for for electrophoresis, Dielectrophoresis, ion exchange chromatography, electro dialysis and permeation techniques for solids, liquids and gases.

Other Separation Processes : Zone melting, Adductive crystallization, Oil spill Management, Foam separation, Aqueous two phase extraction and Industrial effluent treatment by modern techniques.

TOTAL : 45

REFERENCE BOOKS

1. Lacey, R.E. and Loeb S., “Industrial Processing with Membranes”, Wiley – Inter Science, New York, 1972.
2. King, C.J., “Separation Processes”, Tata McGraw–Hill Publishers, New Delhi, 1982.
3. Osadar and Varid Nakagawal., “Membrane Science and Technology”, Marcel Dekkar ,1992.
4. Jimmy L. Humphery and George E. Keller., “Separation Process Technology”, McGraw-Hill Publishers, 1997.
5. Ronald.W.Rousseau., “Handbook of Separation Process Technology”, Wiley India Pvt Ltd, 2009.

11MF015 HEAT AND MASS TRANSFER OPERATIONS

3 0 0 3

Objectives:

- To explore wide knowledge on heat exchangers, steam, evaporators, extractor, distillation unit.
- To make the student to understand the heat and mass transfer operations and to design the equipments.

MODULE– I

15

Steam Properties: Properties of steam, steam tables, mollier chart, Determination of dryness fraction of steam, different types of calorimeters, concepts of steam distribution system, types of steam traps.

Heat Exchangers: Types of Heat Exchanger- Parallel and counter flow heat exchangers - LMTD - Heat exchangers and its effectiveness - Fouling factor.

MODULE– II

15

Evaporation: Single and multiple effect evaporators – mass and enthalpy balance – liquid characteristics – single and multiple effect evaporation-performance of evaporators and boiling point elevation – capacity – economy and heat balance-types of evaporators.

Distillation: Vapour-liquid equilibria- Raoult's law and deviations from ideality. Methods of distillation: Simple distillation- calculations using Rayleigh equation, Flash vaporization, steam distillation. Design of multistage tray towers for binary systems using Mc Cabe Thiele method.

MODULE– III

15

Extraction: Equilibrium in ternary system, solvent selection criteria, equilibrium stage wise contact-single stage extraction, multistage cross current, continuous counter current multistage extraction of insoluble solvents.

Leaching: Solid liquid equilibria, single stage leaching, multistage crosscurrent and counter current leaching, leaching equipment- batch and continuous types – principle and operation.

TOTAL : 45

REFERENCE BOOKS

1. McCabe, W.L., Smith, J.C., and Harriot, P., “Unit Operations of Chemical Engineering”, Seventh Edition, McGraw-Hill, New York, 2005.
2. Dutta Binay K., "Heat Transfer: Principles and Applications", Prentice Hall of India, New Delhi, 2001.
3. Treybal. R.E., “Mass Transfer Operations”, Third Edition, McGraw-Hill, New York, 1981.
4. Gavahane K.A., “ Unit operation I”, 8th Edition , Nirali prakasham publications, Pune 2003.

11MF016 EMERGING TECHNOLOGIES IN FOOD PROCESSING

3 0 0 3

Objectives:

- To acquire knowledge of emerging food processing methods
- To understand the concept of various thermal and non-thermal processing of foods.

MODULE – I

15

Emerging technologies: Emerging technologies in food processing – necessity and advantages – hurdle technology – concepts and applications- behavior of microorganisms during preservation – multi target preservation - minimal processing – optimal range of hurdles - super critical fluid extraction processes in food materials - electrical resistance heating – principles- process and equipments.

High Pressure Processing of Foods: High Pressure Processing – Principles – applications to food systems – effect on quality – textural, nutritional and microbiological quality – High Pressure Freezing, High Pressure non-frozen storage- Principles and Applications

MODULE - II

15

Pulsed Electric Field Processing: Principle - Mechanism of action. PEF treatment systems - processing parameters – applications Equipments – Mechanism of microbial and enzyme inactivation- safety aspects. **High Intensity Pulsed Light Technology:** Principles of Pulsed Light Technology, Effect of Pulsed Light Technology on food products and food properties.

