

**MASTER OF TECHNOLOGY  
FOOD SCIENCE AND TECHNOLOGY**

**REVISED SYLLABUS**  
**(2011-2013)**



**CENTRE FOR FOOD SCIENCE & TECHNOLOGY**  
**SAMBALPUR UNIVERSITY**  
**JYOTI VIHAR**

**COURSE CONTENT**  
**M.TECH PROGRAMME IN FOOD SCIENCE & TECHNOLOGY**  
**Effective from the Academic session 2011-2013**

Course No.	Title of the Course	Credit Hours
<b>F I R S T S E M E S T E R</b>		
FST-611	Food Chemistry and Analysis	04
FST-612	Food Microbiology	04
FST-613	Principles of Food processing & Post harvest Technology	04
FST-614	Food Engineering-I ( Upstream Processing of foods)	04
FST-615	Practicals Related to FST-611 & FST-612	02
FST-616	Practicals Related to FST-613 & FST-614	02
	Total Credits	20
<b>S E C O N D S E M E S T E R</b>		
FST-621	Fermentation Technology & Food products	04
FST-622	Food Engineering-II (Downstream Processing of foods)	04
FST-623	Marketing of food products, Food safety & Food Laws	04
FST-624	Elective Paper ( Any One)	04
	<ul style="list-style-type: none"> <li>a. Protein Technology</li> <li>b. Technology of Dairy Products</li> <li>c. Technology of cereals, pulses and oilseeds</li> <li>d. Post harvest management of fruits and vegetables</li> <li>e. Bakery and Confectionary Technology</li> <li>f. Beverages and Snacks food Technology</li> </ul>	
FST-625	Practicals Related to FST-621	02
FST-626	Practicals Related to FST-622	02
	Total Credits	20
<b>T H I R D S E M E S T E R</b>		
<i>FST-711</i>	<i>Term Paper</i>	<i>06</i>
FST-712	Industrial Tour Report	06
FST-713	Seminar	03
FST-714	Interim Project Report	05
	Total Credits	20
<b>F O U R T H S E M E S T E R</b>		
FST-721	Project Report and Evaluation	15
FST-722	Project Presentation	03
FST-723	Comprehensive Viva-voce	02
	Total Credits	20
	<b>Total Course Credits</b>	<b>80</b>

## FIRST SEMESTER

**FST-611. Food Chemistry and Analysis:**

**4 CH**

### **UNIT-I**

Water: liquid water, ice, effect of water on food storage; Role of water on deterioration of food. Amino acid – structure and properties, essential amino acid peptides, nisin, and sensory peptides. Protein: primary secondary and tertiary structure, protein denaturation and physical properties. Enzymes: classification and mechanism of action and kinetics. Enzyme activity during ripening and sprouting, Effect of processing on enzymes and proteins

### **UNIT-II**

Carbohydrates: mono, di & polysaccharides, structure and chemical properties, chemical reaction and derivatives. Caramelization, millard's reaction, browning reaction. Important polysaccharides like: starch, glycogen, agar, alginate, gums, pectin, dextran, PVP. Enzymatic degradation of polysaccharides. Lipids: Fatty acid and their physiochemical properties, oil, fats, waxes, terpenes and lipid per oxidation.

### **UNIT-III**

Vitamins: types, sources and losses due to food processing, minerals and pigments in foods, Aroma in food, flavor in food (natural and synthetic), food additives: food colours, antioxidants, food contamination, food poisoning, toxic trace element, Browning reaction (enzymatic), Water activity and its role in food deterioration, Phase transition of food.

### **UNIT-IV**

Chromatographic techniques: Paper, TLC, GC, HPLC, Separation techniques: Gel filtration, dialysis, electrophoresis, ultrafiltration and centrifugation, isotopic techniques, Immunoassay techniques; Isotopic, non-isotopic and enzyme immunoassays; thermal methods in food analysis (bomb calorimeter), colour and texture measurement techniques, rheometry

