

REVISED CURRICULUM AND SYLLABI

(With effect from the academic year 2017 – 2018 onwards)

M.Sc Food Science and Technology



DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY PONDICHERY UNIVERSITY

R. Venaktaraman Nagar, Kalapet
Puducherry – 605 014
INDIA

PONDICHERY UNIVERSITY

M.Sc Food Science and Technology

REGULATIONS

The course prepares students with a broad knowledge of the biological, physical and engineering sciences to develop new food products, design innovative processing technologies, improve food quality and nutritive value, enhance the safety of foods and ensure the wholesomeness of our food supply. Food Science majors apply the principles learned in the basic sciences such as food chemistry, biochemistry, microbiology, food engineering and nutrition to provide consumers with safe, wholesome and attractive food products that contribute to their health and well-being. The objective of the curriculum is to prepare Food Scientists for career opportunities in food and allied industries.

Programme of study:

M.Sc Food Science and Technology programme is interdisciplinary in nature comprising of microbiology, biotechnology, biochemistry, Food Science and Technology and nutrition, engineering etc. The course provide promising career opportunities in areas such as food product/process design, technical service, research and development, quality assurance, food safety, food law, regulatory oversight, technological innovation, marketing, corporate sales, sensory evaluation, and operations management. The students admitted in the programme shall be required to take up dissertation work on any emerging areas of food technology which demand attention.

Eligibility for Admission

B.Sc/B.Tech Degree in Agriculture / Agricultural Engineering/ Food Technology/ Home Science/ Food Science and Nutrition/ Food Science and Quality Control/ Clinical Nutrition/ Biochemistry/Biotechnology/ Microbiology. Mathematics at +1/+2 / P.U.C. level is compulsory (exempted for students with B.Sc/ B.Tech Food Science and Technology / Food Technology)

CURRICULUM – M.Sc FOOD SCIENCE AND TECHNOLOGY

Semester	Course Code	Title	Category	Credits	
I	FS&T411	Food Chemistry	HC	3	
	FS&T412	Food Microbiology	HC	3	
	FS&T413	Food Processing and Preservation Technology	HC	3	
	FS&T414	Food process engineering	HC	3	
	FS&T415	Research Methodology and Biostatistics	HC	3	
	FS&T416	Techniques in Food Analysis	HC	3	
	FS&T426	Food Toxicology	SC	3	
	FS&T427	Technology of Cereals , Legumes and Oil Seeds	SC	3	
	LAB				
	FS&T451	Food Chemistry lab	HC	1	
	FS&T452	Food Microbiology Lab	HC	1	
	FS&T453	Food Processing and Preservation Technology Lab	HC	1	
	FS&T454	Technology of Cereals, Legumes and Oil Seeds Lab	SC	1	
	II	FS&T431	Food Plant Equipment	HC	3
FS&T432		Enzymes in Food Processing	HC	3	
FS&T433		Food Product Development and Quality Evaluation	HC	3	
FS&T434		Fermentation Technology	HC	3	
FS&T435		Pollution in Food Industries	SC	3	
FS&T446		Nutraceuticals and Functional Foods	SC	3	
FS&T447		Baking and Confectionery Technology	SC	3	
LAB					
FS&T456		Food Product Development and Quality Evaluation Lab	HC	1	
FS&T457		Enzyme Technology and Down Stream Processing Lab	HC	1	
FS&T458	Baking and Confectionery Technology Lab	SC	1		
III	FS&T511	Food Biotechnology and Nanotechnology	HC	3	
	FS&T512	Food Packaging	HC	3	
	FS&T513	Food safety and Quality Control	HC	3	
	FS&T514	Technology of Animal Products	HC	3	
	FS&T515	Technology of Spices and Plantation Products	HC	3	
	FS&T527	Food Plant Organization and Management	SC	3	
	FS&T528	Food laws and Regulations	SC	3	
	FS&T529	Technology of Fruits and Vegetables	SC	3	
	FS&T530	Food Additives	SC	3	
	FS&T531	Food industry waste management and By product utilization	SC	3	
	LAB				
	FS&T551	Technology of Animal Products Lab	HC	1	
	FS&T552	Technology of Spices and Plantation Products Lab	HC	1	
	FS&T523	Technology of Fruits and Vegetables Lab	SC	1	
FS&T524	Food safety and Quality Control Lab	SC	1		
IV	FS&T571	Project Work	HC	8	

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M.Sc Food Science and Technology

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	FS&T414	Food process engineering	HC	3	
	FS&T415	Research Methodology and Biostatistics	HC	3	
	FS&T416	Techniques in Food Analysis	HC	3	
	FS&T426	Food Toxicology	SC	3	
	FS&T427	Technology of Cereals , Legumes and Oil Seeds	SC	3	
	LAB				
	FS&T451	Food Chemistry lab	HC	1	
	FS&T452	Food Microbiology Lab	HC	1	
	FS&T453	Food Processing and Preservation Technology Lab	HC	1	
	FS&T454	Technology of Cereals, Legumes and Oil Seeds Lab	SC	1	

Unit I**8 HOURS**

Water: Water molecule structure, liquid water and ice, water activity, Phase transition of water molecule, WLF equation. Dispersed System: surface chemistry, colloidal interaction, creaming foams and emulsion.

Unit II**9 HOURS**

Amino acids: classification, physical properties, chemical reaction, synthesis of amino acids in food fortification. Peptides: Nomenclature, physical and sensorial properties, individual peptides, Proteins: conformation, physical properties, chemical and enzyme catalyzed reactions in protein processing.

Unit III**9 HOURS**

Monosaccharides: structure and nomenclature, conformation, physical and sensory properties, chemical reaction and derivatives. Oligosaccharides: Structure and nomenclature, properties and reaction. Polysaccharides: classification and structure, conformation, properties, Individual Polysaccharide, enzyme degradation of polysaccharides, analysis of Polysaccharides.

Unit IV**10 HOURS**

Fatty acids: Nomenclature and classification, Physical properties and chemical reactions, Biosynthesis of Unsaturated fatty acids. Acylglycerols: Nomenclature and classification, Physical, chemical and melting properties. Classification and properties of Phospho and glycolipids, Lipoproteins, Diol lipids, higher alcohols, waxes and cutin. Changes in Acyl lipids of foods, Classification and Properties of Unsaponifiable constituents.

Unit V**9 HOURS**

Enzymes: Nomenclature, specificity, structure, isolation and purification. Enzyme cofactor, Theory of Enzyme catalysis, Kinetics of Enzyme catalyzed reaction, Enzyme analysis, Enzyme utilization in food industries. Vitamins, Minerals and Co-factors.

Text books and Reference materials

1. Belitz HD.2005. *Food Chemistry*. Springer Verlag.
2. Owen R. Fennema ,2006, *Food Chemistry* , Academic Press.
3. Meyer LH. 1987. *Food Chemistry*. CBS publishers and Distributors, New Delhi.
4. Potter, N. and Hotchikiss, J.H. (1996), *Food Sciences*, Fifth edition, CBS publishers and Distributors, New Delhi.
5. Fennema OR.1996. *Food Chemistry*. Marcel Dekker.

UNIT I**8 HOURS**

History and development of Microbiology-Importance and significance of microorganisms in food science. Factors affecting the growth of micro organisms in food – Intrinsic and Extrinsic parameters

UNIT II**10 HOURS**

Determination of microorganisms and their products in food: Sampling, sample collection, transport and storage, sample preparation for analysis. Microscopic and culture dependent methods- Direct microscopic observation, culture, enumeration and isolation methods; Chemical and Physical methods-Chemical, immunological and nucleic acid based methods; Culture independent techniques – PCR Based, DGGE, Metagenomics, etc.; Analytical methods for microbial metabolites- microbial toxins and metabolites.

UNIT III**9 HOURS**

Protection and preservation of Foods: Chemical, Modified atmosphere, Radiation in foods from the microbiological angle. Indicators of water and food safety and quality: Microbiological criteria of foods and their Significance. The HACCP and ISO systems for food safety.

UNIT IV**8 HOURS**

Food spoilage: characteristic features, dynamics and significance of spoilage of different groups of foods - Cereal and cereal products, vegetables and fruits, meat poultry and sea foods, milk and milk products, packed and canned foods.

UNIT V**10 HOURS**

Food borne diseases: *Bacterial food borne diseases* (Staphylococcal intoxication, Botulism, Salmonellosis, Shigellosis, Enteropathogenic Escherichia Coli Diarrhoea, Clostridium Perfringens gastroenteritis, Bacillus cereus Gastroenteritis) *Food Borne Viral Pathogens* (Norwalk virus, Norovirus, Reovirus, Rotavirus, Astrovirus, Adenovirus, Parvovirus, Hepatitis A Virus) *Food Borne Animal Parasites* Protozoa –Giardiasis, Amebiasis, Toxoplasmosis, Sarcocystosis, Cryptosporidiosis. Cysticercosis /Taeniasis. Roundworm – Trichinosis, Anisakiasis. *Mycotoxins*: Aflatoxicosis, Deoxyvalenol Mycotoxicosis, Ergotism. Drug resistance - phenomena and mechanism.