Non thermal processing and Ultrasound: Irradiation preservation of food- ionizing radiation- dosimetry- lethal effects on microorganisms - Principle of ultrasound – Fundamentals – Ultrasound as a processing and preservation aid- Effects on food quality.

MODULE - III

15

Ohmic Heating: Fundamentals of Ohmic Heating – Basic Principles, electrical heat generation - electrical conductivity. Generic Configurations -. Product suitability for thermal treatments.

Hybrid drying Technologies: Product quality degradation during dehydration – Hybrid drying systems – Heat pump drying, , Radio frequency drying, Microwave drying, Infra red drying. Fluidized bed drying - Flash drying - flash evaporation - principle – working. Super heated steam drying – Pressure regulating drying - Combine microwave-vacuum drying.

TOTAL : 45

REFERENCE BOOKS

1. Da-wen sun, "Emerging Technologies for Food Processing", Elsevier Academic press, 2005.
2. Han and Jung H., "Packaging for Non-thermal Processing of Food", Wiley-Blackwell, Oxford, 2007.
3. Lelieveld H. L. M., "Food Preservation by pulsed electric fields: From research to application", Wood Head Publishing Limited, England, 2007.

11MF017 BAKING AND CONFECTIONERY TECHNOLOGY

3 0 0 3

Objectives:

- To study the principles of bakery and confectionary technology and to relate the facts and principles of physical and chemical nature of ingredients.
- To provide the student with an understanding of manufacturing practices and equipments.

MODULE – I

15

Bread, role of Ingredients: Bread, Essential ingredients - Flour, yeast, water, salt and non-essential ingredients - sugar, fat, milk and milk powder, colour, flavor, and bread improvers. Leaveners and yeast foods, Shortenings, emulsifiers, sweeteners and ingredients from milk and eggs. Role of ingredients used in bread making.

Bread making: Stages in processing of bread. Bread making methods - Straight dough fermentation, Sponge and dough, Accelerated processing. Advantages and disadvantages of various methods of bread-making. Characteristics of good bread: Internal characters; external characters. Bread defects and remedies. Spoilage of bread causes and prevention. Equipments: Dough mixers and Ovens.

MODULE - II

15

Production Biscuits and Cookies: Types of biscuit dough - hard and soft dough. Hard dough - Fermented dough, Puff dough and Semi sweet dough. Soft dough – Creaming and all in one method. Cookie preparation – batter and foam type. Methods of mixing cookies – single stage, creaming and blending methods. Role of ingredients. Biscuit/cookies faults and causes.

Cake making: Basic ingredients and their role in cake making, flavor agents, fruits and nuts. Cake mixing methods. Cake formula – rich and lean formula, high ratio and low ratio formula. Baking of cake. Cake characteristics. Cake faults and remedies.

MODULE - III

15

Confectionery: Sugar boiled confectionery- Stages in sugar cookery, Crystalline and amorphous candies. Factors affecting the crystallization of sugar. Production of fondants, fudge, toffee, caramel, marshmallow, brittle. Chocolate confectionery - Cocco products - cocoa bean processing, chocolate liquor, cocoa butter, cocoa powder. Chocolate manufacture – mixing, refining, conching, tempering, molding and enrobing. Spoilage of confectionery products.

Packaging materials and equipments – batch cooker, kneader, former, shell forming equipment, wrapping, lollipop making machineries. Production standards & quality control.

TOTAL : 45

REFERENCE BOOKS

1. Cauvain, Stanley P, and Young, Linda S., “Technology of Bread Making”, Second Edition Aspen publication. Maryland, 1999.
2. Matz, Samuel A., “Bakery Technology and Engineering”, Third Edition, Chapman & Hall, London,1999.
3. Jackson E.B., “Sugar Confectionery manufacture”, 2nd edition, Blackie Academic and professional, Glasgow, 1995.

