KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE – 638 052
(Autonomous)

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

CURRICULUM

(For the candidates admitted from academic year 2014 – 15 onwards)

SEMESTER – I

Course Code	Course Title	Hours/ Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
14AMT10	Applied Statistics for Food Technology	3	1	0	4	40	60	100
14MFT11	Advanced Refrigeration and Cold Chain Management	3	1	0	4	40	60	100
14MFT12	Technology of Food Flavorants and Colorants	3	0	0	3	40	60	100
14MFT13	Food Additives, Nutraceuticals and Functional Foods	3	0	0	3	40	60	100
14MFT14	Unit operations in Food Process Engineering (For Science Graduates)	3	0	0	3	40	60	100
14MFT15	Food Chemistry and Microbiology (For Engineering Graduates)	3	0	0				
	Elective-I (Professional)	3	0	0	3	40	60	100
	PRACTICAL							
14MFL11	Food Processing Technology Laboratory	0	0	3	1	100	0	100
				Total	**21**			

CA - Continuous Assessment, ESE – End Semester Examination

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(Autonomous)

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

CURRICULUM

(For the candidates admitted from academic year 2014 – 15 onwards)

SEMESTER – II

Course Code	Course Title	Hours/ Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
14MFT21	Advanced Drying Technology	3	1	0	4	40	60	100
14MFT22	Novel Technologies in Food Processing	3	0	0	3	40	60	100
14MFT23	Instrumental Techniques and Methods for Food Analysis	3	1	0	4	40	60	100
14MFT24	Food Safety and Quality Control	3	1	0	4	40	60	100
	Elective-II (Professional)	3	0	0	3	40	60	100
	Elective-III (Professional)	3	0	0	3	40	60	100
	PRACTICAL							
14MFL21	Food Analysis and Quality Control Laboratory	0	0	3	1	100	0	100
				Total	**22**			

CA - Continuous Assessment, ESE – End Semester Examination

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

CURRICULUM

(For the candidates admitted from academic year 2014 – 15 onwards)

SEMESTER – III

Course Code	Course Title	Hours/ Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
	Elective-IV (Professional)	3	0	0	3	40	60	100
	Elective-V (Professional)	3	0	0	3	40	60	100
	Elective-VI (Open)	3	0	0	3	40	60	100
	PRACTICAL							
14MFP31	Project Work – Phase I	0	0	12	6	50	50	100
				Total	**15**			

CA - Continuous Assessment, ESE – End Semester Examination

SEMESTER – IV

Course Code	Course Title	Hours/ Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	PRACTICAL							
14MFP41	Project Work – Phase II	0	0	24	12	100	100	200
				Total	**12**			

CA - Continuous Assessment, ESE – End Semester Examination

Total Credits: 70

KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE – 638 052
(Autonomous)

M.Tech. DEGREE IN FOOD TECHNOLOGY (PART TIME)
CURRICULUM

(For the candidates admitted from academic year 2014 – 15 onwards)

SEMESTER – I

Course Code	Course Title	Hours/ Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
14AMT10	Applied Statistics for Food Technology	3	1	0	4	40	60	100
14MFT11	Advanced Refrigeration and Cold Chain Management	3	1	0	4	40	60	100
14MFT14	Unit operations in Food Process Engineering (For Science Graduates)	3	0	0	3	40	60	100
14MFT15	Food Chemistry and Microbiology (For Engineering Graduates)	3	0	0				
	PRACTICAL							
14MFL11	Food Processing Technology laboratory	0	0	3	1	100	0	100
				Total	**12**			

CA - Continuous Assessment, ESE – End Semester Examination

SEMESTER – II

Course Code	Course Title	Hours/ Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
14MFT23	Instrumental Techniques and Methods for Food Analysis	3	1	0	4	40	60	100
14MFT24	Food Safety and Quality Control	3	1	0	4	40	60	100
	Elective-I (Professional)	3	0	0	3	40	60	100
	PRACTICAL							
14MFL21	Food Analysis and Quality control Laboratory	0	0	3	1	100	0	100
				Total	**12**			

CA - Continuous Assessment, ESE – End Semester Examination

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

CURRICULUM

(For the candidates admitted from academic year 2014 – 15 onwards)

SEMESTER – III

Course Code	Course Title	Hours/ Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
14MFT21	Advanced Drying Technology	3	1	0	4	40	60	100
14MFT22	Novel Technologies in Food Processing	3	0	0	3	40	60	100
	Elective-II (Professional)	3	0	0	3	40	60	100
				Total	**10**			

CA - Continuous Assessment, ESE – End Semester Examination

SEMESTER – IV

Course Code	Course Title	Hours/ Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
14MFT12	Technology of Food Flavorants and Colorants	3	0	0	3	40	60	100
14MFT13	Food Additives, Nutraceuticals and Functional Foods	3	0	0	3	40	60	100
	Elective-III (Professional)	3	0	0	3	40	60	100
				Total	**9**			

CA - Continuous Assessment, ESE – End Semester Examination

KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE – 638 052
(Autonomous)

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

CURRICULUM

(For the candidates admitted from academic year 2014 – 15 onwards)

SEMESTER – V

Course Code	Course Title	Hours/ Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
	Elective-IV (Professional)	3	0	0	3	40	60	100
	Elective-V (Professional)	3	0	0	3	40	60	100
	Elective-VI (Open)	3	0	0	3	40	60	100
	PRACTICAL							
14MFP31	Project Work – Phase I	0	0	12	6	50	50	100
				Total	**15**			

CA - Continuous Assessment, ESE – End Semester Examination

SEMESTER – VI

Course Code	Course Title	Hours/ Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	PRACTICAL							
14MFP41	Project Work – Phase II	0	0	24	12	100	100	200
				Total	**12**			

CA - Continuous Assessment, ESE – End Semester Examination

Total Credits: 70

LIST OF ELECTIVES					
Course Code	**Course Title**	**Hours/Week**			**Credit**
		L	**T**	**P**	
14MFE01	Plantation Crops, Spices and Condiment Technology	3	0	0	3
14MFE02	Food Process Equipment, Plant Layout Design and Process Economics	3	0	0	3
14MFE03	Advanced Separation Techniques in Food Processing	3	0	0	3
14MFE04	Heat and Mass transfer operations in Food Processing	3	0	0	3
14MFE05	Advanced Baking and Confectionery Technology	3	0	0	3
14MFE06	Industrial Waste Management *	3	0	0	3
14MFE07	Transport phenomenon in Food Processing	3	0	0	3
14MFE08	Operation Research	3	0	0	3
14MFE09	Lipid Science and Technology	3	0	0	3
14MFE10	Enzyme Engineering and Technology	3	0	0	3
14MFE11	Food Packaging and Storage Engineering	3	0	0	3
14MFE12	Food Biotechnology	3	0	0	3
14MFE13	Food Product Design and Development	3	0	0	3
14MFE14	Food Supply Chain Management	3	0	0	3
14MFE15	Industrial Process Automation	3	0	0	3
14MFE16	Industrial Engineering	3	0	0	3
14MHT14	Project Engineering of Process Plants	3	0	0	3
14MFE17	Industrial Management	3	0	0	3
14MFE18	Advanced Fruit and Vegetable Processing Technology	3	0	0	3
14MFE19	Advanced Grain Science and Technology	3	0	0	3
14MFE20	Advanced Meat Processing Technology	3	0	0	3
14MFE21	Advanced Dairy Technology	3	0	0	3
14MFE22	Advanced Food Processing Technology	3	0	0	3
14MFE23	Sensory Attributes of Foods *	3	0	0	3

*-Open Elective

14AMT10 APPLIED STATISTICS FOR FOOD TECHNOLOGY

3 1 0 4

UNIT – I **9**

Correlation and Regression Analysis: Curve fitting by method of Least Square - Correlation – Linear, multiple and partial correlation - Linear regression - Multiple regression.

UNIT – II **9**

Design of Experiments: Analysis of variance – One-way classification – Completely Randomized Design – Two way classification – Randomized block design – Latin Square Design – Factorial experiments – Two factor factorial experiments – The 2^k factorial design.

UNIT – III **9**

Statistical Quality Control: Introduction to Statistical quality control – Control charts – Control charts for variables – $\bar{X}$-chart – R- chart – s-chart – Control charts for Attributes – np-chart – p-chart – c-chart – CUSUM and RUNSUM Charts.

UNIT – IV **9**

Time series analysis: Significance of time series analysis - Components of Time series - Secular trend - Graphical method - Semi-average method - Method of Moving Averages - Method of Least squares - Seasonal variations - Method of Simple Averages - Ratio to trend method - Ratio to moving average method.

UNIT – V **9**

Index Numbers: Introduction to index numbers – Price relatives – Quantity relatives – Value relatives – Cost of living index numbers – Construction of index numbers – Laspeyre's index – Paasche's index – Fisher's ideal index – Test for index numbers – Time reversal test – Factor reversal test – Circular test.