### **TEXT BOOKS**

1. Belitz & Grosch., Food Chemistry, Springer.

### **Suggested Readings**

1. Aurand, L.W. and Woods, A.E. 1973. Food Chemistry. AVI, Westport.
2. Birch, G.G., Cameron, A.G. and Spencer, M. 1986. Food Science, 3rd Ed. Pergamon Press, New York.
3. Fennema, O.R. Ed. 1976. Principles of Food Science: Part-I Food Chemistry. Marcel Dekker, New York.
4. Meyer, L.H. 1973. Food Chemistry. East-West Press Pvt. Ltd., New Delhi.
5. Potter, N.N. 1978. Food Science. 3rd Ed. AVI, Westport.
6. Bamji MS, Rao NA & Reddy V. 2003. *Textbook of Human Nutrition*. Oxford & IBH.
7. Belitz HD. 1999. *Food Chemistry*. Springer Verlag.
8. DeMan JM. 1976. *Principles of Food Chemistry*. AVI.
9. Fennema OR. 1996. *Food Chemistry*. Marcel Dekker.
10. Meyer LH. 1987. *Food Chemistry*. CBS.
11. Swaminathan M. 1974. *Essentials of Foods and Nutrition*. Vol. II. Ganesh & Co.
12. Joslyn, M.A. Ed. 1970. *Methods in Food Analysis*. Academic Press, New York.
13. King, R.D. Ed. 1978. *Developments in Food Analysis Techniques-I*. Applied Science Publishers Ltd., London.
14. Morris, C.J. and Morris, P. 1976. *Separation Methods in Biochemistry* 2nd Ed. Pitman Pub., London.
15. Plummer, D.T. 1971. *An Introduction to Practical Biochemistry*. Mc-Graw Hill Pub. Co., New York.
16. Raghuramulu, N., Madhavan Nair, K., and Kalyanasundaram, S. Ed. 1983. *A Manual of Laboratory Techniques*. National Institute of Nutrition, ICMR, Hyderabad.
17. AOAC International. 2003. *Official methods of analysis of AOAC International*. 17th Ed. Gaithersburg, MD, USA, Association of Analytical Communities.
18. Kirk RS & Sawyer R. 1991. *Pearson's Chemical Analysis of Foods*. 9th Ed. Longman Scientific & Technical.
19. Leo ML. 2004. *Handbook of Food Analysis*. 2nd Ed. Vols. I-III.
20. Linden G. 1996. *Analytical Techniques for Foods and Agricultural Products*. VCH.
21. Macleod AJ. 1973. *Instrumental Methods of Food Analysis*. Elek Sci. Marcel Dekker.
22. Nielsen S. (Eds.). 1994. *Introduction to Chemical Analysis of Foods*. Jones & Bartlett.
23. Pomrenz Y & Meloan CE. 1996. *Food Analysis - Theory and Practice*. 3rd Ed. CBS.
24. Ranganna S. 2001. *Handbook of Analysis and Quality Control for Fruit and Vegetable Products*. 2nd Ed. Tata-McGraw-Hill.
25. Robinson JW. 1970. *Undergraduate Instrumental Analysis*. Marcel Dekker.

**UNIT I**

History & scope of food microbiology, advance microscopy(light & electron)& its application, Microbial world: a resume, predominant microbial group in food, sources of micro-organism in food, normal microbiological quality of food and its significance.

**UNIT II**

Microbial growth response in food environment, growth analysis, factors affecting microbial growth, microbial growth model, microbial metabolism of food components, control of microbes in food (physical, chemical and antimicrobial preservatives).

**UNIT III**

Beneficial uses of microbes in food: microbes and food fermentation, intestinal beneficial flora, food bio-preservative of microbial origin, food ingredients and enzymes of microbial origin, concept of prebiotic, probiotic & symbiotic.

**UNIT IV**

Microbial spoilage: Factors, spoilage of specific food groups, food spoilage by microbial enzymes, indicators of food spoilage, food borne diseases, intoxication, infection, microbial toxin, food regulatory agency

**TEXT BOOKS:**

1. Adams and Moss, Food Microbiology
2. Fraizer, Food Microbiology
3. Bibek ray, Fundamental of Food Microbiology
4. Pelczar, Microbiology
5. Banarjee, Microbiology