11MF018 INDUSTRIAL WASTE MANAGEMENT

3 0 0 3

Objectives:

- To gain a knowledge on Physical, Chemical, Biological Treatment process and Sludge Disposal Techniques to treat various industrial waste waters.
- Make the students aware that Waste Management is more important in industry and environment

MODULE – I

15

Physical Methods: Screening – Classifications of screens, screening characteristics and quantities; coarse solids reduction; Flow equalization – Description and applications; Mixing and flocculation – Continuous rapid mixing and continuous mixing in wastewater treatment, energy dissipation, time scale mixing; Gravity separation theory – particle settling, discrete particle settling, flocculants particle settling and hindered settling.

Sedimentation – Description, sedimentation tank performance, characteristics and quantities of sludge and scum; High rate clarification processes: Floatation – dissolved air floatation, dispersed air floatation: Oxygen transfer – description, evaluation of oxygen transfer coefficient: Aeration system – diffused air aeration, mechanical aerators.

MODULE - II

15

Chemical Methods: Chemical coagulation – fundamentals: Chemical Precipitation for removal of heavy metals & dissolved inorganic substances, precipitation reactions: Chemical oxidation – fundamentals, applications, chemical oxidation of BOD, COD and ammonia: Chemical neutralization, scale control and stabilization.

Filtration – Introduction and description of depth filtration: Surface filtration – Discfilter and cloth-media disk filter: Membrane filtration processes – terminology, classification, removal mechanism and membrane operation: Adsorption – fundamentals of adsorption, types of adsorbents, activated carbon adsorption kinetics, treatment process and activated carbon contactor: Advanced oxidation processes – theory, technologies used to produce hydroxyl radicals, applications.

MODULE - III

15

Biological methods: Activated sludge process – suspended growth aerated lagoons – types; flow through lagoons membrane biological reactors – membrane fouling control, process capabilities. Trickling filters – classification, applications, rotating biological contactors – physical facilities, combined aerobic treatment processes; submerged attached growth processes – down flow, up flow, fluidized bed bio reactors.

Sludge disposal: Design of Sludge management facilities, sludge thickening, sludge digestion, composting, conditioning, sludge dewatering (mechanical and gravity) – incineration, landfilling, upgrading existing plants – ultimate residue disposal – Recent Advances.

TOTAL : 45

REFERENCE BOOKS

1. Metcalf and Eddy., “Wastewater Engineering Treatment and Reuse”, 4th Edition, Tata McGraw-Hill Publishing Company, New Delhi, 2003.
2. Grady, C. P. L. Jr., G. T. Daigger, and H. C. Lim., “Biological Wastewater Treatment”, 2nd edition Revised and Expanded, Marcel Dekker, New York, 1999.
3. Win Jern N.G.,”Industrial waste water Treatment”, Imperial College Press, London,2006.

11MF019 TRANSPORT PHENOMENA IN FOOD PROCESSING

3 0 0 3

Objectives:

- To know the analytical and numerical solution for momentum transfer concepts
- To acquire knowledge on energy and non isothermal system
- To know about Mass Transfer concepts and application in food processing

MODULE – I

15

Momentum Transport : Phenomenological laws of transport properties; Newtonian and non Newtonian fluids; rheological models; theories of transport properties of low density gases and liquids; effect of pressure and temperature. Shell momentum balances – boundary conditions and flow of falling film.

Interphase Transport In Isothermal System: Friction factor, Fluid –Fluid systems, Flow patterns in vertical and horizontal pipes, Formulation of bubbles and drops and their size distribution, Solid – fluid systems, Forces acting on stagnant and moving solids, Flow through porous medium, Capillary tube model and its applications.