Lecture:45, Tutorial:15, TOTAL: 60

REFERENCE BOOKS:

1. Jay L Devore, "Probability and Statistics for Engineering and the Sciences", Thomson Asia, 2002.
2. Fruend, J.E. and Miller, I, "Probability and Statistics for Engineers", Prentice Hall of India Ltd. 1994.
3. Gupta, S.C. and Kapoor, V.K., "Fundamentals of Mathematical Statistics", Sultan Chand & Sons, New Delhi, 2005.
4. Hines, W.W, Montogomery, D.G, Goldsman,D.M and Borror, C.M, "Probability and Statistics in Engineering", John Wiley & Sons Inc., U.K, Fourth edition, 2009.
5. Medhi, J, "Statistical Methods - An introductory text", New age international publishers, Reprint 2009.

Course outcomes:

On completion of the course the students will be able to

- measure the relationship between variables
- adopt design of experiments techniques in engineering problems
- control manufacturing process

14MFT11 ADVANCED REFRIGERATION AND COLD CHAIN MANAGEMENT

3 1 0 4

UNIT – I **9**

Refrigeration system: Refrigeration, Single vapour compression system, vapour absorption system, Refrigerants - characteristics of different refrigerants, ozone depletion potentials, estimation of cooling load, ton of refrigeration.

UNIT – II **9**

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.

UNIT – III **9**

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.

UNIT – IV **9**

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

UNIT – V **9**

Cold Chain management: Scope and importance of cold chain in food processing industry and retail chain, components of cold chain and integration. Flexibility storage systems cold chain transportation in land and export, retail & supermarket cold chain and display systems.

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.

Course Outcomes:

On the completion of the course the students will be able to

- acquire the basics of refrigeration along with thermodynamic principles
- paraphrase the concept of refrigeration cycles and components of refrigeration system
- appreciate the applications of refrigeration and cold chain management in food processing

14MFT12 TECHNOLOGY OF FOOD FLAVOURANTS AND COLOURANTS

3 0 0 3

UNIT – I **9**

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 **9**

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 **9**

Flavor Analysis: Introduction, Aroma Compounds - Sample Selection/Preparation, Principles of Aroma Isolation – Solubility, Sorptive Extraction, Volatility, Methods of Aroma Isolation - Static Headspace, Headspace Concentration Methods (Dynamic Headspace), Distillation Methods, Solvent Extraction, Sorptive Extraction, Concentration for Analysis, Aroma Isolation Summary, Analysis of Aroma Isolates, Prefractionation - Gas Chromatography, GC/Olfactometry (GC/O) GC-MS/Olfactometry (GC-MS/O), Mass Spectrometry

UNIT – IV **9**

Flavor Applications: Culinary and Meat Products - Soups and Stocks, Sauces, Seasonings, and Marinades, Meat Products. Baked Goods and Bakery Products, Snack Foods, Sugar-Based Confectionery Products and Chewing Gum - Hard Candies, Caramels (Toffees), Pressed Tablets, Starch-Deposited Chews, Chewing Gum. Dairy Products - Flavored Milks, Flavored Yogurts, Flavored Dairy Desserts. Soft Drinks - Carbonated Beverages.

UNIT – V **9**

Natural Food Colours: Chlorophyll and chlorophyll derivatives, Haems and bilins, Carotenoids, annatto, saffron, turmeric, Caramel colour, Anthocyanins and betalains, Monascus, cochineal and related pigments, Stability to pH, temperature and other processing conditions. Technology for the production of dried colourants. Microbial and cell suspensions in the synthesis of colours.

TOTAL : 45

REFERENCE BOOKS:

1. Reineccius G. and Heath H.B., “Flavor Chemistry and Technology”, 2nd Edition, CRC Press, 2006.
2. Rowe D.J., “Chemistry and Technology of Flavors and Fragrances”, Blackwell Publishing Ltd, 2005.
3. Eiri Board., “Hand Book Of Flavours Technology”, Engineers India Research Institute, 2007
4. Eiri Board., “Hand Book Of Flavours & Food Colourants Technology”, Engineers India Research Institute, 2009

5. Socaciu C., “Food Colorants - Chemical and Functional Properties”, CRC Press, 2008.
6. Gabriel J. Lauro and Jack Francis, “Natural Food Colorants: Science and Technology”, Mercel Dekker Press USA, 2000.

Course Outcomes:

On the completion of the course the students will be able to

- demonstrate an understanding of the basics of flavours and colours
- list the steps in the production technology of natural flavours
- outline the techniques of flavor analysis
- comprehend the applications of flavor technology in various foods
- have a thorough understanding of natural food colourants

14MFT13 FOOD ADDITIVES, NUTRACEUTICALS AND FUNCTIONAL FOODS

3 0 0 3

UNIT – I **9**

Food Additives: Introduction , classification and functions; Role of additives in foods - preservatives, antioxidants, sequestrants, emulsifiers, stabilizers and thickeners, bleaching and maturing agents, starch modifiers, food colourants and colour retention agents, sweeteners, humectants, flavorants and flavor enhancers, leavening agents, pH control agents, fat substitutes and replacers, anti-foaming agents.

UNIT – II **9**

Eye, Heart and Digestive Health Ingredients: Eye health ingredients – lutein, zeaxanthin, astaxanthin, beta-carotene, bilberry extracts; Heart health ingredients - omega-3, omega-6, omega-9, beta-glucan, soy protein, phytosterols; Digestive Health Ingredients – prebiotics, probiotics, synbiotics, digestive enzymes, zinc carnosine

UNIT – III **9**

Women and Bone & Joint Health Ingredients: 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, Boswelia Serrata, horsetail extract

UNIT – IV **9**

Functional foods and dietary supplements: Introduction to dietary supplements and functional food & beverages; Agnus castus, Aloe vera, Bee products, Chitosan ,Echinacea, Garlic, Ginger, Ginkgo biloba, Ginseng, Guarana, Kelp, Milk thistle, Saw palmetto, Spirulina, Chlorella, Hypericum perforatum, Tea extracts. Dietary supplements – Need for dietary supplements, supplements forms-tablets, capsules, powders, softgels, gelcaps, liquids

UNIT – V **9**

Asian Functional food and Nutraceuticals: Nutraceuticals from Seafood and Seafood By-Products, Functional Foods from Meat, Functional Foods from Fruit and Fruit, Functional Foods from Fermented Vegetable Products: Kimchi (Korean Fermented Vegetables) and Functionality, Functional Extracts from Sugarcane, Functional Foods from Garlic and Onion, Functional Foods from Date Fruits, Functional Foods and Products from Japanese Green Tea, Miso as a Functional Food, Fermented Soybean Products as Functional Foods

TOTAL : 45

REFERENCE BOOKS:

1. Belitz, H. D., Grosch, W., Schieberle,P. ―Food Chemistry, Third Edition, Springer-Verley, Berlin, 2004.
2. John Shi, Chi-Tang Ho and Fereidoon Shahidi― Asian Functional Foods, First Edition, CRC Press, 2005.
3. Wildman, Robert E.C., ―Handbook of Nutraceuticals and Functional Foods, CRC Press, New York, 2001
4. Vaclavik, V.A. and E. W .Christian ―Essential of Food Science, 2nd Edition, Springer, 2005
5. Lockwood, Brian, and Rapport, Lisa, ―Nutraceuticals: A Guide for Healthcare Professionals‖, Pharmaceutical Press, 2007.

Course Outcomes:

On the completion of the course the students will be able to

- be familiar with various food additives
- understand the different types of eye, heart and digestive health ingredients
- comprehend the types of women and bone & joint health ingredients
- have a thorough understanding of the various functional foods and nutraceuticals in the market
- gain in-depth knowledge on the functional foods in Asia

14MFT14 UNIT OPERATIONS IN FOOD PROCESS ENGINEERING

3 0 0 3

UNIT – I **9**

Principles of fluid flow: 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. 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.

UNIT – II **9**

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

UNIT – III **9**

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.

UNIT – IV **9**

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.

UNIT – V **9**

Humidification: Humidity measurement, calculation of absolute humidity, molal 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.
4. Gavhane, K.A "Heat Transfer SI Units" Nirali Prakashan Publications, Pune, 13 th ed, 2012.

Course Outcomes:

On completion of the course the students will be able to

- recognize the fundamental concepts of fluids and fluid flow properties and apply fundamental concepts to hydrostatic and fluid flow problems.
- recognise heat transfer concepts, estimate heat transfer rate and to acquire fundamental concept of radiations.
- recognize the diffusion phenomena, mass transfer coefficients and humidification

14MFT15 FOOD CHEMISTRY AND MICROBIOLOGY

3 0 0 3

UNIT – I **9**

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.