**Suggested Readings**

1. Branen A.L. and Davidson, P.M. 1983. Antimicrobials in Foods. Marcel Dekker, Newyork.
2. Jay J.M. 1986. Modern Food Microbiology. 3rd Edn. VNR, New York.
3. Robinson, R.K. Ed. 1983. Dairy Microbiology. Applied Science, London.
4. Banawart GJ. 1989. *Basic Food Microbiology*. 2nd Ed. AVI Publ.
5. Frazier J & Westhoff DC. 1988. *Food Microbiology*. 4th Ed. McGraw Hill.
6. Garbutt J. 1997. *Essentials of Food Microbiology*. Arnold Heinemann.
7. Jay JM, Loessner MJ & Golden DA. 2005. *Modern Food Microbiology*. 7th Ed. Springer.
8. Ray B. 2004. *Fundamentals of Food Microbiology*. 3rd Ed. CRC.
9. Robinson RK. (Ed.). 1983. *Dairy Microbiology*. Applied Science.
10. Steinkraus KS. 1996. *Handbook of Indigenous Fermented Foods*. Marcel Dekker.

**UNIT I**

Scope and importance of food processing. National and international perspectives. Principles and methods of food processing and preservation (freezing, heating, dehydration, canning, additives, fermentation, irradiation, extrusion cooking, dielectric heating), Hurdle technology: concept of hurdle technology and its application.

**UNIT-II**

Microwave and radio frequency processing: Definition, Advantages, mechanism of heat generation, application in food processing: microwave blanching, sterilization and finish drying. High Pressure processing: Concept, equipments for HPP treatment, mechanism of microbial inactivation and its application in food processing. Ultrasonic processing: Properties of ultrasonic, application of ultrasonic as processing techniques. Newer techniques in food processing: Application of technologies of high intensity light, pulse electric field, ohmic heating, IR heating, inductive heating and, Nanotechnology: Principles and applications in foods.

**UNIT-III**

Principles of Post-harvest treatments, value-addition, and traceability; Post harvest technology for cereals, legumes, oilseeds, vegetable and spices (cleaning, grading, milling), Hydrothermal treatment & conditioning of grains, Modern paddy and wheat parboiling-systems, equipment, Advances in heat transfer and fluid flow in grain processing operations. Crop drying principles, moisture migration theories, advances in crop drying theories & mathematical modeling, Crop drying methods/systems and Crop dryers-selection, design and testing.

**UNIT-IV**

Food Packaging: Packaging materials & its advancement, Mass transfer in packing material, Innovation in food packing (active, passive, intelligent), Package testing, CA & MA, Kinetics of biological reactions - kinetics of reactions occurring in processed foods, reaction velocity constant, order of reaction; quality changes during storage of foods; application of Arrhenius equation to biological reactions.

**TEXT BOOKS**

1. Sahay KM & Singh KK. 1994. *Unit Operation of Agricultural Processing*. Vikas Publ. House.
2. Heldman DR & Singh RP. 1995. *Food Process Engineering*. AVI Publ.
3. Rao.D.G, Fundamentals of food engg, PHI publ

4. Bhatt & Tommar, An introduction to Food Sc Tech & Quality management. Kalyani publ.
5. Khader, Text book of food storage and preservation, Kalyani publ.
6. S.A. Udipi Food processing and preservation, new age publ.
7. Sood, Food preservation & processing, Kalyani publ.
8. Sun, Emerging Technologies in Food Processing, Elsevier.

#### **Suggested Readings**

1. Arsdel WB, Copley MJ & Morgan AI. 1973. *Food Dehydration*. 2nd Ed. Vols. I, II. AVI Publ.
2. Desrosier NW & James N. 1977. *Technology of Food Preservation*. 4th Ed. AVI. Publ.
3. Fellows PJ. 2005. *Food Processing Technology: Principle and Practice*. 2nd Ed. CRC.
4. Potter NN & Hotchkiss 1997. *Food Science*. 5th Ed. CBS.
5. Potty VH & Mulky MJ. 1993. *Food Processing*. Oxford & IBH.
6. Ramaswamy H & Marcotte M. 2006. *Food Processing: Principles and Applications*. Taylor & Francis.
7. Bender, A.E. 1978. *Food Processing and Nutrition*. Academic Press, London.
8. Fellows, P. and Ellis H. 1990. *Food Processing Technology: Principles and Practice*, New York.
9. Jelen, P. 1985. *Introduction to Food Processing*. Prentice Hall, Reston Virginia, USA.
10. Lewis, M.J. 1990. *Physical Properties of Food and Food Processing Systems*. Woodhead, UK.
11. Wildey, R.C. Ed. 1994. *Minimally Processed Refrigerated Fruits and Vegetables*. Chapman and Hall, London.
12. Haard, N.F. and Salunkhe, D.K. 1975. *Postharvest Biology and Handling of Fruits and Vegetables*. AVI, Westport.
13. Kader, A. A. 1992. *Postharvest Technology of Horticultural Crops*, 2nd Ed. University of California, Division of Agriculture and National Resources, California.