MODULE- II

15

Energy Transport : Fouriers law of heat conduction, theory of thermal conductivity of liquids, solids, shell energy balances- boundary conditions, heat conduction with an electrical heat source, chemical heat source

Interphase Transport In Non Isothermal System: Heat Transfer coefficient, Forced convection in tubes, around submerged objects, Heat Transfer by free convection, film type and dropwise condensation and equations for heat transfer, Heat transfer in boiling liquids.

MODULE - III

15

Mass Transport : Ficks law of diffusion, Theories of ordinary diffusion in gases and liquids, shell mass balances- boundary conditions, diffusion with heterogeneous and homogeneous reaction – effectiveness factor

Interphase Mass Transfer: Mass Transfer co-efficient in single and multiple phases at low and high mass transfer rates, Film theory, Penetration theory, Boundary layer theory, Macroscopic balance to solve steady and Unsteady state problems.

TOTAL : 45

REFERENCE BOOKS

1. Bird R.B., Stewart, W. E. and Lightfoot, E. N., “Transport Phenomena”, 2nd Edition, John Wiley and Sons, 2002.
2. Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, and David P. DeWitt., “Fundamentals of Heat and Mass Transfer”, 7th edition , John Wiley and Sons, 2011.
3. Welty.J.R, Wicks.C.E and Wilson,R.E., “Fundamentals of Momentum, Heat & Mass transfer” 5th Edition, John Wiley & Sons, 2007

11MF020 OPERATION RESEARCH MANAGEMENT

3 0 0 3

Objectives:

- To provide insight knowledge about various techniques involved in the research.
- To enable the students to apply these techniques during the research.

MODULE – I

15

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.

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.

MODULE - II

15

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.

Principles of modeling; Linear programming-concepts, graphical and algebraic solution; Simplex method; Duality theory; Post-optimality analysis; Sensitivity analysis; Transportation and assignment models; Computer applications to LP, queuing theory; Project scheduling and management by PERT-CPM; Integer programming; Non-linear programming; Simulation; Goal programming; Decision theory; Markov chains; Sequencing problem.

MODULE - III

15

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.

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.

TOTAL : 45

REFERENCE BOOKS

1. Panneerselvam, R., “Research Methodology”, Prentice Hall of India, New Delhi, 2011.
2. Kumar and Ranjit., “Research Methodology-A Step-by-Step Guide for Beginners”, 2nd Edition, Pearson Education, Singapore, 2005.
3. Dawson and Catherine., “Practical Research Methods”, UBS Publishers Distributors, New Delhi, 2002.

11MF021 SENSORY ATTRIBUTES OF FOODS

3 0 0 3

Objective:

- To provide an exposure about the various methods involved in organoleptic evaluation of food materials.

MODULE – I

15

Sensory Perception: The perceptions of taste, smell and oral texture of foods; anatomy of the chemical senses-olfaction and taste; chemesthesis. Taste perception in food choice and control of eating.

Sensory Characteristics of Foods: Colour pigments in foods; artificial colours; colour perception. Classification of food flavours, Non-volatile and volatile flavour composition of foods; flavour perception. Rheology, classification of textural properties, structure and texture perception; Interactions between colour, flavour and texture.

MODULE - II

15

Sensory Analysis of Foods: Basic requirements for sensory analysis- objectives, panel size and screening, recruitment & training, testing environment & laboratory features.

Sensory threshold values- detection, difference, recognition & terminal thresholds analytical tests- discrimination tests- different types & descriptive tests- scaling procedures, flavour and texture profiling methods; simple and quantitative descriptive analysis. Measurement of off flavours and tastes; Data handling, analysis and presentation.

MODULE - III

15

Consumer Testing: Consumer surveys and tests; acceptance & preference tests, hedonic scales, ratio scales, ranking & rating tests, central location tests

Subjective & Objective Methods of Evaluation: Instrumental methods of measuring sensory characteristics of foods- measurement of colour, flavour and texture, electronic nose for aroma testing; relation between instrumental methods and sensory methods.