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.

UNIT – II **9**

Lipids: Classifications, Structure 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.

UNIT – III **9**

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.

UNIT – IV **9**

Microbial growth: Physical and chemical factors influencing destruction of microorganisms. Types of microorganism normally associated with food-mold, yeast, and bacteria. Microorganisms in natural food products and their control. Biochemical changes caused by microorganisms, deterioration of various food & food products. Food poisoning and microbial toxins, microbial food fermentation, standards for different foods. Food borne intoxicants and mycotoxins.

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.

UNIT – V **9**

Microbiology of preservation: 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. 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.

Course Outcomes:

On completion of the course the students will be able to

- gain knowledge on concepts of, carbohydrate proteins & lipids and their derivatives
- apply the knowledge on microbial growth and spoilage of foods during food processing and preservation

14MFL11 FOOD PROCESSING TECHNOLOGY LABORATORY

0 0 3 1

LIST OF EXPERIMENTS:

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 osmotic dehydration characteristics of food materials.
8. Preparation of Cookies.
9. Preparation of Cake.
10. Studies on Minimal Processing of fruits and vegetables.
11. Studies on efficiency of Butter churner.
12. Experiment on spray drier.

TOTAL : 45

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 Reasearch, New Delhi.1986
3. Sukumar De. R."Outlines of Dairy Technology", Royal, Oxford University, Press, Delhi. 1983

Course Outcomes:

On completion of the course the students will be able to

- gain knowledge on various food processing operation
- Infer knowledge on different properties of food materials.
- know about the processing steps involved in production of bakery products.
- know about the processing steps involved in production of fruit and vegetable based products.

14MFT21 ADVANCED DRYING TECHNOLOGY

3 1 0 4

UNIT – I **9**

Introduction to Drying: Drying and dehydration - principles - Mechanism of drying. Drying curves - Internal and external conditions of drying -Drying rate characteristic curve. Diffusion theories of drying - Effective Fickian diffusivity, Alternative effective diffusion theories. Water activity – Hysteresis, water activity predictive models, Determination of sorption isotherms - Gravimetric method, Manometric method and Hygroscopic methods.

UNIT – II **9**

Spray and Freeze drying: Spray drying – concept, components of spray drier, mechanism of atomization – drop size and drop distribution. Drying of droplets – Fundamentals, drying kinetics, residence time. Heat and mass balance. New developments in Spray drying. Freeze drying- principle - types - heat and mass transfer, design consideration. Freeze drying – Concept. Stages in freeze drying. Industrial freeze dryers. Advances in freeze drying.

UNIT – III **9**

Drying on inert particles: Mechanism and process considerations. Pneumatic and flash drying – principles and its applications. Fluidized bed drying (FBD) - principles of fluidization, Components of fluidized bed system, Classification of fluidized bed dryers – conventional and modified FBD.

UNIT – IV **9**

Superheated steam drying: Principles, classification, selection, applications. Heat pump drying (HPD) – principle, low temperature HPD, chemical HPD, Developments and trends. Contact-Sorption drying- Mechanism, Characteristics of sorbents/carriers. Airless drying. Fry drying. Conveyor dryers.

UNIT – V **9**

Microwave and dielectric drying: basic concept, Generators, applicators and other control devices, industrial applications. Infra red drying – principles, industrial dryers, applications. Sonic drying. Impingement drying. Slush drying. Refractance Window drying.

Lecture:45, Tutorial:15, TOTAL: 60

REFERENCE BOOKS:

1. A.S.Mujumdar. Handbook of Industrial drying – Third edition, CRC press, Taylor and Francis group.UK.2007.
2. Potter, N. N. and Hotchkiss, J. H.., ―Food Science. Fifth Edition, CBS Publishers and Distributors, New Delhi. 1996.
   Kudra, T and A.S. Mujumdar. Advanced Drying Technologies. Second Edition, CRC press, Taylor and Francis Group. UK. 2009.
3. Rao, M. A. and Rizvi, S.S.H., ―Engineering Properties of Foods, Marcel Dekker, Inc. New York. 1986.

Course Outcomes:

On completion of the course the students will be able to

- recall the mechanism of drying and various dehydration techniques
- acquire knowledge on freeze and spray drying
- familiarize with the concepts of drying on inert particles, fluidized and pneumatic drying
- gain insight on superheated steam drying, heat pump drying and other novel drying techniques
- acquire knowledge on microwave, infra red and sonic drying techniques

14MFT22 NOVEL TECHNOLOGIES IN FOOD PROCESSING

3 0 0 3

UNIT – I **9**

Emerging technologies: Emerging technologies in food processing – necessity and advantages – hurdle technology – concepts and applications - minimal processing – super critical fluid extraction processes in food materials.

High Pressure Processing of Foods: High Pressure Processing – Principles – applications to food systems – effect on quality – High Pressure Freezing, High Pressure non-frozen storage.

UNIT – II **9**

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.

UNIT – III **9**

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.

UNIT – IV **9**

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

UNIT – V **9**

Hybrid drying Technologies: Heat pump drying, Radio frequency drying, Microwave drying, Infra red drying. Fluidized bed drying - Flash drying - flash evaporation - Super heated steam drying - Combine microwave-vacuum drying.

TOTAL : 45

REFERENCE BOOKS:

1. Da-wen sun,"Emerging Technologies for Food Processing", Elsevier Academic press, 2005.
2. Lelieveld H. L. M., "Food Preservation by pulsed electric fields: From research to application", Wood Head Publishing Limited, England, 2007.
3. Tadeusz Kudra and Arun. S. Mujumdar, Advanced Drying Technologies, Eastern Hemisphere Distribution, New York, 2002.

Course Outcomes:

On completion of the course the students will be able to

- outline the basics of high pressure processing, pulsed electric field, pulsed light technology and its effects on foods
- acquire knowledge on the principles of ultrasound and ohmic heating in food processing
- infer knowledge on hybrid drying technologies

14MFT23 INSTRUMENTAL TECHNIQUES AND METHODS FOR FOOD ANALYSIS

3 1 0 4

UNIT – I **9**

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.

UNIT – II **9**

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.

Morphology analysis – SEM, TEM, Laser diffraction for particle analysis.

UNIT – III **9**

Conductometry and Potential Measurement: Conductance measurements - applications. Conductometry titrations Types, advantages, and disadvantages. Potential measurement - pH, pO_2, pCO^2, $pHCO_3$, determination. Basic Principle of electrophoresis, application of paper, starch gel, agarose, native and denaturany PAGE. Isoelectric focusing capillary, microchip and 2D electrophoresis.

UNIT – IV **9**

AAS, NMR Spectroscopy: Atomic Absorption Spectrophotometer: Principle, instrumentation and applications. Nuclear Magnetic Resonance: Introduction to NMR; Principle and instrumentation (proton NMR only) chemical shift applications. Mass spectroscopy – Theory, instrumentations – Ion fragmentation- applications.

UNIT – V **9**

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

Lecture:45, Tutorial:15, TOTAL: 60

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.

Course Outcomes:

On completion of the course the students will be able to

- know the principle of various spectroscopy analyze different food materials
- analyze the components of food products using various instrumental methods (x ray diffraction, flame photometers and conductometric methods)
- acquire knowledge about to analyze the food product by thermal and chromatography methods

14MFT24 FOOD SAFETY AND QUALITY CONTROL

3 1 0 4

UNIT – I **9**

Contemporary Food Safety Strategies: Principles and Need for quality control and safety - Strategy and criteria for food safety- Consumer lifestyle and demand- Issues in Food safety- Case against Food biotechnology and irradiation. Impact of food safety on world trade issues.

UNIT – II **9**

Food Hazards and Contaminants: Characterization of food hazards, food borne diseases and their control, Food contaminants- physical, biological and chemical contaminants - factors affecting toxicity of compounds - quality control and food safety.

Sampling: Purpose of sampling, Sampling plan, Sample preparation, Statistical design for sampling, Sampling procedure.

UNIT – III **9**

Integration of Food Process Engineering and Food Microbial Growth: Process Dependent Microbial modeling, Integration of process and microbial growth modeling. Systems –Monitoring of Safety, wholesomeness and nutritional quality of food.

UNIT – IV **9**

International Food Agencies and Quality Practices: 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). 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).

UNIT – V **9**

Food Quality Management System: International Scenario on Food Safety , FSSAI Functions, duties & responsibilities of food safety regulators, Food safety and standards for food products, Implementation, validation, verification and improvement of food safety management systems – Advances in Food Safety & Quality Management, Food Safety Audit. ISO 22000. FSSC 22000. Case Studies in FSMS.

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. 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.

Course Outcomes:

On completion of the course the students will be able to

- recognize the risks associated with the processing of foods and their preventive measures
- familiarize on international food agencies and Quality Norms of FSSAI.