### **FST-614. Food Engineering-I (Upstream processing of foods):**

**4CH**

#### **UNIT I**

Introduction to food engineering & processes: principles of thermodynamics and heat transfer applied to food engineering; Engineering properties of foods (electrical, Optical, Frictional, Aerodynamic, Rheology, Physical), their significance in equipment design, processing and handling of food and food products. Fluid flow in food processing; continuity equation, Bernoulli's equation, Flow through pipes & conduits, Flow measurement, pump types & performance evaluation.

#### **UNIT-II**

Process Heat Transfer – Thermal properties of food, Modes of heat transfer and overall heat transfer; Fourier's law, steady state and unsteady state conduction; heat exchange equipment; energy balances; rate of heat transfer; thermal boundary layer; heat transfer by forced convections; heat transfer to flat plate and in non Newtonian fluids; heat transfer in turbulent flow; heating and cooling of fluids in forced convection outside tubes; natural convection, Method for thermal process evaluation - Commercial sterility, pasteurization and sterilization methods based on slowest heating region; determination of the process time based on region of greatest temperature lag; calculation of process time for fluids on stream line flow and turbulent flow heated in heat exchangers

#### **UNIT III**

Mass transfer, molecular diffusion and diffusivity, Fick's law, diffusion in solids, liquids and gases equilibrium stage process, convective mass transfer co-efficient, mass transfer with laminar and turbulent flow. Heat and mass transfer analogy Design equations for convective mass transfer, simultaneous momentum, Separation by equilibrium stages, immiscible phases, distillation of binary mixtures and multi-component separations. Application of mass transfer in food processing.

#### **UNIT IV**

Refrigeration system; components, refrigerants types, cooling load estimation, refrigeration design and application in food processing., Food chilling and freezing – Precooling and cold storage, freezing point depression; general introduction to enthalpy change during freezing; Plank's equation for predicting rates of product freezing; Cryogenic freezing and IQF; design of food freezing equipment ( air blast freezers, plate freezers and immersion freezers).

#### **TEXT BOOKS**

1. Sahay KM & Singh KK. 1994. *Unit Operation of Agricultural Processing*. Vikas Publ. House.
2. Heldman DR & Singh RP. 1995. *Food Process Engineering*. AVI Publ.
3. Rao.D.G, Fundamentals of food engg, PHI publ

#### **Suggested Readings**

1. Batty, J.C. and Folkman, S.L. 1983. *Food Engineering Fundamentals*. John Wiley and Sons, New York.
2. Fennema O.R. Ed. 1985, *Principles of Food Science: Part-II Physical Principles of food Preservation*. Marcel Dekker, New York.
3. Harper, J.C. 1975. *Elements of Food Engineering*. AVI, Westport.
4. Heldman, D.R. and Lund, D.B. Ed. 1992. *Handbook of Food Engineering* Marcel, Dekker, New York.
5. Brennan JG, Butter JR, Corell ND & Lilly AVE. 1990. *Food Engineering Operations*. Elsevier.
6. Charm SE, McCabe WL, Smith JC & Harriott P. 1993. *Unit Operations of Chemical Engineering*. McGraw Hills.

7. Earle RL. 1985. *Unit Operations in Food Processing*. Pergamon Press.
8. Fellows P. 1988. *Food Processing Technology*. VCH Ellis Horwood.
9. McCabe WL & Smith JC. 1971. *Fundamental of Food Engineering*. AVI Publ.
10. Singh RP & Heldman DR. 1993. *Introduction to Food Engineering*. Academic Press.