Text books and reference materials

1. Prescott LM Harley JP and Klein DA (2006). Microbiology (7th edition) McGraw Hill, Newyork.
2. Frazier, W.C. (1988) Food Microbiology, Mc Graw Hill Inc. 4th Edition.
3. Vijaya Ramesh,K. (2007) Food Microbiology. MJP publishers, 2007
4. Yasmine Motarjemi and Martin Adams. (2006) Emerging Food borne pathogen- Wood Head Publishing England.
5. Arun, K Bhunia. (2008) Food borne microbial pathogens: Mechanisms and pathogenesis. Springer.
6. Thomas J. Montville, Karl R. Matthews, Kalmia E. Kniel (2012). Food Microbiology: An Introduction, American Society for Microbiology.
7. Dubey, R.C. and Maheswari, D.K. (2008) Text book of Microbiology. S Chand Publishing.

UNIT I**8 HOURS**

Principles of fresh food storage: Nature of harvested crop, plant, animal; product storage; effect of cold storage and quality – storage of grains.

UNIT II**9 HOURS**

Processing and preservation by heat: Blanching, pasteurization, sterilization and UHT processing, canning, extrusion cooking, dielectric heating, microwave heating, baking, roasting and frying. Retort processing of Ready to eat (RTE) products. Newer methods of thermal processing – batch and continuous.

UNIT III**9 HOURS**

Processing and preservation by low Temperature: refrigeration, freezing, CA, MA, and dehydro-freezing. Food irradiation, history and mechanism, the electro-magnetic spectrum, forms of radiant energy. Principles of using electromagnetic radiation in food processing, ionizing radiations and non ionizing radiations, advantages and disadvantages. Controlling undesirable changes in food during irradiation.

UNIT IV**10 HOURS**

Processing and preservation by drying, concentration and evaporation: Drying – water activity, microbial spoilage due to moisture. Dehydration of fruits, vegetables, milk, animal products. Various methods employed in production of dehydrated commercial products, selection of methods based on characteristics of foods to be produced, advantages and disadvantages of different methods, sundrying, tray or tunnel drying, spray drying, drum drying, freeze drying, fluidized bed drying. Physical and chemical changes during drying control of chemical changes, desirable and undesirable changes. Packaging and storage of dehydrated products .Food Concentration- methods of food concentration, freeze concentration, Ultra-filtration, reverse osmosis.

UNIT V**9 HOURS**

Processing and preservation by non-thermal methods: High pressure, pulsed electric field, hurdle technology. GRAS and legal aspects for gamma irradiation. Permissible limits for chemical preservatives. Use and application of enzymes and microorganism in processing and preservation of foods; food fermentations, pickling smoking ; Food additives; Definition, types and functions, permissible limits and safety aspects. Chemical Preservatives- type I and type II.

Text books and Reference materials

- 1) Rao, Chandra Gopala (2006). Essentials of food process engineering. B.S. Publications.
- 2) Khatkar, Bhupendra Singh ed (2007). Food science and technology. Daya Publishing House.
- 3) Singh, N.P (2007). Fruit and vegetable preservation. Oxford Book Company.
- 4) Ahlluwalia, Vikas (2007). Food processing. Paragon International Publishers.
- 5) Sivasankar,B (2005). Food processing and preservation. Prentice - Hall of India
- 6) Paul, Meenakshi (2007). Effects of food processing on bioactive compounds. Gene-Tech Books.
- 7) Rahman, Shafiur : (2007). 2nd Edn Handbook of food preservation. CRC press.
- 8) Arthey, David . (2005). 2nd ed Fruit processing. Springer,
- 9) Fellows.P (2005). 2nd edn Food processing technology. woodhead publishing company.
- 10) Lewis Michael (2000). Continuous Thermal Processing Of Foods. Aspen.
- 11) Koutchma, Tatiana (2007). Ultraviolet light in food technology , CRC Press.
- 12) Sun, Da-Wen (2005). Emerging technologies for food processing. Elsevier Academic Press.
- 13) Zeuthen, Peter (2005). Food preservation techniques. Woodhead publishing ltd,
- 14) Berk, Zeri (2009). Food process engineering and technology. Elsevier.
- 15) Fellows, P (2015). 3rd ed Food processing technology. Elsevier India.
- 16) Daniel B.-Gagne, Chloe M. (2013). Processed Foods, Jones, Nova Science Publishers, Inc.

UNIT -I**9 HOURS**

Transport Phenomena: Nature and properties of fluids. Transport phenomena with respect to foods. Transport property, Flow of food fluid - Laminar and turbulent flow. Laws governing fluid flow. Newtonian and non Newtonian fluids. Visco-elastic behaviour of dough. Pressure measurement and fluid metering, Pumping of liquid food.

UNIT -II**10 HOURS**

Heat processing of food: Mechanism of heat transfer, Factors affecting heat and mass transfer. Study of heat exchangers, boiling and condensation, Evaporation. Multiple effect evaporators in sugar and fruit juice industry. Thermal processing as applicable in canning, sterilization, microbial death rates. Batch and continuous processing. Operation of plate heat exchangers, shell and tube and other designs for aseptic processing, HTST, UHT.

UNIT -III**9 HOURS**

Drying: water activity and Microbial growth rate, equilibrium moisture, adsorption isotherms and relation to storage, absolute humidity and relative humidity. Batch Drying, Drying Curves, Drying of milk, fruit juices and liquid foods as well as convective drying for solid foods. Psychrometry- Wet bulb and dry bulb temperature, psychrometry charts.

UNIT -IV**8 HOURS**

Principles of mass and energy balance. Phase change operations - Freezing and thawing. Mechanical refrigeration and refrigerants.

UNIT -V**9 HOURS**

Principles of other food processing such as membrane filtration (ultra, osmosis and reverse osmosis, dialysis), pulsed electric, High Pressure Processing, ohmic heating, Radio Frequency Heating, Food irradiation

Text Books and Reference Materials

1. Fellows, P.J. (2015). Food processing technology. Elsevier India.
2. Singh, Paul R. (2009). Introduction to food engineering. Academic Press.
3. Berk, Zeri. (2009). Food process engineering and technology. Elsevier India.
4. Smith, P.G. "Introduction to Food Process Engineering" Springer, 2005.
5. Gopala Rao, Chandra, "Essential of Food Process Engineering", BS Publications, 2006.
6. Toledo, Romeo T. (2007). Fundamentals of food process engineering. Springer.

UNIT I**9 HOURS**

Research Methodology: Meaning, objectives and types of research, research approaches, Significance of research, Research and scientific methods, research process and criteria of good research definition and identification of a research problem – Selection of research problem, Justification, theory, hypothesis, basic assumptions, limitations and delimitations of the problem.

UNIT II**9 HOURS**

Population and sample – types of statistical data – collection and classification of data – Frequency distribution – Diagrammatic Representation of data – Measures of central tendencies – Mean , Median and Mode: Measures of dispersion – Range, Quartile deviation, standard deviation, Skewness and Kurtosis – Sampling techniques – Simple and Stratified Random Sampling techniques.

UNIT III**9 HOURS**

Elementary Probability Theory – Addition and Multiplication – Bayes Theorem – Random Variables and Probability distribution- Binomial, Poisson, and Normal. Study of relationship between variables – correlation: Simple, Partial, Multiple Correlation (three variables); Regression – Simple, Multiple (three Variables). Measures of association – Chi square test for goodness of fit & contingency table.

UNIT IV**9 HOURS**

Basic concept of hypothesis testing - Type I and type II errors. Tests based on Means & Proportions on Normal. Two way analysis of variance (RBD), LSD, - Multiple comparison tests (DMRT, Bonferonni, Dunnett's).– t test for independent samples, paired samples, F test two sample variances: One-way ANOVA, two-way ANOVA, Correlation & Regression(three variables).

UNIT V**9 HOURS**

Framing Proposal for acquiring grants: The question to be addressed – Rationale and importance of the question being addressed – Empirical and theoretical framework – Presenting pilot study / data or background information - Research proposal and time frame – Specificity of methodology – Organization of different phases of study – Expected outcome of study and its implications – Budgeting - Available infra-structure and resources - Executive summary.

Text books and Reference materials

1. Gurumani N. (2010). Scientific thesis writing and paper presentation. MJP Publishers.
2. Vijayalakshmi G. (2009). Research methods. MJP Publishers.
3. Gurumani N. (2010). Introduction to biostatistics. MJP Publishers.
4. Bandarkar, P.L. and Wilkinson T.S. (2000): Methodology and Techniques of Social Research, Himalaya Publishing House, Mumbai.

5. Copper, H.M. (2002). Intergrating research : A guide for literature reviews (2nd Edition). California: Sage
6. Harman, E & Montages, I. (Eds.) (2007). The thesis and the book, New Delhi : Vistar.

UNIT I

9 HOURS

Introduction, Food Regulations and Standards - Sampling methods - Sample preparation for analysis; Statistical evaluation of analytical data - Official Methods of Food Analysis. Moisture in foods - determination by different methods - ash content of foods, wet, dry ashing, microwave ashing methods; Significance of Sulphated Ash, water soluble ash and acid insoluble ash in foods; titratable Acidity in foods, determination of dietary fiber and crude fiber.