14MFL21 FOOD ANALYSIS AND QUALITY CONTROL LABORATORY

0 0 3 1

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 Polyphones 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

TOTAL : 45

REFERENCES / MANUALS / SOFTWARE:

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

Course Outcomes:

On completion of the course the students will be able to

- detect and estimate the various food additives present in the food samples

14MFE01 PLANTATION CROPS, SPICES AND CONDIMENT TECHNOLOGY

3 0 0 3

UNIT – I **9**

Plantatation and Oil Seed Processing: Description of various types of Plantation crops, viz., coconut, arecanut, coffee, tea, cocoa etc. 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.

UNIT – II **9**

Spices and 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.

UNIT – III **9**

Processing of 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.

UNIT – IV **9**

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

UNIT – V **9**

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.

Course Outcomes:

On completion of the course the students will be able to

- identify the steps in the processing of plantation crops
- recognize the processing of spice and tuber crops products

14MFE02 FOOD PROCESS EQUIPMENT, PLANT LAYOUT DESIGN AND PROCESS ECONOMICS

3 0 0 3

UNIT – I **9**

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.

UNIT – II **9**

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.

UNIT – III **9**

Product development and **Plant layout:** Introduction of new product-stages of product development considerations in product development. 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.

UNIT – IV **9**

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

UNIT – V **9**

Inventory Control: 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

Course Outcomes:

On completion of the course the students will be able to

- familiarize with the construction materials and design fundamentals
- design pipes, process vessels and supports
- design the process equipments

14MFE03 ADVANCED SEPARATION TECHNIQUES IN FOOD PROCESSING

3 0 0 3

UNIT – I **9**

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

UNIT – II **9**

Adsorption based and other Separation Processes: Types and choice of adsorbents, Mechanisms of Affinity chromatography and immuno chromatography. Application of adsorption process in food processing industry. Zone melting, Adductive crystallization, Oil spill Management, Foam separation, Aqueous two phase extraction and Industrial effluent treatment by modern techniques

UNIT – III **9**

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.

UNIT – IV **9**

Membrane 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.

UNIT – V **9**

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

TOTAL : 45

REFERENCE BOOKS:

1. King, C.J., "Separation Processes", Tata McGraw–Hill Publishers, New Delhi, 1982.
2. Osadar and Varid Nakagawal., "Membrane Science and Technology", Marcel Dekkar ,1992
3. Jimmy L. Humphery and George E. Keller., "Separation Process Technology", McGraw-Hill Publishers, 1997.
4. Ronald.W.Rousseau., "Handbook of Separation Process Technology", Wiley India Pvt Ltd, 2009

Course Outcomes:

On completion of the course the students will be able to

- infer the concepts of separation techniques
- acquire knowledge on separation by membrane and adsorption
- familiarize with ionic separation and other commercial process

14MFE04 HEAT AND MASS TRASFER OPERATIONS IN FOOD PROCESSING

3 0 0 3

UNIT – I **9**

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.

UNIT – II **9**

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

UNIT – III **9**

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 McCabe Thiele method.

UNIT – IV **9**

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.

UNIT – V **9**

Leaching: Solid liquid eqilibria, 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.

Course Outcomes:

On completion of the course the students will be able to

- acquire knowledge on steam properties
- comprehend the principle and operations of heat exchangers and evaporators
- recognize fundamental concepts of distillation process
- estimate the number of stages required for separation of liquid-liquid and solid -liquid mixtures

14MFE05 ADVANCED BAKING AND CONFECTIONERY TECHNOLOGY

3 0 0 3

UNIT – I **9**

Bakery ingredients and Equipments: Essential ingredients: Flour, yeast and sour dough, water, salt- Other ingredients: Sugar, color, flavor, fat, milk, milk powder and bread improvers. Leaveners and yeast foods. Shortenings, emulsifiers and antioxidants. Equipments- Introduction to utensils and equipments used in bakery industry with their purpose. Bulk handling of ingredients- Dough mixing and mixers, Dividing, rounding, sheeting, and laminating- Fermentation enclosures and brew equipment - Ovens and Slicers.

UNIT – II **9**

Bread, Biscuits, Cookies and Cakes: 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.

Biscuits: 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.

Cakes: 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.

UNIT – III **9**

Dough and Batter Rheology: Rheological methods- Dough testing equipments, texture profile analysis, compression, penetration, modified penetrometer, transient tests, dynamic tests, extensional viscosity. Effect of ingredient, mixing, dosing and temperature on rheological properties of dough and batter. Rheology of dough- Farinograph, Amylograph, Alveograph, and Extensiograph.

UNIT – IV **9**

Heat and Mass Transfer during Baking: Heat transfer mechanism- Refrigeration and retarding, Proving, Baking cake batters, bread dough, biscuit and cookies, pastry products, laminated products. Microwave baking, Baking on a hotplate, cooling and deep freezing, Foam to sponge conversion and the collapse of bakery products, ingredient, recipe and product interactions. Mass transfer mechanism- Mass diffusion, Evaporation on the surface and mass convection, Internal evaporation and condensation, combined transport phenomena during baking, Impact of heat and mass transfer during baking on product characteristics.

UNIT – V **9**

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 - cocoa 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. Matz, S. A., "Bakery Technology and Engineering", Chapman & Hall, London, 2006.
2. Cauvain, S. P, and Young, L.S., "Technology of Bread Making", Aspen publication. Maryland, 1999.
3. Edwards W.P., " Science of bakery products", The Royal Society of Chemistry, UK,2007
4. Matz. S.A., "Equipment for Bakers", Pan Tech International Publication. 1988.
5. Sugar Confectionery manufacture-(Ed) E.B.Jackson, 2nd edition, Blackie Academic and professional, Glasgow (1995).

Course Outcomes:

On completion of the course the students will be able to

- acquire knowledge about ingredients and equipments used in baking industries
- express the making of bread and other bakery products
- summarize the methods used for production of confectionery products

14MFE06 INDUSTRIAL WASTE MANAGEMENT

3 0 0 3

UNIT – I **9**

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, and flocculants particle settling and hindered settling.

UNIT – II **9**

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.

UNIT – III **9**

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.

UNIT – IV **9**

Filtration – Introduction and description of depth filtration; Surface filtration – Disc filter 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.

UNIT – V **9**

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

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.

Course Outcomes:

On completion of the course the students will be able to

- identify the physical and chemical methods for waste water treatment
- infer aerobic and anaerobic treatment methods in biological waste water treatment
- acquire knowledge on waste management and water treatment plants

14MFE07 TRANSPORT PHENOMENA IN FOOD PROCESSING

3 0 0 3

UNIT – I **9**

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.

UNIT – II **9**

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.

UNIT – III **9**

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

UNIT – IV **9**

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.

UNIT – V **9**

Mass Transport & Interphase Mass Transfer: 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. 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" 5thEdition, John Wiley & Sons,2007

Course Outcomes:

On completion of the course the students will be able to

- gain knowledge on mass, momentum and energy balance in transportation of fluids
- apply the concepts in interphase transport in isothermal and non isothermal systems

14MFE08 OPERATION RESEARCH

3 0 0 3

UNIT – I **9**

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 **9**

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 **9**

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 **9**

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.

UNIT – V **9**

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. 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.

4. N. K. Tiwari and Shishir K. Shandilya., “Operations Research”, Prentice Hall, New Delhi, 2006.
5. Sharma., “Operations Research : Theory and Applications”, Macmillan Publishers, New Delhi, 2009.
6. Gupta C.B., “Optimization Techniques In Operation Research”, I.K. International Publishing House, New Delhi, 2008.

Course Outcomes:

On completion of the course the students will be able to

- demonstrate an understanding of the basic concepts of research
- outline the process of data collection, sampling design and literature review
- select suitable statistical techniques for various applications
- be familiar with the principles of modeling
- elaborate on data interpretation and report writing

14MFE09 LIPID SCIENCE AND TECHNOLOGY

3 0 0 3

UNIT – I **9**

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.

UNIT – II **9**

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 – removal and recovery of solvent from miscella - removal and recovery of solvent from extracted residue. Processing equipment-mechanical extraction.

UNIT – III **9**

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.

UNIT – IV **9**

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

UNIT – V **9**

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

REFERENCE 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”, 6thEdition, Volume 1 – 6, John Wiley & Sons, 2005.

Course Outcomes:

On completion of the course the students will be able to

- interpret the nutritional aspects of food lipids and their sources
- recognize the formulations and characterization of different food lipids
- identify the type of frying and storage for lipid foods

14MFE10 ENZYME ENGINEERING AND TECHNOLOGY

3 0 0 3

UNIT – I **9**

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. Structure and function of Co-enzyme – reaction involving TPP, Pyridoxal phosphate, Nicotinamide, Flavin Nucleotides, Co-A, Biotin and Vitamin K dependent carboxylation.