TOTAL : 45

REFERENCE BOOKS

1. Marshall and David W., "Food Choice: And the Consumer", Blackie Academic & Professional / Chapman & Hall, 1995.
2. Fisher, Carolyn and T.R. Scott., "Food Flavours: Biology and Chemistry", The Royal Society of Chemistry, 1997
3. Harry.T.Lawless, Hildegarde Heymann., "Sensory Evaluation of Food: Principle and Practices (Food Science Text series)" 2nd Edition, Springer, 2010.

11MF022 MILK AND MILK PRODUCTS

3 0 0 3

Objectives:

- To make up the basic knowledge of dairy plant and mechanics used in dairy industry.
- To impart understanding of advances in theoretical and practical aspects of food processing.

MODULE– I

15

Milk- Definition, Types and Constituents, Factors affecting milk composition, Engineering properties of dairy products: Thermal (specific heat, thermal conductivity and diffusivity), Optical (colour), Electrical (conductivity and permittivity), and rheological properties (viscosity).

Basic operations in milk processing- Reception, Filtration, Pasteurization, Separation, Homogenization. **Cleaning systems-** CIP and COP systems

MODULE - II

15

Basic concepts of plant maintenance- Breakdown Maintenance, Preventive Maintenance, Predictive Maintenance, Proactive Maintenance, Evolution in maintenance strategy, Maintenance Cost, Effect of maintenance, Planned overhaul and PERT planning, Hygienic design concepts: Sanitary pipes and fittings.

Concept of rheology: Viscoelastic characterization of materials, ideal elastic, plastic and viscous behavior, Rheological models: Maxwell model, Kelvin model and Burgers model, Stress-strain behavior, Creep, stress relaxation, Water activity: Uses and its measurement, relation with moisture content

MODULE - III

15

Fat-rich milk products- Types, Methods of manufacture, Equipments used for manufacturing, Storage conditions, Butter substitutes: types, Methods of manufacture, Equipments used for manufacturing, Frozen dairy products: types, Methods of manufacture, Equipments used for manufacturing, Storage conditions.

Coagulated milk products- types, Methods of manufacture, Equipments used for manufacturing, Storage conditions, Traditional Indian Dairy Products: types, Methods of manufacture, Equipments used for manufacturing, Storage conditions.

TOTAL : 45

REFERENCE BOOKS

1. Sukumar De., “Outlines of Dairy Technology”, Oxford University Press, India, 2010.
2. Tufail Ahmad., “Dairy Plant Systems Engineering” Kitab Mahal, Allahabad, India, 2010.
3. Rao M.A., Rizvi S.S.H. and Datta A.K., “Engineering Properties of Foods” 3rd Edition, CRC Press, 2010.

11MF023 INSTRUMENTAL METHODS FOR FOOD ANALYSIS

3 0 0 3

Objectives :

- This Course covers a variety of methods of food analysis with various instrumentations like Spectroscopy, Chromatographic methods.
- This course also presumes knowledge of classical food analysis carried out using conductance, potential measurement, X-Ray & Thermal Studies.

MODULE – I

15

Spectrometry: The Electromagnetic spectrum – Interaction of photons with matter, absorbance and transmittance – classification of instrumental methods based on physical properties – Visible spectrometry and calorimetry - Theory ; Derivation from Beer’s law, instrumentation and application. Ultra violet spectroscopy – Theory instrumentation and application.

Infra red spectroscopy: Theory Fundamental vibrations – Instrumentation – application – Finger print region – conjugated diene. Mass spectroscopy – Theory, instrumentations – Ion fragmentation-applications. Morphology analysis – SEM, TEM, Laser diffraction for particle analysis.

MODULE - II

15

X-Ray and thermal studies-X- Ray diffraction, mosey’s law, K and R bands instrumentation and applications Flame photometer, Polarimetry and Refractrometry – Principle and instrumentation Saccharimetry – Analysis of sugar. Thermogravimetry – Differential, Thermal analysis, Differential scanning calorimetry applications.