UNIT II

10 HOURS

Determination of Total fat in foods by different methods; Analysis of oils and fats for physical and chemical parameters, Quality standards, and adulterants; different methods of determination of protein and amino acids in foods; determination of total carbohydrates, starch, disaccharides and simple sugars in foods.

UNIT III SPECTROSCOPIC TECHNIQUES

9 HOURS

Basic Principles- Spectrophotometric analysis of food additives and food Components -IR Spectroscopy in online determination of components in foods; AAS and ICP-AES in mineral elements and toxic metals analysis; use of fluorimeter in vitamin assay- specific use of Tintometer in vanaspathi analysis.

UNIT IV

9 HOURS

Chromatographic Techniques- Basic principles and types of:- Paper chromatography, thin layer chromatography, column chromatography, Ion exchange chromatography, HPTLC, HPLC, UHPLC, GC,GC-MS, Types of detectors ,Uses and applications of chromatographic techniques.

UNIT V

8 HOURS

Basic Principles, application of electrophoresis in food analysis, refractive indices of oils and fats, total soluble solids in fruit juice and honey, specific rotation of sugars, estimation of simple sugars and disaccharides by polarimeter; Immunoassay techniques and its applications in foods.

Text books and Reference materials

1. Fung, D.Y.C. and Matthews, R. (1991): Instrumental Methods for Quality Assurance in Foods, Marcel Dekker, Inc. New York.
2. Skoog, D.A., Holler, F.H. and Nieman (1998): Principles of Instrumental Analysis Saunders College Publishing, Philadelphia.

3. Gruenwedel, D.W.; Whitaker, J.R. (editors) (1984): Food Analysis Principles and techniques, Volumes 1 to 8, Marcel Dekker, Inc., New York.
4. Herschdoerfer, S.M. (ed) (1968 – 1987): Quality Control in the Food Industry, Vols. 1 to 4, Academic Press, London.
5. Pomeranz, Y. and MeLoan, C.E. (1996): Food Analysis: Theory and Practice; 3rd Edition, CBS Publishers and Distributors, New Delhi.
6. Wilson and John Walker ,Principles and Techniques of Biochemistry and Molecular Biology (2010), Keith Wilson and John Walker, Cambridge University Press.

UNIT- I**10 HOURS**

Principles of Toxicology: classification of toxic agents; characteristics of exposure; spectrum of undesirable effects; interaction and tolerance; biotransformation and mechanisms of toxicity. Evaluation of toxicity: risk vs. benefit: experimental design and evaluation: prospective and retrospective studies: Controls :Statistics (descriptive, inferential): animal models as predictors of human toxicity: Legal requirements and specific screening methods as per OECD guidelines *in vitro* and *in vivo* studies; clinical trials.

UNIT – II**8 HOURS**

Natural toxins in food: natural toxins of importance in food- toxins of plant and animal origin; microbial toxins (e.g., bacterial toxins, fungal toxins and Algal toxins), natural occurrence, toxicity and significance, determination of toxicants in foods and their management.

UNIT – III**9 HOURS**

Food allergies and sensitivities: natural sources and chemistry of food allergens; true/untrue food allergies; handling of food allergies; food sensitivities (anaphylactoid reactions, metabolic food disorders and idiosyncratic reactions); Safety of genetically modified food: potential toxicity and allergenicity of GM foods. Safety of children consumables.

UNIT – IV**9 HOURS**

Environmental contaminants and drug residues in food: fungicide and pesticide residues in foods; heavy metal and their health impacts; use of veterinary drugs (e.g. Malachite green in fish and β -agonists in pork); other contaminants in food, radioactive contamination of food, Food adulteration and potential toxicity of food adulterants. Endocrine disrupters in food.

UNIT – V**9 HOURS**

Food additives and toxicants added or formed during food processing: safety of food additives; toxicological evaluation of food additives; food processing generated toxicants: nitroso-compounds, heterocyclic amines, dietary Supplements and toxicity related to dose: common dietary supplements; relevance of the dose; possible toxic effects.

Text books/ Resources

1. Klaassen, Curtis; Watkins III, John B. (2015), Casarett & Doull's Essentials of Toxicology, Third Edition, McGraw-Hill Medical, ISBN 10: 0071847081 ISBN 13: 9780071847087.
2. Tõnu Püssa (2013), Principles of Food Toxicology, Second Edition, CRC Press, ISBN 9781466504103.
3. S.S. Deshpande Ed (2013), Handbook of Food Toxicology, CRC Press, ISBN 9780824707606.
4. Helferich, W., and Winter, C.K. (2001) Food Toxicology, CRC Press, LLC. Boca Raton, FL
5. Shibamoto, T., and Bjeldanes, L. (2009) Introduction to Food Toxicology, 2nd Ed. Elsevier Inc., Burlington, MA.
6. Watson, D.H. (1998) Natural Toxicants in Food, CRC Press, LLC. Boca Raton, FL
7. Duffus, J.H., and Worth, H.G. J. (2006) Fundamental Toxicology, The Royal Society of Chemistry
8. Stine, K.E., and Brown, T.M. (2006) Principles of Toxicology, 2nd Ed. CRC Press.
9. Tõnu, P. (2007) Principles of Food Toxicology. CRC Press, LLC. Boca Raton, FL.

UNIT -I**8 HOURS**

General introduction and production and utilization trends; Structure and composition of common cereals, legumes and oilseeds.

UNIT -II**10 HOURS**

Wheat: Types and physicochemical characteristics; wheat milling -products and byproducts; factors affecting quality parameters; physical, chemical and rheological tests on wheat flour; additives used in bakery products; flour improvers and bleaching agents; manufacture of bakery products, pasta products and various processed cereal-based foods; manufacture of whole wheat atta, blended flour and fortified flour. Production of starch and vital wheat gluten.

UNIT -III**9 HOURS**

Rice: Classification, physicochemical characteristics; cooking quality; rice milling technology; by-products of rice milling and their utilization; Rice bran stabilization, oil extraction and refining, parboiling methods of rice criteria of quality of rice: aging of rice – quality changes; processed products based on rice.

UNIT -IV**9 HOURS**

Corn: Types and nutritive value; dry and wet milling, processing of corn in breakfast cereals, snacks, tortilla etc., production of glucose syrups, dextrose, high fructose corn syrups, modified starches.

Barley: composition, milling, malting of barley, chemical and enzymatic changes during malting, uses of malt.

Oat: composition, processing of oat, byproducts of oatmeal milling.

UNIT -V**9 HOURS**

Legumes and oilseeds: composition, anti-nutritional factors, processing and storage; processing for production of edible oil, meal, flour, protein concentrates and isolates; extrusion cooking technology; snack foods; development of low cost protein foods. Oil extraction process – mechanism, solvent, SCE, oil refining, utilization of biproducts of oil milling.

Text books and Reference materials

1. Chakrabarthy, M.M. (2003). Chemistry and Technology of Oils and Fats. Prentice Hall.
2. Dendy, D.A.V., & Dobraszczyk, B.J. (2001). Cereal and Cereal Products. Aspen.
3. Hamilton, R.J., & Bhati, A. (1980). Fats and Oils - Chemistry and Technology. App. Sci. Publ.
4. Hosney, R.S. (1994). Principles of Cereal Science and Technology. 2nd Ed. AACC.
5. Kay, D.E. (1979). Food Legumes. Tropical Products Institute.
6. Kent, N.L. (1983). Technology of Cereals. 4th Ed. Pergamon Press.

1. Water activity and moisture isotherm
2. Specific gravity and Refractive Index
3. Emulsions and foaming properties of proteins
4. Millard Reaction, qualitative test for protein
5. Quantitative estimation of protein by biuret method, factors affecting protein quality
6. Fehling's test for reducing sugars, Microscopic examination of starch
7. Starch Gels, Viscosity curves of starch pastes
8. Lipids: Solubility, specific gravity and refractive index of fats,
9. Water absorption and plasticity of fats, Oxidative rancidity

1. Preparation of common laboratory media and special media.
2. Staining: Gram's staining, acid-fast, spore, capsule and flagellar staining, Motility of bacteria, Staining of yeast and molds..
3. Identification of important molds and yeast.
4. Microbiology of milk.
5. Microbiology of water.
6. Microbiology of hand and effect of sanitation on the hand microbiology in a small food joint.
7. Microbiological analysis of typical processed food.
8. Microbiological analysis of a typical unprocessed food.
9. Isolation of specific culture.

1. Blanching and browning control
2. Preparation of fruit preserves (jam, jelly).
3. Preparation of vegetable preserves (pickle)
4. Dehydrated products – vegetables dices tray drying, osmotic dehydration of seasonal fruit.
5. Tomato processing
6. Fruit pulping / juice / beverage preparation
7. Preparation and standardization of traditional Indian fermented foods
8. Bread making - texture.
9. Confectionery

1. Physical-tests on wheat and rice
2. Physicochemical and rheological properties;
3. Determination of gluten content in wheat flour;
4. Conditioning of wheat; Milling of wheat and rice by laboratory mill;
5. Parboiling of rice;
6. Quality tests of rice: Amylose content determination in rice;
7. Malting, puffing and popping of grains;
8. Preparation of protein concentrates and isolates and their evaluation for protein content and solubility;
9. Extraction of oil using expeller and solvent extraction methods

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II	FS&T431	Food Plant Equipment	HC	3	
	FS&T432	Enzymes in Food Processing	HC	3	
	FS&T433	Food Product Development and Quality Evaluation	HC	3	
	FS&T434	Fermentation Technology	HC	3	
	FS&T435	Pollution in Food Industries	SC	3	
	FS&T446	Nutraceuticals and Functional Foods	SC	3	
	FS&T447	Baking and Confectionery Technology	SC	3	
	LAB				
	FS&T456	Food Product Development and Quality Evaluation Lab	HC	1	
	FS&T457	Enzyme Technology and Down Stream Processing Lab	HC	1	
FS&T458	Baking and Confectionery Technology Lab	SC	1		

UNIT -I**9 hours**

Milling Equipments : Types of equipment used for milling rice and wheat, pearling and flaking equipment; dhal mills.