UNIT – II **9**

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.

UNIT – III **9**

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.

UNIT – IV **9**

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

UNIT – V **9**

Enzyme Engineering and Biosensor – Enzyme engineering- design and construction of novel enzymes, site directed mutagenesis, artificial enzymes. Design of enzyme electrodes and their application as biosensors in industry.

TOTAL : 45

REFERENCE 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

Course Outcomes:

On completion of the course the students will be able to

- acquire knowledge on enzyme kinetics and influence of environmental factors on enzyme activity
- outline enzyme classification and interpret enzyme kinetics and enzyme inhibition
- identify the methods for enzyme isolation and immobilization and understand the concepts of enzyme engineering
- employ suitable enzymes in food processing

14MFE11 FOOD PACKAGING AND STORAGE ENGINEERING

3 0 0 3

UNIT – I **9**

Packaging – Importance and 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 and laminates - test for tensile strength, bursting strength, tear strength, permeability (water vapor & gas), stretch, metals, glasses & retort pouches.

UNIT –II **9**

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**.**

UNIT –III **9**

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.

UNIT –IV **9**

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 **9**

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. Dong Sun Lee, Kit L. Yam and Luciano Piergiovanni**—** Food Packaging Science and Technology, CRC press, USA 2008

4. Otto G. Piringer and A. L. Baner ― Plastic Packaging Materials for Food, Wiley-VCH Verlag GmbH, Germany 2008
5. Fred J. Baur ― Insect management for food storage and processing, Amer Assn of Cereal Chemists 2006
6. Sahay, K.M. and Singh K.K.. ―Unit Operations of Agricultural Processing, Vikas Publishing House Pvt. Ltd., New Delhi, 2003.

Course Outcomes:

On completion of the course the students will be able to

- be familiar with the properties of packaging materials
- gain in-depth knowledge on packaging systems
- outline the recent advances in food packaging
- comprehend the concepts in food storage
- have a thorough understanding of grain storage and handling

14MFE12 FOOD BIOTECHNOLOGY

3 0 0 3

UNIT – I **9**

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.

UNIT – II **9**

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.

UNIT – III **9**

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

UNIT – IV **9**

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.

UNIT – V **9**

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 Stanishlaw., Tranmper Johannes and Polak Jacek., "Food Biotechnology", Elsevier Science Publishing Company, New Delhi, 2000.
2. Bernard. Glick, Jack J. Pasternak and Cheryl l. 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.

Course Outcomes:

On completion of the course the students will be able to

- express the concepts of recombinant technology and gene transfer methods
- acquire knowledge on molecular diagnostic methods and application of molecular biotechnology
- apply the molecular diagnostic tools in food analysis and regulatory aspects of GM foods

14MFE13 FOOD PRODUCT DESIGN AND DEVELOPMENT

3 0 0 3

UNIT – I **9**

Food needs & Consumer preference: Market survey and its importance in; designing a questionnaire to find consumer needs for a product or a concept; advantages of processed foods in urbanized Modern Society; why people buy processed foods. Developing a Product to Meet the Requirements**.**

UNIT – II **9**

Designing new products: New Food Product Development (NPD) process and activities, NPD success factors, new product design, food innovation case studies, market-oriented NPD methodologies, organization for successful NPD; Recipe Development; use of traditional recipe and modification; recent developments in food ingredients/additives flavorings, colorings, emulsifiers, stabilizer and sweeteners; involvement of consumers, chefs and recipe experts; selection of materials/ingredients for specific purposes; modifications for production on large scale, cost effectiveness, nutritional needs or uniqueness; use of novel food ingredients and novel processing technologies.

UNIT – III **9**

Standardization & Large scale production: Process design, equipment needed and Design; establishing process parameters for optimum quality; Sensory Evaluation; Lab requirements; different techniques and tests; statistical analysis; application in product development and comparison of market samples; stages of the integration of market and sensory analysis.

UNIT – IV **9**

Quality, Safety & Regulatory aspects: Product Stability; evaluation of shelf life; changes in sensory attributes and effects of environmental conditions; accelerated shelf life determination; developing packaging systems for maximum stability and cost effectiveness; interaction of package with food; Regulatory Aspects; whether standard product and conformation to standards; Approval for Proprietary Product.

UNIT – V **9**

Advertisement, Marketing & Case studies: Product performance testing; market positioning, Marketing: developing test market strategies; various tools and methodologies to evaluate consumer attitudes, preferences and market acceptance factors; Case Studies of some successes and failures- Factors that influence NPD success, innovation case studies to highlight best practice in terms of the integration of technological and marketing approaches to NPD; food choice models and new product trends.

TOTAL : 45

REFERENCE BOOKS:

1. Brody, A. L., and John B. L., “Developing New Food Products for a Changing Marketplace”, 2nd Edition, CRC / Taylor & Francis, 2008.
2. Fuller, G.W., “New Food Product Development: From Concept to Marketplace”, CRC, 2004.
3. Macfie, H., “Consumer-led Food Product Development”, CRC/Wood Head, 2007.

4. Side, C., “Food Product Development: Based on Experience”, Iowa State Press/Blackwell, 2002.
5. Gupta, R., “Food Retailing: Emerging Trends”, ICFAI University, Press, 2005.
6. Chakraborty, A., “Food Processing: Opportunities and Challenges”, ICFAI University Press, 2006.

Course Outcomes:

On completion of the course the students will be able to

- recognize the concept of consumer preference and designing of new food products
- gain the knowledge of standardization and large scale production of new food products
- infer the quality, safety and marketing of new food products

14MFE14 FOOD SUPPLY CHAIN MANAGEMENT

3 0 0 3

UNIT – I **9**

Introduction: Building blocks of Food Supply Chain Management , Significance in Nation's Economy, International Food Supply Chains - Special emphasis to Indian Scenario and challenges thereof; Agricultural policy impacts, and problems in the modern food supply chain; Human Resource Development in Supply Chain, Understanding the changing customer needs: domestic and export;. Food Disaster and Hunger relief.

UNIT – II **9**

Food Supply Chain Management Modules: Inbound and outbound logistics, Supply Chain as a source of competitive advantage, Buyer – Vendor co-ordination, Procurement, Vendor development and evaluation, reduced sourcing and supplier partnership – benefits, risks and critical success factors, The Logistics/SC product: Nature and classification of products, the product life cycle, product characteristics, weight – bulk ratio, substitutability, risk characteristics, product packaging, product pricing, geographic pricing methods, legal concerns; Coordination and management of transportation, Inter model transportation and third party transportation services; Facility location, Transportation infrastructure and management.

UNIT – III **9**

Order processing: Multi-level supply control, Inventory control systems of stock replenishment, Cost elements, EOQ and derivative models; Order processing and information systems- Defining order processing, order status reporting- industrial order processing, retail order processing, customer order processing; web – based channel order planning.

UNIT – IV **9**

Models and E- Commerce Inputs: Porter's industry analysis and value chain models; concept of total cost ownership; Use of stochastic models and combinatorial optimization in SC planning, layout, capacity planning, inventory optimization; Operation research models for operational and strategic issues in supply chain management, the Bullwhip effect and supply chain management game; Internet technologies and electronic commerce in SCM related to ERP, Q procurement, e-logistics, internet auctions.

UNIT – V **9**

Application of supply chain management in Multi-Sector: Specific supply chain practices (buy local vs. commodity supply chain)- Pre and Post Harvest Management of Fresh Produce; Food Manufacturing Restaurant and Hospitality Industry, Controlling Food Safety and Insuring Quality, Sustainable and Organic Food Supply Chains and Certification Programs. Benefits and risks associated with FDI in retail sector of India.

TOTAL : 45

REFERENCE BOOKS:

1. Pullman, M., and Wu, Z., "Food Supply Chain Management: Economic, Social and Environmental Perspectives", 2011.
2. Chopra, S., and Meindl, P., "Supply Chain Management Strategy, Planning and Operation", Pearson Education, 2004.
3. Janat, S., "Supply Chain Management: Text and Cases", Pearson, 2009.

4. Raghuram, G., and Rangaraj, N., "Logistics and Supply Chain Management: Cases and Concepts" , Macmillan, 2000.
5. Simchi, L.D., Kaminski. P., and Simchi, L.E. "Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies" , 2nd edition, Irwin/McGraw- Hill, 2003.

Course Outcomes:

On completion of the course the students will be able to

- understand the fundamentals and various modules of food supply chain management
- gain the knowledge on models and order processing systems in food supply chain management
- know the application of supply chain management in various sectors

14MFE15 INDUSTRIAL PROCESS AUTOMATION

3 0 0 3

UNIT – I **9**

Basics and Tools: Process Controls in Food Industry, Computer based instrumentation, Food Process modeling and simulation, Image processing and its applications in food processing.