Conductometry and Potential measurement: Conductance measurements applications. Conductometry titrations Types, advantages, and disadvantages. Potential measurement pH, pO₂, pCO₂, pHCO₃, determination. Basic Principle of electrophoresis, application of paper, starch gel, agarose, native and denaturany PAGE. Isoelectric focusing capillary, microchip and 2D electrophoresis.

MODULE - III

15

AAS, NMR Spectroscopy: Atomic Absorption Spectrophotometer: Principle, instrumentation and application. Nuclear Magnetic Resonance: Introduction to NMR; Principle and instrumentation (proton NMR only) chemical shift applications.

Chromatographic Methods: Classification of chromatographic methods: Column, Thin Layer, Paper, Gas; High Performance Liquid Chromatography (HPLC), (Principle, mode of separation technique) HPTLC, GC-MS, LC-MS and GC- FTIR. Solid – phase extraction System. Recent Development of Rapid Techniques – electric nose techniques, e-tongue, flow cytometry, epifluorescence microscopy.

TOTAL : 45

REFERENCE BOOKS

1. Chatwal, Gurdeep R and Anand, Sham K., “Instrumentation Methods of Chemical Analysis”, Himalaya Publications, Bombay, 2003.
2. Willard, H.H., Merritt, L.L., Dean, J.A., and Settle, F.A., “Instrumental Methods of Analysis”, Seventh Edition, C B S Publishers & Distributors, Delhi, 1988.
3. Yeshasahu pomeranz, Clifton E. meloan “Food Analysis” CBS Publishers & Distributors, Delhi, 1996.

11MF024 LIPID SCIENCE AND TECHNOLOGY

3 0 0 3

Objectives:

- To understand the properties, chemistry and formulation of lipids
- To study the problems and changes occurring during storage
- To impart knowledge on Packaging standards for fats and oil

MODULE – I

15

Nutritional aspects of food lipids and their sources: omega-3 and omega-6 fatty acids and their significance, Phytosterols and their nutraceutical significance. Measurement of lipid degradation parameters during deep-fat frying and storage of foods. Flavour emulsions and their stability.

Properties of Oils and Fats and Preprocessing of oils and fats: Chemical reactions in fat and oil- Industrial production of oils- palm oil, peanut oil, rice bran oil, coconut oil, sunflower oil and soy bean oil - cold pressing and hot pressing. Solvent extraction- Processing equipment-mechanical extraction

MODULE - II

12

Formulation and characterization: Low-fat spreads, whipped creams, margarines, mayonnaise, salad dressings etc. Bakery shortenings chemistry, formulation and technology. Alternative fats, low fat substitutes. Fat powders - cream, butter, cod-liver oil etc-Techniques involved such as micro encapsulation, Fat substitutes based on carbohydrates and proteins.

Trans-fatty acids: Formation during processing and nutritional aspects, Enzymatic approach to tailor made fats.

MODULE - III

18

Edible oils and fats products and Modification of Oils: Modification of oils - Refined oil – fractionation- Blending – Interesterification – Types of Interesterification – Applications of Interesterification - Cocoa butter alternative fats, Milk fat and milk fat substitutes - Hydrolysis And Esterification, Edible oils and fats products – Cooking oils, Salad oils and dressings, Fats and oils in bakery products and confectionery lipids.

Frying and Storage: Changes during storage of oil – frying of oil – Role of fat or oil in frying – Applications of frying oil – Selection of frying oil – frying process – changes occurring in the food and oil - rancidity - causes - atmospheric oxidation and enzyme action –Quality standards of oil - Packaging requirements for oils and fats.

TOTAL : 45

REFERENCES BOOKS

1. Chakrabathy. M.M., “Chemistry and Technology of Oils and Fats”, Allied Publishers Pvt.Ltd, 2003.
2. Wolf Hamm and Richard J. Hamilton., “Edible oil processing”, Blackwell Science Ltd, 2004 .
3. Bailey., “Bailey's Industrial Oil and Fat Products”, 6th Edition, Volume 1 – 6, John Wiley & Sons, 2005.