UNIT -II**11 hours**

Washing, Filtration & Centrifugation equipment. Different Fruits and Vegetable washing systems; Filtration of liquid foods (dairy, fruit & vegetables); centrifugation systems: Solid bowl and disc bowl centrifuges; cyclone separator and self cleaning centrifuge. Conveyor belts - types, material of construction, product specific conveyors. Screw, bucket, belt, oscillating and vibratory conveyors.

UNIT -III**9 hours**

Heat Processing & Cooling Equipments: Heat exchangers – Plate, shell and tube etc. Autoclaves - types, operation; Different Dryers and freezers – Tray, tunnel, Fluidized. Spray dryer, Blast and IQF, Freezers, short tube and pan evaporators.

UNIT -IV**9 hours**

Mixing, Blending. extrusion & Filling Equipments: Agitation and mixing of liquid foods, powders and pastes; Mixers - ribbon blenders, augur, nauta, cone.

Cold and hot extruders, single screw, twin screw, extrusion cooking.

UNIT -V**10hours**

Screening; Types of screens; Grizzly; Revolving screen; Shaking screen, Rotary screen, Vibratory screen; Horizontal screen; Perforated metal screens; Wiremesh screens; Ideal and Actual screens; Effectiveness of screen; Air-screen cleaners; Separators

Storage: Direct damages; Indirect damages; Sources of infestation; Traditional storage structures; Improved storage structures; Modern storage structures; Storage of agricultural perishables; Controlled and modified atmosphere storage.

Text Books and Reference materials

1. Chen, Xiao Dong ed. (2008). Drying technologies in food Processing. Blackwell.
2. Sahay, K M. (2008). Unit operations of agricultural processing. Vikas publishing house.
3. Saravacos, George D. (2006). Handbook of food processing equipment. Springer.
4. Lopez – Gomez, A. and Barbosa – Canovas, G.V. “Food Plant Design”, Taylor & Francis, 2005.

5. Smith, P.G. “Introduction to Food Process Engineering”, Springer, 2005.
6. Rao, M.A. Rizvi, S.S.H. and Datta, A.K. “Engineering Properties of Food”, 3rd Edition, Taylor & Francis, 2005.
7. Sahay, K.M. and Singh, K.K. Unit operations of agricultural processing. Vikas Publishing house Pvt. Ltd., 2001

UNIT -I**9 HOURS**

Enzymes classification, properties, characterization, kinetics and immobilization; fermentative production of enzymes (amylases, proteases, cellulases, pectinases, xylanases, lipases) used in food industry and their downstream processing.

UNIT -II**9 HOURS**

Enzymes for starch modification (maltodextrins and corn syrup solids :liquefaction, saccharification, dextrinization, isomerization for production of high-fructose-corn-syrup, fructose and fructo-oligosaccharides). Enzymes for protein modification(hydrolysates and bioactive peptides), Enzymes for Lipid modification.

UNIT III**9 HOURS**

Enzymes as processing aids: Role of enzymes in Dairy processing (cheese making and whey processing). Role of enzymes in meat processing (tenderization and flavour development) and fish processing(De-skinning, collagen extraction etc.,) Egg processing.

UNIT IV**9 HOURS**

Role of enzymes in Brewing, Baking (fungal -amylase for bread making; maltogenic -amylases for anti-staling; xylanases and pentosanases as dough conditioners; lipases or dough conditioning; oxidases as replacers of chemical oxidants; synergistic effect of enzymes);

UNIT V**9 HOURS**

Role of enzymes in the production of flavours (enzyme-aided extraction of plant materials for production of flavours, production of flavour enhancers such as nucleotides, MSG; flavours from hydrolyzed vegetable/animal protein)

Text books and References

1. Whitehurst,R.J. & Van-Oort,M., (2010), Enzymes in Food technology, Second edition, Blackwell Publishing Ltd
2. Aehle, W. (2007) Enzymes in Industry: Production and application. Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim
3. Rastall,R (2007) Novel enzyme technology for food applications Woodhead Publishing Limited, Abington Hall, Abington, Cambridge CB21 6AH, England
4. Kalaichelvan, P.T., (2002), Bio process technology, MJP publishers, Chennai

UNIT I

8 HOURS

FOOD NEEDS & CONSUMER PREFERENCE - Market survey and its importance in; designing a questionnaire to find consumer needs for a product or a concept. Developing a Product to Meet the Requirements. Product life cycle. Creating brand value for the Product. The SWOT analysis

UNIT II

10 HOURS

DESIGNING NEW PRODUCTS - New Food Product Development (NPD) process and activities, The Stage-Gate model 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; involvement of consumers, chefs and recipe experts; selection of materials/ingredients for specific purposes; modifications for production on large scale, cost effectiveness and return on investment, nutritional needs or uniqueness; use of novel food ingredients and novel processing technologies.

UNIT III

9 HOURS

STANDARDIZATION & LARGE SCALE PRODUCTION - Process design, equipment needed; 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 HOURS

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 HOURS

PRODUCT COMMERCIALIZATION, LAUNCH, EVALUATION & CASE STUDIES -

Outcomes and activities in product commercialization, Pre-launch trial, Steps in product launch, Evaluation of the Launch, product performance testing, developing test market strategies, Case Studies of some successes and failures, food choice models and new product trends.

REFERENCES

1. Jacqueline H. Beckley, M. Michele Foley Elizabeth J. Topp & J. C. Huang Witoon Prinyawiwatkul (2007). Accelerating New Food Product Design and Development. Blackwell Publishing Company. IFT Press. USA
2. Howard R. Moskowitz, I. Sam Saguy & Tim Straus (2009). An Integrated Approach to New Food Product Development. Taylor and Francis Group, LLC. USA
3. Mary Earle and Richard Earle (2008). Case studies in food product development Wood head Publishing Limited and CRC Press LLC. USA
4. Creating New Foods. The Product Developer's Guide: Marie D. Earle and Richard L. Earle (2001). Chadwick House Group Ltd. New Zealand.
5. David H. Lyon, Mariko A. Francombe, Terry A. Hasdell and Ken Lawson (1992). Guidelines for sensory analysis in food product development and quality control. Chapman & Hall, 2-6 Boundary Row, London.

UNIT I**9 HOURS**

Fermentation, types of fermentation, Fermentation Pathways for Industrial Products: Biochemical pathways of metabolic reactions for utilization of carbon sources and formation of different metabolites by microorganisms; Strain Development -Various techniques of modifying the strains for increased production of industrial products. Use of chemicals, UV rays, genetic engineering to produce newer strains.

UNIT II**8 HOURS**

Typical media, Media formulation:-Carbon Source, Nitrogen source, Minerals, Growth Factors, Buffers, Precursors and Inhibitors, O₂ requirement and antifoams.

UNIT III**8 HOURS**

Fermenter design, Instrumentation and control, Types of fermenters (Shake flask, Batch/stir tank, Continuous, Bubble column, airlift and Tower fermenter), Types of fermentation processes, aeration and agitation (The oxygen requirement for industrial fermentation, Determination of K_{La} values).

UNIT IV**10 HOURS**

Downstream Processing: Various equipment for product recovery; micro-filters and Ultrafiltration systems for separation of cells and fermentation medium and for concentration of medium containing product; chromatographic systems of separation; extraction of product with solvent; evaporation and crystallization; centrifugation, different types of centrifuges; drying techniques; instrumentation and controls.

UNIT V**9 HOURS**

Fermentative Production: **a) Foods:** Processes for preparing fermented products including Yogurt (curd) and other Traditional Indian Products like idli, dosa, dhokla, shrikhand,, Soya based products like soya sauce, natto,, , Cheese.; Alcoholic Beverages based on fruit juices (wines), cereals (whisky, beer, vodka.), sugar cane (rum) Process description, quality of raw materials, fermentation process controls.

b) Industrial chemicals: Fermentative Production of Organic acids

Text books and Reference material

1. Shikha, O, K Tiwari, Brijesh K (Eds.). 2016. *Novel Food Fermentation Technologies*. Springer International Publishing
2. Stanbury, P.F., A. Whitaker and S.J. Hall, 2016, *Principles of Fermentation Technology* Butterworth-Heinemann, Elsevier publishers
3. Vogel, H.C. and C.L. Todaro, 2005 *Fermentation and Biochemical Engineering Handbook : Principles, Process Design and Equipment*, 2nd Edition, Standard Publishers.
4. El-Mansi, E.M.T, 2007, *Fermentation Microbiology and Biotechnology* 2nd Edition, CRC / Taylor & Francis.
5. Joshi, V.K. and Ashok Pandey, 1999, *Biotechnology: Food Fermentation, Microbiology, Biochemistry and Technology*, Vol. I & vol. II Educational Publisher.
6. Pepler, H.J. and D. Perlman, 2004, *Microbial Technology : Fermentation Technology*, 2nd Edition, Vol. II Academic Press / Elsevier.