UNIT – II **9**

Automation in Food Processing: General considerations, Packaging, palletizing, and mixed pallet automation, raw product handling and assembly, Decorative product finishing, integrated automation.

UNIT – III **9**

Computer based controls: Fermentation process control, Process control for thermal processing, Automatic control of drying process, computerized food freezing/chilling operations, Food warehouse automation, control systems in food packaging.

UNIT – IV **9**

Applications in food manufacturing: Dairy Processing, Meat Processing, Industrial Cooking operations, Bakery/Cereal Industry, Fish Processing Industry, integrated manufacturing in food industry.

UNIT – V **9**

Automated evaluation in food industry: Food quality quantization and process control, Typical problems in food quality evaluation and process control, Data acquisition and analysis.

TOTAL: 45

TEXT BOOKS:

1. Mittal, G.S., "Computerized control systems in food industry", Marcel Dekker Inc, New York, USA, 1997.
2. Nof, Y.S., "Handbook of Automation", Springer Publications, New York, 2009.
3. Huang, Y., Whittaker, A.D., and Lacey, R.E., "Automation for food engineering- Food Quality Quantization and Process Control" CRC press, Florida, 2000.
4. Besterfield, D.H., "Quality Control", Prentice-Hall Publications, New Jersey, 1990

Course Outcomes:

On completion of the course the students will be able to

- understand the fundamental concepts and tools used in automation in food processing
- recognize the importance and applications of computer based control systems in various food operations
- recognize the importance and applications of computer based control systems in food manufacturing and quality control

14MFE16 INDUSTRIAL ENGINEERING

3 0 0 3

UNIT – I **9**

Productivity: Industrial Engineering – Role of Industrial Engineering - System concept of production-Types of production system-flow, job, batch and project- Productivity-Factors affecting productivity-Productivity measures-Productivity improvement techniques-Business Process Reengineering (BPR).

UNIT – II **9**

Work Study: Method, basic procedure-Selection-Recording of process -Critical analysis, Development -Implementation -Micro motion and memo motion study –Principles of motion economy-Work measurement-Techniques of work measurement -Time study –computation of standard time-Work sampling -Synthetic data -Predetermined motion time standards-Job Evaluation, Merit Rating-Ergonomics and Safety.

UNIT – III **9**

Forecasting: Need for forecasting -demand patterns-Forecasting models-Judgmental Techniques, Time series analysis, moving average, exponential smoothing, Regression and correlation method-Forecast error-costs and accuracy of forecasts.

UNIT – IV **9**

Facility Planning: Facility location-factors influencing plant location-single and multi facility location problems-Minimax, Gravity and Euclidean –Distance location problem. Capacity planning, Plant layout-Layout classification-Layout Design Procedures-CRAFT, ALDEP, CORELAP-Material handling systems-unit load concept-material handling principles- Types of material handling equipments and its selection.

UNIT – V **9**

Value Engineering: Value engineering –Function, aims, procedure. Make or buy decision, Interest formulae and their applications –Time value of money, Single payment compound amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series payment Present worth factor-equal payment series capital recovery factor-Uniform gradient series annual equivalent factor, Effective interest rate, Examples in all the methods. Methods of comparison of alternatives –present worth method (Revenue dominated cash flow diagram), Future worth method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), Annual equivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), rate of return method, Examples in all the methods.

TOTAL : 45

REFERENCE BOOKS:

1. Telsang, M., “Industrial Engineering and Production Management”, S. Chand and Company, New Delhi, 2006.
2. Panneerselvam. R., “Production and Operations Management”, Prentice - Hall of India, 2007.
3. Buffa Elwood S., and Sarin Rakesh K., “Modern Production and Operations Management”, Eighth Edition, John Wiley and Sons, New York, 2003
4. Chary, S.N., “Production and Operations Management”, McGraw Hill, Fourth edition, New Delhi, 2009

5. Nair, N.G., “Production and Operations Management”, Tata McGraw –Hill, New Delhi, 2002
6. Chase,Jacobs and Aquilano., “Operations Management for Competitive Advantage”, Tenth Edition, Tata McGraw - Hill, New Delhi, 2004

Course Outcomes:

On completion of the course the students will be able to

- recognize the concept of industrial engineering and work study
- exhibit the procedure for forecasting and facility planning
- recognize the importance of industrial engineering in cost analysis

14MHT14 PROJECT ENGINEERING OF PROCESS PLANTS

(Common to Chemical Engineering & Food Technology)

3 0 0 3

UNIT – I **9**

Project identification and process planning: Project definition, Project Profile and standards, Feedback information (MIS), Evaluation and Modification, Selection, Criteria. Planning the process, Strategic and Managerial Planning, Organizing the process planning.

UNIT – II **9**

Project engineering: Economic Balancing, Network Planning, Methods (PERT/CPM), Engineering Flow Diagrams, Cost requirements, Analysis and Estimation of Process Feasibilities (Technical/Economical) Analysis, Application of reliability theory.

UNIT – III **9**

Engineering management : Plant Engineering Management, Objectives, Programme, Control, Plant Location and Site Selection, Layout diagrams, Selection and procurement of equipment and machineries, Installation, Recommissioning, Commissioning and performance appraisal, Strategies choice and Influence, Product planning and development, Provision and maintenance of service facilities.

UNIT – IV **9**

Financial aspects: Cost and Costing, Cost Control systems, Cost – Benefit Ratio Analysis, Project Budgeting, Capital Requirements, capital Market, Cash Flow Analysis, Break even strategies. Defining project financing, typical project stages, setting up a basic project finance structure, risk management in context of project financing.

UNIT – V **9**

Legal aspects of business enterprises: Government regulations on procurement of raw materials and its allocation. Export – Import regulations, Pricing policy, Industrial licensing procedure, Excise and other commercial taxes, Policies on depreciation and corporate tax, Labour laws, Social welfare legal measurements, Factory act, Regulations of Pollution Control Board.

TOTAL: 45

REFERENCE BOOKS:

1. Clements .T and Gido.L. "Effective Project Management", Thomson Education press, New Delhi, 2007.
2. Peters, M.S. and Timmerhaus, K.D., "Plant design and economics for chemical engineers, McGraw Hill (ISE)", 2002.
3. Perry, J. H. "Chemical Engineer's Hand Book", 8th Edition, McGraw-Hill, New York, 2007.
4. Rase F.Howard and Barrows M.H., "Project engineering of process plants", Wiley, 1957.
5. Pathi P.K. "Labour and Industrial laws", Second Edition, Prentice Hall India, 2012.

Course Outcomes:

On completion of the course the students will be able to

- acquire the basic knowledge in project engineering and management
- understand process planning, costing, network planning, process feasibilities and break even strategies
- understand plant engineering management, plant location and layout
- apply the financial concepts and the legal aspects of business enterprises

14MFE17 INDUSTRIAL MANAGEMENT

3 0 0 3

UNIT – I **9**

Principles of Management: Management, different functions of management: Planning, organizing, coordination and control, Structure of an industrial organization, Functions of different departments, Relationship between individual departments, Human relations and performance in organization, Understand self and others for effective behaviour, Behaviour modification technique, Industrial relations and disputes, Relations with subordinates, peers and superiors, Labour welfare, Workers' participation in management.

UNIT – II **9**

Professional Ethics: Concept of ethics, Concept of professionalism, Need for professional ethics, Code of professional ethics, Typical problems of professional engineers, Professional bodies and their role. Motivation- Factors determining motivation, Characteristics of motivation, Methods for improving motivation, Incentives, pay, promotion, rewards, Job satisfaction and job enrichment. Leadership - Need for leadership, Functions of a leader, Factors for accomplishing effective leadership, Manager as a leader. Human Resource Development – Introduction, Staff development and career development, Training strategies and methods. Wage Payment- Introduction, Classification of wage payment scheme.

UNIT – III **9**

Labour, Industrial and Tax Laws: Importance and necessity of industrial legislation, Types of labour laws and disputes, Brief description of the following Acts: The Factory Act 1948; Payment of Wages Act 1936; Workmen Compensation Act 1923; Industrial Dispute Act 1947; Employee' State Insurance Act, 1948; Provident Fund Act. Various types of Taxes-Production Tax, Local Tax, Sales Tax, Excise Duty, Income Tax. Labour Welfare schemes.

UNIT – IV **9**

Accidents and Safety: Classification of accidents; according to nature of injuries i.e. fatal, temporary; according to event and according to place, Causes of accidents-psychological, physiological and other industrial hazards, Effects of accidents, Accidents-prone workers, Action to be taken in case of accident with machines, electric shock, road accident, fires and erection and construction accidents, Safety consciousness & publicity, Safety procedures, Safety measures-Do's and don'ts & good housekeeping (5S), Safety measures during executions of Electrical Engineering works.