11MF025 ENZYME TECHNOLOGY

3 0 0 3

Objectives:

- To impart knowledge on the basic concepts of enzyme action, enzyme technologies and their applications.
- The course enables the students in understanding isolation, purification and characterization of enzymes and their technologies.

MODULE – I

15

Enzymes: Introduction, Classification and Nomenclature of enzymes according to IUB. Mechanisms of enzyme action; concept of active site and energetic of enzyme substrate complex formation; specificity of enzyme action; principles of catalysis-collision theory, transition state theory; role of entropy in catalysis.

Kinetics of enzyme action: Order of reaction, Activation energy, Kinetics of single substrate reactions; Estimation of Michelis-Menten parameters, multisubstrate reactions-mechanisms and kinetics; turn over number; pH and temperature effect on enzymes and deactivation kinetics.and kinetics; turn over number; pH and temperature effect on enzymes and deactivation kinetics.

MODULE - II

15

Enzyme Inhibitor – Kinetics of competitive, non-competitive and uncompetitive inhibitors. Allosteric regulation of enzymes, Monod changeux wyman model. Mechanism of enzyme catalysis-electrostatic proximity and orientation effect.

Enzyme Immobilization - Physical and chemical techniques for enzyme immobilization-adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding - examples, advantages and disadvantages.

MODULE - III

15

Production and purification of crude enzyme extracts: Plant, animal and microbial sources; methods of characterizations of enzymes; development of enzymatic assays. Enzyme application in food processing, meat industry, fruit and vegetable industry, dairy industry, health care and environment.

Enzyme Biosensor in analysis- Design of enzyme electrodes and their application as biosensors in industry. Structure and function of Co-enzyme – reaction involving TPP, Pyridoxal phosphate, Nicotinamide, Flavin Nucleotides, Co-A, Biotin and Vitamin K dependent carboxylation.

TOTAL : 45

REFERENCES BOOKS

- 1 Trevor Palmer., “Enzymes: Biochemistry, Biotechnology and Clinical Chemistry”, Horwood Publishing, 2007.
- 2 Martin F. Chaplin and Christopher Bucke., “Enzyme Technology”, Cambridge University Press, 1990
3. Parmjit S.Panesar, Satwinder S.Marwaha, Harish K Chopra., “Enzymes in Food Processing: Fundamentals & potential Applications”, I.K.International Publishing House, 2010

11MF026 FOOD PACKAGING AND STORAGE ENGINEERING

3 0 0 3

Objectives:

- To study about the different packaging materials used for food products, and recent trends in food packaging equipments.
- To gain the knowledge about the various storage systems for food products.

MODULE– I

15

Packaging – importance & materials: Importance of packaging & packaging materials, Functions of packaging; Type of packaging materials; Selection of packaging material for different foods. Selective properties of packaging film; Methods of packaging and packaging equipment, 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.

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. The use of freshness indicator in packaging.

MODULE– II

15

Developments in packaging: Novel MAP gases, Testing novel MAP applications, Applying high oxygen MAP. Smart packaging systems, design of packaging materials.

Integrating intelligent packaging, storage & distribution: The supply chain for perishable foods, The role of packaging in the supply chain, Creating integrated packaging, storage and distribution: alarm systems and TTIs. Testing consumer responses to new packaging concepts: New packaging techniques and the consumer, Methods for testing consumer responses, Consumer attitudes towards active and intelligent packaging.

MODULE– III

15

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.

Grain storage & 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.

TOTAL : 45

REFERENCE BOOKS

1. Kirwan M.J., Derek McDowell D., and Coles R., “Food Packaging Technology”, Blackwell Publication, 2003.
2. Robertson G.L., “Food packaging: Principles and practice”, CRC Press, 2006.
3. Mathlouthi M., “Food Packaging and Preservation” Elsevier Applied Science Publications Essex, UK, 1986

11MF027 TECHNOLOGY OF FOOD FLAVOURANTS AND COLOURANTS

3 0 0 3

Objective:

- To provide students the basics of food flavours and colours and to impart knowledge about their production and analysis

MODULE – I

15

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.