UNIT -I**9 HOURS**

Environment and Pollution: Components of environment; Environmental pollutions, its measurements and management; Air pollution and its control: Air duct design and room air distribution; air conditioning systems; important pollutants of air; properties of particulate matter. Biofuels and non - conventional energy

UNIT -II**8 HOURS**

Xenobiotic compounds; Organo chloride Pesticides and pest management; processes; Microorganisms as components of the environment; microorganisms as indicators of environmental pollution; bioorganic pollution; microbial toxicants and pollutants, and their bio-degradation; biodegradation of plastics, biofouling and biofilms; bioremediation, toxic metals/metalloids- Arsenic and lead.

UNIT -III**10 HOURS**

Water pollution and its control-Waste water sources characteristics - standards for disposal of water, physical, chemical and biological characteristics of waste water; measurement of organic content in waste water; Physical UNIT operations in waste water treatment - screening; racks, mixing, flocculation, sedimentation, floatation, elutriation, vacuum filtration, incineration; chemical UNIT operations in waste water treatment - reaction kinetics; chemical precipitation, aeration and gas transfer process, rate of gas transfer, adsorption, disinfection; biological UNIT operations - aerobic and anaerobic.

UNIT -IV**9 HOURS**

Storage & Disposal of Waste: Types of waste generated; Non- degradable & biodegradable wastes, Solid waste storage and disposal methods- land-filling, burial, incineration, recycling; Biological treatment of food industry wastes, storage and disposal of liquid and gaseous waste; legal aspects related to storage and disposal; environmental laws and regulations.

UNIT -V**9 HOURS**

Utilization of Waste: Methods of utilizing wastes to make value added products CASE STUDIES: Pectin, food colorants, antioxidants from fruit peels (citrus, mango, and pomegranate), lycopene from tomato peels, vegetable seed oils, biomolecules and enzymes from meat processing. Generation of biogas, SCP, microalgae, animal feeds, zero emission plants; recovery & recycling of materials.

References

1. Eckenfelder, W. W. Jr., "Industrial Water Pollution Control", 3rd Edn., McGraw Hill, Boston, MA, 2000
2. Roday, S. "Hygiene and Sanitation in Food Industry", Tata McGraw – Hill Publishing, 1999.
3. Frank Kreith, George Tchobanoglous. "Handbook of Solid Waste Management", 1994.
4. Wilson, C.L. "Microbial Food Contamination", 2nd Edition, CRC, 2008.

UNIT -I**9 HOURS**

Nutraceuticals and functional Foods –Definition, concept, history and market; Evolution of nutraceuticals and functional foods market. Classification of nutraceuticals and functional foods. Significance and relevance of nutraceuticals and functional foods in the management of diseases and disorders.

UNIT -II**9 HOURS**

Natural occurrence of certain phytochemicals- Antioxidants and flavonoids: omega – 3 fatty acids, carotenoids, dietary fiber, phytoestrogens; glucosinates; organosulphur compounds. Dosage for effective control of disease or health benefit with adequate safety; studies with animals and humans; acute and chronic studies. Regulatory issues.

UNIT -III**9 HOURS**

Isolation of phytochemicals from plant materials: Care in handling and storage of raw materials with minimal damage to sensitive bioactive compounds; Extractive methods for maximum recovery and minimal recovery and minimal destruction of active material; stability studies. Recent developments in the isolation, purification and delivery of phytochemicals.

UNIT -IV**9 HOURS**

Prebiotics, probiotics and symbiotics- Probiotics: Definition, types and relevance; Usefulness in gastro intestinal health and other health benefits; development of a probiotic products; recent advances in probiotics; Challenges and regulatory issues related to probiotic products. Prebiotics: Prebiotic ingredients in foods; types of prebiotics and their effects on gut microbes; health benefits of prebiotics; recent development in prebiotics. Synbiotics.

UNIT -V**9 HOURS**

Functional foods - Definition, development of functional foods, use of bioactive compounds in appropriate form with protective substances and activators; Effect of environmental condition and food matrix; Effects of processing conditions and storage; Development of biomarkers to indicate efficacy of functional ingredients; Research frontiers in functional foods; delivery of immunomodulators /vaccines through functional foods. Nutrigenomics-concept of personalized medicine.

Text Books and Reference materials

1. Wildman, Robert. *Nutraceuticals and Functional Foods*, second edition. Taylor and Francis Group. 2007.
2. Gibson GR & William CM. *Functional Foods - Concept to Product*. 2000.
3. Goldberg I. *Functional Foods: Designer Foods, Pharma Foods*. 1994.
4. Brigelius-Flohé, J & Joost HG. *Nutritional Genomics: Impact on Health and Disease*. Wiley VCH. 2006.
5. Cupp J & Tracy TS. *Dietary Supplements: Toxicology and Clinical Pharmacology*. Humana Press. 2003.

UNIT-I**10 HOURS**

INTRODUCTION: Raw materials required for bread making and their functional properties. Essential ingredients: Flour, yeast, water, salt. Other ingredients: Sugar, colour, flavor, fat, milk and milk powder and bread improvers. Functions of various raw materials used in baking industries Materials of Baking. Leaveners and yeast foods, shortenings, emulsifiers and antioxidants, Sweeteners and, water and salt, Ingredients from milk and eggs. Fruits, vegetables, and nuts, Spices, flavors and colors.Preservation methods.

UNIT-II**8 HOURS**

BAKERY EQUIPMENT: Introduction to utensils and equipments used in bakery UNIT and their uses small equipments, big equipments and oven. Bulk handling of ingredients, Dough mixing and mixers, dividing, rounding, sheeting, and laminating, fermentation enclosures and brew equipment.Ovens and Slicers, Packaging materials and equipment.

UNIT-III**10 HOURS**

BREAD MANUFACTURING PROCESS: Straight dough fermentation, Sponge and dough, Accelerated processing. Chorley wood bread process, Dough retarding and freezing, Stages in processing of bread and bread making methods and advantages and disadvantages of various methods of bread-making. Characteristics of good bread: Internal characters; external characters. Bread defects/faults and remedies. Spoilage of bread Causes, detection and prevention. Preparation pastries and pie – types of pastries – different methods of making pastries – methods of lamination process in pastries.

UNIT-IV**9 HOURS**

BISCUITS AND COOKIES: Production of cakes and cookies/biscuits. Types of biscuit dough's – Developed dough, short dough's, semi-sweet, enzyme modified dough's and batters –importance of the consistency of the dough. Cake making: Ingredients and their function structure builders. Tenderizers, moisteners and flavor enhancers – Selection and preparation of mould Temperature and time required for different type of cake, problems of baking.

UNIT-V

8 HOURS

CONFECTIONERY PRODUCTS: Definition, importance of sugar confectionery and flour confectioner. Types of confectionery products-chocolate boiled sweets caramels toffees.Fondants.Manufacturing process and spoilage of confectionery products. Good manufacturing practices (GMP) in baking and confectionery industries. Computerization in plant and laboratory, Sanitation and safety.

Text Books and Reference materials

1. Matz, Samuel A., “Bakery Technology and Engineering”, Third Edition, Chapman & Hall, London,
2. Cauvain, Stanley P, and Yound, Linda S., “ Technology of Bread Making”, Second Edition Aspen publication, Maryland, 2005.
3. Pomeranz. Y. “Modern Cereal Science and Technology”. MVCH Publications, New York.2003.
4. Samuel A., Matz., “ Equipment for Bakers”, Pan Tech International Publication, 2009.
5. Manley, Duncan., “ Biscuit Doughs Manual 2”, Woodhead Publishing Ltd., England. 2009.