UNIT – V **9**

Financial management, Marketing and sales: Important, ledger, Journal, Profit and Loss Account, Balance Sheet, Interpretation of Statements, Ration Analysis, Project financing, Project appraisal, return on investments. Sellers and Buyers markets, Marketing, Sales, Market conditions, monopoly, oligraphy, perfect competition, Cost Elements of Cost, Contribution, Break even analysis, Budgets, Pricing Policies.

TOTAL : 45

REFERENCE BOOKS:

1. Banga, T.R., Agarwal, N.K., and Sharma, S.C., "Industrial Engineering and Management Science", Khanna Publishers, New Delhi 2007.

2. Khanna, O.P., “Industrial Engineering and Management”, Dhanpat Rai Publication, New Delhi, 2005.
3. Sharma, S.K., “Industrial Engineering and Organization Management”, S. K. Kataria & Sons, New Delhi, 2009.
4. Sharma, R.K., “Industrial labour in India”, Atlantic Publishers, New Delhi, 1997.
5. Bagad, V.S., “Industrial Management”, Technical Publications, Pune, 2008.
6. Wilson, L., and McCutcheon, D., “Industrial Safety and Risk Management”, The University of Alberta Press, Canada, 2003.

Course Outcomes:

On completion of the course the students will be able to

- recognize the concept of management and professional ethics
- know the various laws and regulations, accident and safety procedures
- understand the concept of finance management, marketing and sales

14MFE18 ADVANCED FRUIT AND VEGETABLE PROCESSING TECHNOLOGY

3 0 0 3

UNIT – I **9**

Post harvest processing: Preharvest factors on postharvest life, Maturity index, Harvesting and handling methods, Precooling, Post harvest treatments- curing, sprout suppressants, degreening. Storage – Refrigerated storage, Hypobaric storage. Controlled atmosphere stores. Fruit ripening – changes during ripening, ripening rooms. Ethylene – sources, alternatives.

UNIT – II **9**

Edible coatings: Introduction, Principle, selection of edible coatings, Gas permeation properties, Wettability, coating effectiveness, Diffusivities of fruits – determination. Measuring internal gas composition. Future trends. Vacuum technology – introduction, principles – mass transfer and product behaviour. Applications and future trends.

UNIT – III **9**

Minimal processing: introduction, quality changes, Processing – physiological and microbiological impacts, Fresh cut products – Fresh produces quality and safety. Strategies for minimizing quality loss improving quality, bio-control agents, browning inhibition. Storage and packaging. Fresh-cut chain – harvest to market. Equipment requirements. Traceability of fresh cut products. Layout of a fresh cut processing facility. Future trends.

UNIT – IV **9**

High pressure processing of fruit and vegetables: Introduction. High pressure technology. Impact of HP on spore forming, vegetative bacteria and enzymatic activity. HP processing. Fruit and vegetable quality. Combined HP processing. Future trends.

UNIT – V **9**

Fruit and vegetable product manufacturing: Jams & Jellies – Gelling agent, sweetening agent, acidulants, colouring and flavoring agents, method of manufacturing. Fruit Beverages. Fruit as an ingredient – In dairy product, confectionary, distillery, baked, frozen and heat treated products.

TOTAL : 45

REFERENCE BOOKS:

1. Jongen W, "Fruit and Vegetable Processing: Improving Quality". Woodhead Publishing Series in Food Science, Technology and Nutrition. 2002
2. Y. H. Hui, József Barta, M. Pilar Cano, Todd W. Gusek , Jiwan S. Sidhu and Nirmal K. Sinha. "Handbook of Fruits and Fruit Processing". Blackwell Publishing. 2006.
3. Keith Thompson. "Fruit and Vegetables: Harvesting, Handling and Storage". Blackwell Publishing. 2008.

Course Outcomes:

On completion of the course the students will be able to

- familiarize with the post harvest processing
- familiarize with the edible coatings for fruit and vegetables
- acquire knowledge on minimal processing
- acquire knowledge on high pressure processing
- gain insight on novel fruit and vegetable based products

14MFE19 ADVANCED GRAIN SCIENCE AND TECHNOLOGY

3 0 0 3

UNIT – I **9**

Grains: Introduction, Grain structure, composition, physical properties. Harvesting and Threshing – methods, machines and losses. Drying and storage – grain cleaning, drying, storage, aeration and stored grain management, control of insects, micro organisms and rodents during storage

UNIT – II **9**

Rice: Structure. Rice milling- Cleaning, husking and husk aspiration, equipments, polishing – water mist polishing, rice moisture conditioning, separation of broken from whole grains. Instruments for rice quality control – rice analyzer, broken rice analyzer, FWM analyzer, rice taste analyzer.

UNIT – III **9**

Wheat: Morphology of wheat. Classification and grading. Wheat milling. Grading. Purificatioin, milling performance evaluation. Functional properties of flour, Flour treatment – enrichment, enhancement, additives for gas retention and flour oxidation. Mill end products. Finished byproducts and their utilization.

UNIT – IV **9**

Speciality milling: Barley – Processing, finishes products and end uses. Whole barley grain, pot and pearled barley, barley semolina, barley flour. Corn – Dry milling, dehuller, degermination - degerminator, milling. Corn products and end uses. Wet milling of corn. Oat milling and flaking. Oat products.

UNIT – V **9**

Cereal products: Rice snack foods, Rice noodles, quick cooking rice, canned and frozen rice, Baby foods, extruded rice, puffed rice cake, pasta, instant noodles, breakfast cereals, cereal enrichment, malted cereals, special food ingredients from cereals, future trends.

TOTAL : 45

REFERENCE BOOKS:

1. G. Owens, “Cereals Processing Technology”. Woodhead Publishing. 2001.
2. Karel Kulp, “Handbook of Cereal Science and Technology”, Second Edition.CRC Press. 2000.
3. Norman Leslie Kent, “Technology of Cereals: An Introduction for Students of Food Science and Agriculture”
4. Amalendu Chakraverty, Arun S. Mujumdar, Hosahalli S. Ramaswamy. “Handbook of Postharvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices”. CRC Press, 2003.
5. Y. H. Hui, Frank Sherkat, “Handbook of Food Science, Technology, and Engineering” Part 1, CRC Press. 2001.

Course Outcomes:

On completion of the course the students will be able to

- familiarize with the grain properties, storage and cleaning methods
- acquire knowledge on rice milling techniques
- acquire knowledge on wheat milling techniques
- gain insight on specialty milling of grains
- acquire knowledge on different cereal products

14MFE20 ADVANCED MEAT PROCESSING TECHNOLOGY

3 0 0 3

UNIT – I **9**

Meat: An Introduction: Meat and meat products in India; Importance of meat and meat industries in national economy; Chemical composition and structure of meat; Scientific methods of slaughter - Stunning techniques - mechanical, electrical, chemical methods; Pre- and post- slaughter operations; Factors affecting post-mortem changes; Meat quality evaluation; Gene technology for meat quality, Meat plant sanitation and hygiene;

UNIT – II **9**

Advances in Poultry: Types and characteristics of poultry products, Composition of poultry products, Structure, composition, nutritive value and functional properties of eggs, Preservation methods of eggs, Processing of egg products, Measures of egg quality, Pre-slaughter care, handling, Transport and dressing of poultry birds

UNIT – III **9**

Marine: Marine processing industries in India, Types and composition of fish, Post-mortem changes in fish, Handling and transportation of fish, Freezing and Individual quick freezing, Quality Assurance of Seafood, Advances in fishery by-products technology, Canning, smoking, freezing and dehydration of fish, Productions of fish meal, fish protein concentrate, fish liver oil and fish sauce and other important byproducts.