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.

MODULE - II

15

Natural colours and Synthetic colours: Chlorophyll and chlorophyll derivatives, Haems and bilins, Carotenoids, annatto, saffron, turmeric; curcuminoids- Stability to pH, temperature and other processing conditions - Tartrazine ,Sunset yellow, Quinoline yellow,Allura red - Technology for the production of dried colourants - Caramel colour. Microbial and cell suspensions in the synthesis of colours.

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.

MODULE - III

15

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.

Recent Techniques: E nose technology. Tristimulus colorimetry – Basics and application to foods.

Total : 45

REFERENCE BOOKS

1. Reineccius G. and Heath H.B., “Flavor Chemistry and Technology”, 2nd Edition, CRC Press, 2006.
2. Socaciu C., “Food Colorants - Chemical and Functional Properties”, CRC Press, 2008.
3. Rowe D.J., “Chemistry and Technology of Flavors and Fragrances”, Blackwell Publishing Ltd, 2005.

11MF028 FOOD BIOTECHNOLOGY

3 0 0 3

Objectives:

- To provide knowledge of methods and tools applied to the production of biotechnologically derived foods and food ingredients.
- To understand safety assessment strategies for food developed through genetic engineering, plant tissue culture.
- To impart knowledge on production of transgenic plants pertaining to development of foods that promotes health and well being.

MODULE – I

15

Introduction to Molecular Biotechnology – Components of molecular biotechnology-Genetic engineering and Recombinant DNA Technology- Tools in genetic engineering- Enzymes – DNA Polymerases, Restriction Endonucleases, Ligases, Reverse Transcriptases, terminal transferase, phosphatases and nucleases, Cloning Vectors – plasmid, bacteriophage vectors, cosmids, phagemids, vectors for plant and animal cells, expression vector.

Transfer and selection: Methods of gene transfer in prokaryotic and eukaryotic cells; Recombinant selection and screening methods – genetic, immunochemical, south-western analysis, nuclei acid hybridization. Expression of cloned DNA molecules and maximization of expression.

MODULE - II

15

Molecular Diagnostic Methods: PCR, Nucleic acid sequence based amplification (NASBA), Loop Mediated Isothermal Amplification (LAMP), Random Amplified Polymorphic DNA Analysis (RAPD), Amplified Fragment Length Polymorphism (AFLP), Oligonucleotide DNA microarray, Ligation detection reaction-universal arrays (LDR-UA), Gold Nanoparticle Based Biosensor, Fibre Optic Biosensor, Electrochemical / Electric Biosensors

Application of molecular biotechnology: Improvement of plant nutritional and functional quality-Genetic modification of plant starches and plant oils, nutraceutical enrichment and shelf life improvement of food crops. Transgenic animals. Protein engineering.

MODULE - III

15

Biotechnological processes in industry: Microbial products – enzymes, alcohol, organic acids, amino acids, polysaccharides, pigments, flavours and vitamins. Role of biotechnology in food processing industries like Brewing, wine, fruit and vegetable processing, meat processing, dairy processing and baking.

Regulatory and social aspects of food biotechnology: GM foods and food security- Safety aspects and social acceptance - Ethical issues. GMOs- current guidelines for the production, release and movement of GMOs; labeling and traceability; trade related aspects.

TOTAL : 45

REFERENCE BOOKS

1. Bielecki Stanislaw., Tranmper Johannes and Polak Jacek., “Food Biotechnology”, Elsevier Science Publishing Company, New Delhi, 2000.
2. Bernard. Glick, Jack J. Pasternak and Cheryl I. Patten,”Molecular Biotechnology: Principles and Applications of Recombinant DNA”, 4th Edition, ASM press.
3. Belitz, H. D., Grosch, W. and Schieberle P., “Food Chemistry”, Third Edition, Springer-Verley, Berlin, 2004.