FS&T456 FOOD PRODUCT DEVELOPMENT AND QUALITY EVALUATION LAB CREDIT 1

Survey on types of convenience foods / consumer behavior / analysis of food labeling

Group projects to Develop Food Products at Laboratory scale

Project Identification: Products/Processes Review, Project Feasibility, Design and Product Specification

Project Planning: Identifying Objectives, Identifying Tools/Methods, - Permutation and Combination, Response Surface Methodology, Use of Information/ Communication Technology

Project Execution: Product Trials and Standardization, Evaluation of product- Analysis of Physical and Chemical Properties and Sensory Evaluation

Project Presentation: Documentation and Report, Viva Voice

1. Effect of pH & temperature on enzymes
2. Separation of enzymes - SDS Page
3. Effect of inhibitors on the activity of enzymes
4. Immobilization of enzyme by entrapment and comparison with free enzyme
5. Enzymes in meat tenderization
6. Downstream processing –precipitation- organic solvents, salts, Thin layer chromatography, column chromatography
7. Extraction of alkaline phosphatase from liver.
8. Extraction of lipase from plants
9. Estimation of lipase activity

1. Study of ingredients (major and minor): Characteristics of flour, yeast, shortening, sugar, egg and salts.
2. Experiment on leavening action of baking powder, sodium-bicarbonate and ammonium-bi-carbonate.
3. Estimation of gluten content (atta and maida)
4. Estimation of water absorption power (atta and maida)
5. Determination of yeast-ferment test and dough rising capacity
6. Studies of flour and dough characteristics
7. Preparation of biscuits – different types
8. Preparation of cookies-different types
9. Preparation toffees.
10. Preparation sugar boiled confectionary.
11. Preparation of chocolates, fruit drops.
12. Preparation of fruit toffees candies and preserves.
13. Preparation of pastries and pie
14. Determination of friction factor for dough and batter

PONDICHERY UNIVERSITY
Department of Food Science and Technology

M.Sc Food Science and Technology

Semester	Course Code	Title of the Course	Category	Credits	
III	FS&T511	Food Biotechnology and Nanotechnology	HC	3	
	FS&T512	Food Packaging	HC	3	
	FS&T513	Food safety and Quality Control	HC	3	
	FS&T514	Technology of Animal Products	HC	3	
	FS&T515	Technology of Spices and Plantation Products	HC	3	
	FS&T527	Food Plant Organization and Management	SC	3	
	FS&T528	Food laws and Regulations	SC	3	
	FS&T529	Technology of Fruits and Vegetables	SC	3	
	FS&T530	Food Additives	SC	3	
	FS&T531	Food industry waste management and By product utilization	SC	3	
	LAB				
	FS&T551	Technology of Animal Products Lab	HC	1	
	FS&T552	Technology of Spices and Plantation Products Lab	HC	1	
	FS&T523	Technology of Fruits and Vegetables Lab	SC	1	
FS&T524	Food safety and Quality Control Lab	SC	1		

FS&T511 FOOD BIOTECHNOLOGY AND NANOTECHNOLOGY CREDIT 3

UNIT -I

9 HOURS

Basic principles of molecular biology and biotechnology: Introduction to Genetics, Population & Evolutionary genetics, Gene Mapping. Microbial gene transfer mechanisms, Mutation, Types of mutations, Molecular mechanism of mutations, practical applications, DNA repair Mechanisms, Recombinant DNA Technology. Nutrogenomics - concept, working, significance and relevance. Biosensors and novel tools and their application in food science.

UNIT -II

9 HOURS

Traditional applications of biotechnology in food - Fermented foods: eg dairy products, oriental fermentations, alcoholic beverages, and food ingredients. Health benefits of fermented foods. Types of fermented foods and importance of food fermentation in food preservation and nutritional enhancement. Examples of genetically modified crops- Bt brinjal , Bt maize and golden rice.

UNIT -III

9 HOURS

Plant and animal culture, transgenic plants, application of genetic engineering in food science and technology. Genetically modified foods – concept, types and application- Regulations concerning Genetically Modified Foods in India and at the International level; Ethical issues concerning GM foods; testing for GMOs; current guidelines for the production, release and movement of GMOs; labeling and traceability; trade related aspects; bio safety; risk assessment and risk management. Public perception of GM foods.IPR.

UNIT -IV

9 HOURS

Introduction to Nanotechnology: Characteristic scale for quantum phenomena, nanoparticles, nano-clusters, nanotubes, nanowires and nanodots. *Nanobiotechnology*: Nanoparticles and nucleic acid and protein based recognition groups – application in optical detection methods – Nanoparticles as carrier for genetic material - nanobioelectronic devices and polymer nanocontainers – microbial production of inorganic nanoparticles – magnetosomes.

UNIT -V

9 HOURS

Biological synthesis of nanoparticles: Biosynthesis of Nanoparticles: Biomineralization -Microbial Nanoparticle production. Biofunctionalizaion of gold nanoparticles – phospholipids polymer nanoparticles – magnetic nanoparticles–metallic nanoparticle. Application of nanotechnology in food Science in brief: Nanosensors for microbial, chemical contaminants; Foods incorporated with nanoscale antimicrobial compounds, antioxidants and flavours which would improve shelf-life or sensory characteristics such as flavour, odour.

Text books and reference materials

1. Dubey, R.C. “Textbook of Biotechnology” Chand publishing. 2009.
2. Kalaiselvan, “Bioprocess technology” MJP Publishers, 2007.
3. Glenn R. Gibson and Marcel Roberfroid “Handbook of Prebiotics”, CRC Press, 2008
4. Shanmugham,S. “Nanotechnology” MJP publishers. 2011.

UNIT I**9 HOURS**

Introduction to food packaging: Packaging terminology- definition . Functions of food packaging, Packaging environment. Characteristics of food stuff that influences packaging selection.

UNIT II**9 HOURS**

Packaging material and their properties: Glass, Paper and paper board, Corrugated fibre board (CFB), Metal containers: Tin Plate and Aluminum, Composite containers, Collapsible tubes, Plastic Films, Laminations, Metalized films, Co extruded films, Testing of packaging material.

UNITs III**9 HOURS**

Packaging Systems and methods: Vacuum Packaging, Controlled atmospheric packaging, Modified atmospheric packaging, Aseptic Packaging, Retort processing, Microwave packaging, Active Packaging, intelligent packaging, ecofriendly Edible packaging, Shrink and stretch packaging.

UNIT IV**9 HOURS**

Packaging of fresh and processed foods: Packaging of Fruits and vegetables, Fats and Oils, Spices, meat, Poultry and sea foods, Dairy Products, Bakery, beverages, Dehydrated and frozen foods. Liquid and powder filling machines – like aseptic system, form and fill (volumetric and gravimetric), bottling machines. Form Fill Seal (FFS) and multilayer aseptic packaging machines.

UNIT V**9 HOURS**

Packaging Design & Environmental Issues in Packaging: Food marketing and role of packaging- bar coding, Migration in food packaging. FSSAI regulations for packaging and food labeling.

Text Books and Reference materials

1 Miquel Angelo P R C, Ricardo Nuno C P, Oscar Leandro D S R, Jose Antonio C T, Antonio Augusto V , 2016, Edible Food Packaging: Materials and Processing Technologies, CRC Press. Taylor & Francis ,Boca Raton , FL

2 Luciano P, Sara L,2016, Food Packaging Materials, Springer cham Heidelberg, New york

3. Robertson, G.L. 2006 Food Packaging: Principles and Practice (2nd ed.), Taylor & Francis
4. NIIR. (2003). Food Packaging Technology Handbook, National Institute of Industrial Research Board, Asia Pacific Business Press Inc.
5. Ahvenainen, R. (Ed.) 2003 Novel Food Packaging Techniques, CRC Press,
6. Han, J.H. (Ed.) 2005 Innovations in Food Packaging, Elsevier Academic Press,
7. Coles, R., McDowell, D. and Kirwan, M.J. (Eds.) 2003 Food Packaging Technology, CRC Press

UNIT I**9 HOURS**

Food safety concept - Importance of food safety in the food processing industry Risk classification, National and international food regulatory agencies, General food laws and food safety regulations, Nutritional labeling regulation (mandatory and optional nutrients, nutritional descriptors and approved health claims); Microbial contamination (including cross-contamination/indirect contamination) Chemical contamination, Physical contamination, Allergen contamination

UNIT II**9 HOURS**

Food Safety Programs: Definitions and importance, Good Manufacturing Practices (GMPs), Pest Control Program, Facility Maintenance, Personal Hygiene, Supplier Control, Sanitary Design of Equipment and Infrastructure, Procedures for Raw Material Reception, Storage and Finished Product Loading, Sanitation Program. (Sanitation Standard Operating Procedures (SSOPs)., Product Identification, Tracking and Recalling Program, Preventive Equipment Maintenance Program, Education and Training Program

UNIT III**9 HOURS**

Hazard Analysis and Risk Assessment: Physical hazards (metals, glass, etc), Chemical hazards (food additive toxicology, natural toxins, pesticides, antibiotics, hormones, heavy metals and packaging components), Biological hazards (epidemiology of biological pathogens: virus, bacteria and fungi), Evaluation of the severity of a hazard Controlling Food Hazards . Hazard Analysis Critical Control Point (HACCP) system.

UNIT IV**8 HOURS**

Food Hygiene Programs: Personal hygiene, Training programs, Infrastructure, Personal habits, Hygiene verification, Water in the food industry, Water sources, Water uses, Water quality, Treatments, Cleaning and sanitation, Cleaning agents, Sanitizing agents, Equipment and systems, Evaluation of sanitation efficacy,. Pest Control, Pest Classification (insects, rodents and birds), Prevention and control

UNIT V**10 HOURS**

Food safety regulation in India: An overview of Food Regulation in India; Food Laws and Regulations; Structure, organization and duties of regulatory system; Duties and responsibilities of food business operator; Registration and Licensing process and requirements; Labeling of Food Products; Traceability; Import and Export of Foods; Liability for Defective Products; Food safety management systems and certifications; Regulation of special category Foods: Regulation of Irradiated foods; Regulation of Biotechnology and Genetic Modifications; Regulation of Dietary Supplements, Functional Foods and Nutraceuticals.