UNIT – IV **9**

Advances in meat processing operations: Current decontamination techniques and their limitations; Automated meat processing; New developments in the chilling and freezing of meat; Impact of chilling and freezing – texture, colour, drip loss and evaporative weight loss; High pressure processing of meat; Fermented meat products; Meat calculations for QUID (Quantitative Ingredient Declarations); functional meat products; Drug residues in meat;

UNIT – V **9**

Advances in meat, poultry and marine processing operations: Meat products – cooked ham, cooked sausages, bacon, canned products; Sectioned and formed meat formulations; Mechanically recovered meat; Hot boning of meat, Vacuum salting treatment of meat; Canned poultry meat; Refrigerated poultry handling; HACCP for poultry industry; Microwave in fish handling and processing

TOTAL : 45

REFERENCE BOOKS:

1. George M. Hall – Fish Processing: Sustainability and New Opportunities, John Wiley & Sons, 2011
2. P. D. Warriss – Meat Science: An Introductory Text, CABI, 2010
3. Isabel Guerrero-Legarreta – Handbook of Poultry Science and Technology, Secondary Processing, John Wiley and Sons, 2010
4. Fidel Toldra – Handbook of meat processing, John Wiley and Sons, 2010
5. Hui Y.H. -- Handbook of Meat and Meat Processing, Second Edition, CRC Press, 2012

Course Outcomes:

On completion of the course the students will be able to

- outline the science involved in meat processing technology
- understand the advances in technology of poultry science
- relate to the advances in marine processing technology
- understand the advances in technology of meat processing
- understand the advances in technology of marine and poultry processing

14MFE21 ADVANCED DAIRY TECHNOLOGY

3 0 0 3

UNIT – I **9**

Milk: Introduction: Milk- introduction; Composition of milk; Types of market milk, Factors affecting milk composition, Engineering properties: Thermal (specific heat, thermal conductivity and diffusivity), Optical (colour), Electrical (conductivity and permittivity), and rheological properties (viscosity), Refractive Index, Nutritional profile of milk

UNIT – II **9**

Dairy processing: Advances: Membrane technologies – applications in dairy industry; Indirect Biological Acidification process (IBA) for butter making; Microwave Processing of milk; High Pressure processing of milk; Pulsed Electric Field processing of milk; Ultrasound processing of milk; Innovative Steam Injection processing of milk; processing by Combined Technologies; Enriched and Modified Milks

UNIT – III **9**

Heat-induced changes in milk: Changes in physicochemical properties of milk – pH, Buffering Capacity, Creaming; Changes in processing characteristics of milk – rennet induced coagulation, acid induced coagulation, heat induced coagulation; changes caused by concentration; age thickening; gelation; powder characteristics of milk powder

UNIT – IV **9**

Operational considerations and limitations: Fouling- types; mechanisms of fouling; factors affecting fouling; Composition and properties of dairy fluids for membrane processing; Applications of membrane bioreactors and fermenters in the dairy industry; Biofilm – formation; detection of biofilm; control/removal of biofilm

UNIT – V **9**

Advances in product manufacture: Reconstituted milk; recombined milk; Whey fermentation; Bioactive components in buffalo milk; Infant formula - formula composition and manufacture; High fat products- AMF, recombined butter, low-fat butter products; Cheese ripening; Enzymes of Significance to Milk and Dairy Products

TOTAL : 45

REFERENCE BOOKS:

1. Barry A. Law, A. Y. Tamime – Technology of Cheesemaking, John Wiley & Sons, 2011
2. Hui, Y.H. – Handbook of Food Science, Technology and Engineering, CRC Press, 2006
3. Sukumar De – Outlines of Dairy Technology, Oxford University Press, 2010
4. Trevor Britz, Richard K. Robinson – Advanced Dairy Science and Technology, John Wiley & Sons, 2008
5. Rao M.A., Rizvi S.S.H. and Datta A.K. – Engineering Properties of Foods, 3rd Edition, CRC Press, 2010

Course Outcomes:

On completion of the course the students will be able to

- understand the basic concepts of milk and its characteristics
- understand the technology of milk processing
- relate to the changes occurring in milk due to heat induced processes
- able to summarize the operational considerations and limitations concerned with biofilms
- understand the advances in processing operations of dairy products

14MFE22 ADVANCED FOOD PROCESSING TECHNOLOGY

3 0 0 3

UNIT – I **9**

Properties and Post Harvest Processing: Properties of Food materials: Physical properties, Thermal properties, Rhelogical properties, Electromagnetic properties – Colour and Dielectric Properties, Aero and Hydrodynamic properties. Moisture content – free moisture, bound moisture. Water activity and sorption properties. Equilibrium moisture content, EMC determination methods, EMC Models, hysteresis effect. Post Harvest Processing– 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.

UNIT – II **9**

Material Handling and Size Reduction: Material handling equipments- screw conveyor, bucket elevator, belt conveyor, chain conveyor, pneumatic conveyor. Size reduction- Solids - 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, Plate mill, Roller mill. Cryogenic grinding and its application. Size reduction – liquids - Homogenization, Emulsification, Atomization – Principles and Equipments

UNIT – III **9**

Mixing: Characteristics of mixtures – Mixing of fluids – Blending Equipments- Flow patterns – Energy input in fluid mixing. Mixing of Particulate Solids – Kneading - Equipments. Quality of mixing. Measurement of mixing – mixing index.

UNIT – IV **9**

Thermal Processing: Thermal processing of food- Blanching, pasteurization, sterilization, aseptic sterilization – Principles and Equipments. Kinetics of Thermal Inactivation of Microorganisms and Enzymes. Process time calculations. 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.

UNIT – V **9**

Extrusion & Crystallization: Extrusion - Theory and mechanism, Single & Twin screw system. Effect on foods. Applications. Crystallization - Equilibrium – Nucleation and Crystal growth. Meta stable region – Seed Crystals – Heat of Crystallization – Rate of crystal growth – Equipments. Applications in Food industries.

TOTAL: 45

REFERENCE BOOKS:

1. Zeki Berk. Food Process Engineering and Technology. Elsevier. 2009.
2. Earle.R.L. "Unit Operations in Food Processing, 2nd Edition, Pergamon, 1983
3. Sahin S and Servet Gulum Sumnu. Physical Properties of Foods. Springer. 2006.
4. Paul Singh R. and Dennis R. Heldman., "Introduction to Food Engineering" 4th Edition, Academic Press, 2009
5. Fellows P., "Food Processing Technology- Principles and practice", CRC Press, 2009.

Course Outcomes:

On completion of the course the students will be able to

- familiarize with the Properties of food materials and equipments involved post harvest processing
- gain knowledge on material handling and size reduction
- acquire insight on mixings of solids and liquids
- acquire knowledge on freeze and spray drying
- gain insight on extrusion and crystallization process involved in food processing

14MFE023 SENSORY ATTRIBUTES OF FOODS

3 0 0 3

UNIT – I **9**

Introduction to Sensory Evaluation: Sensory evaluation – Definition, Sensory perception – Vision, Gustation, olfaction, touch, audition, multimodal perception, Factors affecting sensory measurements, Role of sensory evaluation, Factors contributing to successful sensory evaluation

UNIT – II **9**

Planning a Sensory Project: Requirements for sensory testing - Professional conduct in sensory testing: health, safety, ethical and legal considerations, Good working and laboratory practices, Setting objectives, Resources needed for sensory testing, Product type, Assessors, Budget, Timings, Selecting the test method, Setting action standards, Experimental design, Data analysis

UNIT – III **9**

Discriminative Test Methods: Overall Difference tests - Triangle test, Duo-trio test, Difference from control test, Same & different test, 'A' 'not A' test, Attribute specific test - Paired comparison, Alternative forced choice, Ranking test, Similarity test - The power of the test, Proportion of true discriminators

UNIT – IV **9**

Descriptive and Affirmative Tests: Descriptive analysis tests - Consensus profiling, Flavor Profiling®, Texture Profiling®, Quantitative Descriptive Analysis®, Spectrum™ method, Free choice profiling, Flash profiling. Affective tests - Focus groups, Preference tests, Acceptance tests, Attribute diagnostics

UNIT – V **9**

Basic Statistical Concepts for Sensory Evaluation: Introduction, Hypothesis Testing and Statistical Inference, Variations of the t-Test, Introduction to Nonparametric Tests - Binomial-Based Tests on Proportions, Chi-Square, Rank Order Tests, Analysis of Variance, Correlation, Regression & Measures of Association

TOTAL : 45

REFERENCE BOOKS:

1. Harry.T.Lawless and Hildegarde Heymann., "Sensory Evaluation of Food: Principle and Practices" 2nd Edition, Springer, 2010.
2. Herbert Stone, Rebecca. N. Bleibaum, Heather. A. Thomas "Sensory Evaluation Practices", 4th Edition, Academic Press, 2012
3. Morten C. Meilgaard, B. Thomas Carr, Gail Vance Civille, "Sensory Evaluation Techniques", 4th Edition, CRC Press, 2010.
4. Sarah Kemp , Tracey Hollowood , and Joanne Hort, "Sensory Evaluation: A Practical Handbook", Wiley-Blackwell Publishers, 2011.
5. Jian Bi, "Sensory Discrimination Tests and Measurements", Blackwell Publishers, 2008.
6. Roland P. Carpenter, David H. Lyon, Terry A. Hasdell, "guidelines for sensory analysis in food product development and quality control", Springer, 2000.

Course Outcomes:

On completion of the course the students will be able to

- demonstrate an understanding of the concepts in sensory evaluation
- plan a sensory evaluation session
- outline the Discriminative test methods
- select suitable descriptive and affirmative tests
- elaborate on the basic statistical concepts for sensory evaluation