Text books and Reference materials

1. Food Safety and standards Act 2006, Rules 2011, Regulations, 2011, 10th Edition, ILBCO India, Indian Law Book Company, 2013.
2. Early, R. (1995): Guide to Quality Management Systems for the Food Industry, Blackie, Academic and professional, London.
3. Gould, W.A and Gould, R.W. (1998). Total Quality Assurance for the Food Industries, CTI Publications Inc. Baltimore.
4. Pomeraz, Y. and MeLoari, C.E. (1996): Food Analyasis: Theory and Practice, CBS publishers and Distributor, New Delhi.
5. Bryan, F.L. (1992): Hazard Analysis Critical Control Point Evaluations A Guide to Identifying Hazards and Assessing Risks Associated with Food Preparation and Storage. World Health Organisation, Geneva.
6. Kirk, R.S and Sawyer, R. (1991): Pearson's Composition and Analysis of Foods, Longman Scientific and Technical. 9th Edition, England.
7. FAO (1980): Manuals of Food Quality Control. 2-Additives Contaminants Techniques, Rome.
8. FSSAI, FSIS, EU and FAO website for updates

UNIT I**8 HOURS**

Meat composition from different sources; muscle structure and compositions; post-mortem muscle chemistry; Factors influencing the quality of meat. Meat Microbiology and safety.

UNIT II**10 HOURS**

Slaughter house operations-Hoisting rail and traveling pulley system; .Modern abattoirs, typical layout and features, Ante mortem inspection and handling , Stunning types, Slaughtering types. Steps in slaughtering (Pig, Cattle, Sheep/ Goat) and dressing. Offal handling and Post-mortem inspection. Grading of meat- retail and whole sale cuts. Operational factors affecting meat quality. Byproduct utilization . Meat plant hygiene – GMP and HACCP.

UNIT III**8 HOURS**

Processing and preservation of meat: Chilling and freezing of meat, Canning, cooking, drying, pickling, curing and smoking; prepared meat products like sausages, kebabs, etc.. Intermediate moisture and dried meat products, Packaging of meat products.

UNIT IV**10 HOURS**

Poultry: methods of slaughtering, Slaughtering equipment and operations, dressing, handling, storage and preservation of poultry meat . Spoilage and its control. Freezing and chilling of poultry. Whole sale and retail cuts.

Eggs: Composition , handling , candling, washing, coating, packaging and storage. Egg processing (Egg powder manufacturing, pasteurization, etc., Spoilage and its control.

UNIT V**9 HOURS**

Commercially important marine products from India, Proximate composition, Post mortem changes in fish muscle . Handling, Preservation and transportation of fish. Indices of fish quality, Microbiology of fish and shell fish , Freezing of fish and shell fish. FSSAI guidelines on FSMS compliance for meat and meat products

Text books and References

1. Sahoo, J & Chatli, M. K. 2016 Textbook on meat, Fish and Poultry Technology, Daya publ., New Delhi.
2. Collins,D. S, Huey, R.J, 2015 Gracey's meat Hygiene , John Wiley & Son Ltd, UK
3. Sam, A.R, 2001, *Poultry meat processing* CRC Press Taylor & Francis Group
4. Hui YH. 2001, *Meat Science and Applications*. Marcel Dekker.
5. Kerry, J. 2002, *Meat Processing*. Woodhead Publ. CRC Press.
6. Levie A. 2002, *Meat Hand Book*. 4th Ed. AVI Publ.
7. Mead M. 2004. *Poultry Meat Processing and Quality*. Woodhead Publ.

8. Pearson, A.M. & Gillett, T.A. 2006. *Processed Meat*. 3rd Ed. Chapman & Hall.
9. Lawrie, R.A. 2006. *Meat Science* 7th Edn. Woodhead publishers .UK.
10. Legarreta,I.G. (2010). *Handbook of Poultry Science and Technology* (Volume I and Volume II), John Wiley & Sons, Inc., Hoboken, New Jersey. U.S

UNIT -I**10 HOURS**

Coffee: Occurrence, chemical constituents; harvesting, fermentation of coffee beans; changes taking place during fermentation; drying; roasting; process flow sheet for the manufacture of coffee powder; instant coffee technology; chicory chemistry; quality grading of coffee.

UNIT -II**10 HOURS**

Tea: Occurrence, chemistry of constituents; harvesting; types of tea – green, oolong and CTC; chemistry and technology of CTC tea; manufacturing process for green tea and black tea manufacture; instant tea manufacture; quality evaluation and grading of tea.

UNIT -III**10 HOURS**

Cocoa: Occurrence, chemistry of the cocoa bean; changes taking place during fermentation of cocoa bean; processing of cocoa bean; cocoa powder; cocoa liquor manufacture; chocolates–types, chemistry and technology of chocolate manufacture; quality control of chocolates.

UNIT -IV**10 HOURS**

Major spices: Pepper, cardamom, ginger, chili and turmeric–Oleoresins and essential oils; method of manufacture; chemistry of the volatiles; enzymatic synthesis of flavour identicals; quality control; fumigation and irradiation of spices.

UNIT -V**5 HOURS**

Other plantation crops processing: vanilla, coconut, cashew, Oil palm, arecanut, palmera.

Text Books and Reference Materials

1. Banerjee B. 2002. *Tea Production and Processing*. Oxford Univ. Press.
2. Minifie BW. 1999. *Chocolate, Cocoa and Confectionery Technology*. 3rd Ed. Aspen Publ.
3. NIIR. 2004. *Handbook on Spices*. National Institute of Industrial Research Board, Asia Pacific Business Press Inc.

FS&T527 FOOD PLANT ORGANIZATION AND MANAGEMENT CREDIT 3

UNIT -I

9 HOURS

Operation Research , definition and scope, techniques in operation research. Food plant management . Factors bearing on location and layout of food plants. Regulatory requirements of food industries.

UNIT -II

9 HOURS

Structure and operation of food plants. Executive design making in a food plant. Decision protocols. Evolution and role of management planning , organising and controlling. Decision processed for raising efficiency, productivity and quality in food plant operation. System analysis, its need and methodology.

UNIT -III

9 HOURS

Model building- deterministic and probabilistic models. Management decision making, problems of productions, production intending, marketing-sales forecasting, inventory , finance-Break down maintenance, inventory, finance replacement and maintenance , inventory, finance replacement and maintenance .

UNIT -IV

9 HOURS

Network models.. Computer applications, database operating systems, networking project management, spread sheeting and Statistical Quality Control (SQC).

UNIT -V

9 HOURS

Industrial cost accounting, purchase procedure, stores procedure, material accounting, overhead costing, budget and budgetary control, process costing,. Cost factor in fixation of prices, job costing and product costing.

Text Books and Reference Materials

1. Brody, Aaron L ed.,(2008). .Developing new food products for a changing market place. CRC Press
2. Baisya, Rajat Kanti. (2008). Changing face of processed food industry in India. Ane Books India
3. Sivarethinamohan, R. Operations Research. Tata McGraw_Hill Pub. Co. Ltd., 2005
4. Metha, P.L. 2003. Managerial Economics- Analysis, Problems and cases, Sultan Chand and Sons, New Delhi.
5. Sherilaker,2001. Marketting management. Himalaya Publishing Company.

UNIT -I**8 HOURS**

Historical Perspectives including necessity of Food Laws. Establishment of US Pure Food Law in early 1900s and of Food & Drug Administration to enforce safety of food products; Urbanisation of population and necessity of processed and preserved foods and the necessity of ensuring quality of food to prevent adulteration

UNIT -II**11 HOURS**

Food Quality, Safety & Testing: Quality of Foods and Quality Standards like BIS; Agmark and other optional standards; the difference between mandatory and optional standards; enforcement of optional standards; Food Safety Systems: Quality systems standards including ISO; Auditing; Good Manufacturing Practice and HACCP. Various ways of testing the safety of foods; Detection of harmful chemicals and microbes in foods; Testing of ingredients and additives; using animals for evaluating safety; Clinical studies. Responsibility of agriculture, food industry & food supply sector; Standards of Weights & Measures, British Regulatory Consortium(BRC), American Institute of Bakers(AIB) and some provisions under these regarding food products such as requirements of labelling and giving information therein, size of packages etc. Important Issues of GM Foods, Fortification, Nutrition Information on Label, Organic Foods, Safety of Additives, Processes etc. affecting consumers and industry.

UNIT -III**10 hours**

Food Laws & Implementing Agencies-National: Prevention of Food Adulteration Act 1954 & Rules 1955 established in India to enforce safety and purity of food products; Various aspects of defining adulteration, taking samples of food for analysis by public analyst, prosecution for adulteration and punishment; Standards of various food products; FPO; Infant Milk Substitute Act; Laws relating to vegetable oils; Use of permitted additives like colours, preservatives, emulsifiers, stabilisers, antioxidants. Food Safety & Standards Act 2006 and the provisions therein; Integrated Food Law - Multi departmental - multilevel to single window control system, consumer protection Act

UNIT -IV**8 HOURS**

International Scenario in Food Regulation USFDA, EFSA, UK, Canada, A & NZ, Japan, Malaysia, Singapore; Consumer Movements; Intellectual Property Rights and Trade Marks: Protection of investment and efforts in research and development by patenting; Criteria of patentability; National and international patent; Terms of patents; Copyright.

UNIT -V**8 HOURS**

International Agencies in Food Regulation: Food Codex Alimentarius: The necessity of harmonised Food Standards for international trade; various aspects and relation with domestic laws; Codex Nodal agency, FAO, WHO, WTO, TUV, Consumer protection forums.

References

1. Rajesh, M., and George, J. (2005) “Food Safety Regulations, Concerns and Trade : The Developing Country Perspective”, Macmillan.
2. Naomi, R., and Watson, D. (2007) “International Standards for Food Safety”, Aspen Publication.
3. Newslow, D.L. “The ISO 9000 Quality System: Applications in Food and Technology”, John Wiley & Sons, 2007.
4. Hubbard, Merton R. “Statistical Quality Control for the Food Industry”, 3rd Edition, Springer, 2003.

UNIT -I

9 HOURS

Indian and global scenario on production and processing of fruits and Vegetable. Pre-processing: Fresh fruits and vegetables – Handling, grading, cleaning, pretreatments, transportation, pre cooling, chilling, modified atmosphere packaging, Controlled atmosphere storage, packaging, transportation, quality assurance.

UNIT -II

8 HOURS

Freezing of Fruits and Vegetables: Different freezing methods and equipments, problems associated with specific fruits and vegetables;

UNIT -III

9 HOURS

Dehydration of Fruits and Vegetables: dehydration – different methods of drying including sun, tray, cabinet, drum, spray, vacuum, tunnel, spray, low temperature drying process, process calculations ,osmotic dehydration and other modern methods, choice of suitable methods, preserving the colour, flavour and nutrient content of the products

UNIT - IV

10 HOURS

Canning, Juices & Concentrates: Different UNIT operations involved in fruit and vegetable Pulp/juice extraction, concentration, Bulk aseptic packaging of fruit and vegetable pulps, juices and concentrates; aseptic packaging of fruit drinks, juices and other products

Bottling, canning - essential principles, different types of cans, UNIT operations in canning

blanching, exhausting, processing conditions. Fruit Juice / pulp/ Nectar/Drinks, concentrates – General and specific processing, different packing including aseptic; Vegetable Purees/pastes - processing of Tomato and tomato products

UNIT -V

9 HOURS

Fruit and Vegetable Products & Standards: Ready to eat vegetable products, Jams/Marmalades, Squashes/cordials, Ketchup/sauces, Chutneys, Fruit Bar, Soup powders, Candied Fruits, Natural colors, Fruit and Vegetable Fibres - specific processing, different packing including aseptic, Product specifications and standards; food regulations with respect to fruit and vegetable products

Reference

1. Potter, N.N. and Hotchkiss, J.H. "Food science", 5th Edition, CBS, 2001.
2. Vaclavik, V.A. and Christian, E.W. "Essentials of Food Science", 2nd Edition, Springer, 2005.

3. Salunkhe, D.K. and Kadam, S.S. “Handbook of Fruit Science and Technology : Production, Composition, Storage, and Processing”, Marcel Dekker, 2005.
4. Alzamora, S.M., Tapia, M.S. and Lopez – Malo, A. “Minimally Processed Fruits and Vegetables: Fundamental Aspects and Applications”, Springer, 2005.

UNIT I**10 HOURS**

Food additives – definitions, classification and function , chemistry, food uses and functions in formulations; toxicological evaluation of food additives. Proteins, starches and lipids as functional ingredient; isolation, modification, specifications, functional properties and applications in foods.

UNIT II**9 HOURS**

Functionality of food additives, regulatory and legal aspects, sensory properties of foods objectives of additives, functional classification of additives, additives of natural origin, synthetic additives, indirect additives. Health and safety aspects of food additives. Present status of various food additives.. Controversial food additives Saccharin, history, function, controversy status, aspartame, nitrite and nitrate compounds, nitrosamines.

UNIT III**9 HOURS**

Additives to improve acceptability, permitted food colors, natural and artificial, food flavours, natural and artificial, sweeteners natural and artificial. acidulents, antimicrobials, aerating agents, ant staling agents, bodying agents, clouding agents, curing agents clarifiers, dietary supplements, dietary fiber , emulsifiers, enzymes, fat replacers, gelling agents, leavening agents, stabilizers, surfactants, tenderizers, texturizers, thickeners, vitamins, nutraceuticals, viscosity modifiers, whipping agents.

UNIT IV**8 HOURS**

Flavor technology; types of flavours, flavours generated during processing – reaction flavours, flavor composites, stability of flavours during food processing , analysis of flavours, extraction techniques of flavours, flavours emulsions; essential oils and oleoresins; authentication of flavours etc.

UNIT V**9 HOURS**

Food adulteration, definition, reasons for food adulteration, methods of adulteration, and methods of detection. Consumer’s responsibilities, consumer organizations. The prevention of food adulteration Act, 1954. The consumer protection Act 1986, normal food adulterants in coffee, tea leaves, edible oil, milk, cereals, spice powders.

Text books and Reference materials

1. Branen, A.L., Davidson PM & Salminen S. 2001. Food Additives. 2nd Ed. Marcel Dekker.
2. Gerorge, A.B. 1996. Encyclopedia of Food and Color Additives. Vol. III. CRC Press.
3. Gerorge, A.B. 2004. Fenaroli's Handbook of Flavor Ingredients. 5th Ed. CRC Press.
4. Madhavi, D.L., Deshpande, S.S & Salunkhe, D.K. 1996. Food Antioxidants: Technological, toxicological and Health Perspective. Marcel Dekker
5. Morton, I.D. & Macleod, A.J. 1990. Food Flavours. Part A, BC. Elsevier.
Nakai S & Modler HW. 2000. Food Proteins. Processing Applications. Wiley VCH

BY PRODUCT UTILIZATION

UNIT I WASTE UTILIZATION FROM RICE MILL INDUSTRY 10 hours

Waste from rice mill industry – waste based furnace-Types, design-Utilization of rice husk- cement preparation, ceramic materials-Utilization of rice bran -problems in processing of rice bran- stabilization- methods of utilization- rice bran stabilizers-extraction of rice bran-refining-uses of bran, bran oil and defatted bran.

UNIT II UTILIZATION OF FRUIT AND VEGETABLE WASTES 10 hours

Different sources of wastes from fruit and vegetable industries and their availability in India- Status and types of waste available- possible byproducts- Utilization of mango, citrus, apple, guava, grape waste-vinegar production-SCP production-organic acid production-Utilization of moringa, potato, leafy vegetable waste- Distillation for production of alcohol.

UNIT III FISH AND POULTRY WASTE UTILISATION 9 hours

Fish industry by products- methods and production of fish meal, fish protein concentrate-fish and body oils- poultry waste recycling.

UNIT IV TUBER CROPS WASTE UTILISATION 9 hours

Tapioca waste utilization- furfural production methods-paper making from cellulosic waste

UNIT V BY- PRODUCT UTILIZATION OF COCONUT PROCESSING 10 hours

Waste from Coconuts – uses of coir pith-biogas production-particle board-utilization of husk-coir fibre-shell- methods for production of shell charcoal- fuel briquette-machineries used.

Text Books and Reference material

1. P. N. Cheremimoff & A.C Morresi, 1976, "Energy from Solid Wastes"
2. A. Chakravarthy & De, "Agricultural Waste and By Product Utilisation".
3. Bor S. Luli (ed), "Rice Production and Utilisation"
4. E. Beagle, "Rice Husk Conversion to Energy"

1. Slaughtering and dressing of meat animals; study of post-mortem changes;
meat cutting and handling;
2. Evaluation of meat quality; estimation of meat: bone ratios.
3. Preservation by dehydration, freezing.
4. Evaluation of quality of eggs
5. Preservation of shell eggs
6. Preparation of meat products
7. Tenderization of various meat
8. Preparation of fish based products
9. Evaluation of fish and other marine products

1. Estimation of extractives, caffeine in tea and coffee; the aflavin and thearubigens of tea and total solids
2. Estimation of Moisture and volatile oil content of spices
3. Estimation of Aromatic compounds in spices
4. Estimation of capsaicin content
5. Scoville Heat UNITS in chilies
6. Curcumin content of turmeric
7. Storage and packaging of spices
8. Detection of microbial quality and adulteration in spices

1. Evaluation of pectin content
2. Canning of fruits and vegetables
3. Quality evaluation of fruits
4. Fruit preserve and candy
5. RTs products
6. Dehydrated products of fruits
7. Dehydrated products of vegetables
8. Preparation of pickles
9. Wafers from vegetables and fruits

Market sample evaluation and statistical application of:

1. Qualitative tests for detection of adulterants
2. Test for assessment of purity of water
3. Test for assessment of quality of milk and milk products
4. Test for assessment of quality of cereals/millets
5. Test for assessment of quality of pulses
6. Test for assessment of quality of fats and oils
7. Test for assessment of quality of meat/fish products
8. Test for assessment of quality of canned/bottle fruits and vegetables
9. Test for assessment of quality of baked foods

PONDICHERRY UNIVERSITY
Department of Food Science and Technology

M.Sc Food Science and Technology

Semester	Course Code	Title of the Course	Category	Credits
IV	FS&T571	PROJECT WORK	HC	8

Students will work on specific project attached to a supervisor and submit a thesis at the end of the semester. The assessment will be based on the midterm evaluation, evaluation of final report and viva-voce examination.