**FST-615 Practical related to FST611 & FST612** **2CH**

**FST-616 Practical Related to FST 613& FST 614** **2CH**

## **SECOND SEMESTER**

**FST-621. Fermentation Technology and Food products;** **4CH**

### **UNIT-I**

Introduction to fermentation : Modern methods of cell culture: synchronous and co- cell culture, continuous cell culture in liquid and solid media, Cell immobilization and applications, cultures. Media design(Plunked Burman & Demeo) method, Rate of microbial growth and death, Fermentation kinetics(batch, fed batch and continuous).substrate utilization and product formation.

### **UNIT-II**

Fermenter design & operation: Fermentation vessel design, sterilization process design of air and media, aeration & agitation: air requirement calculation, design of impeller, baffle, sparger. mass transfer in bioreactor,rheology and mixing of fermentation broth,scale up ,types of fermentors,instrumentation in bioprocess.

### **UNIT-III**

Product recovery: cell lysis(mechanical, enzymatic),Solvent extraction, aqueous two phase extraction, industrial chromatographic separation and calculation and correlation to adsorption isotherm.sedimentation,dialysis,crystallization,drying,multiple reaction concept during biochemical processes, integrated bioprocess.

### **UNIT-IV**

Production of vitamins, amino acids, organic acids, enzymes (amylase, pectinase, proteases), antibiotics, alcohols and single cell proteins.

Fermented food: origin, scope and development, sauerkraut, yogurt, cheese, miso, tempeh, idli, dosa., , production of food flavor, colour.Bread production,SSF,DRC calculation

### **TEXT BOOKS**

1. Stanburry P.P. and Whitaker, A. 1984. Principles of Fermentation Technology. Pergamon Press, Oxford UK.

### **Suggested Readings**

- 1.Steinkraus, K.H. 1983. Handbook of Indigenous Fermented Foods. Marcel Dekker,New York.
- 2.Food, Fermentation, and Micro-Organisms by Charles W. Bamforth
- 3.Food Fermentation edited by Rob Nout, Willem de Vos and Marcel Zwietering
- 4.Fermented Beverage Production edited by A.G.H. Lea
- 5.Handbook of Fermented Functional Foods Second edition edited by Edward R. Farnworth **C.H.I.P.S.**
- 6.Practical Fermentation Technology edited by Brian McNeil
- 7.Microbiology of Fermented Foods Two-Volume Set Second Edition edited by Brian J. B. Wood

**FST-622. Food Engineering-II (Downstream processing of foods):** **4CH**

### **UNIT-I**

Basic concepts of bio separation Technology, Separation characteristics of Food products (Carbohydrates, proteins, fats and enzymes)- size, stability, properties; purification methodologies, Characteristics of food-products; Flocculation and conditioning of broth, overview of reaction processes involved in separation; Filtration at constant pressure and at constant rate; empirical equations for batch and continuous filtration, centrifugal and cross-flow filtration, Centrifugation: basic principles, design characteristics; Ultracentrifuges: Principles and applications to food product (SCP) recovery.

### **UNIT-II**

Techniques involved in Separation Processes: Foam-fractionation; Solvent extraction of bio-processes, aqueous two-phase extraction, IMAC, adsorption-desorption process; Salt precipitation; Chromatographic separation based on size, charge hydrophobic interactions and metal ion affinity. Affinity chromatography, inhibitors: their preparation and uses, method of linkages, Electrophoresis SDS-PAGE (Polyacrylamide Gel), horizontal and vertical type,2D electrophoresis method methods, case studies.

### **UNIT III**

Thermodynamic properties of moist air, kinetics of water absorption, Evaporation and dehydration of foods, design of single and multi-effect evaporators, mechanics of movement of air through stationary bed, thin layer

and thick layer bed drying, simulation models for drying systems, use of weather data for drying operations, design of dryers, New direction in freeze bed drying, cyclic pressure freeze drying, vacuum drying, freeze concentration and drying, freezing point curves, phase diagrams, methods of freeze concentration, design problems.

#### UNIT-IV

Separation & Effluent treatment: Membrane based filtration of food products: Micro filtration, Ultra filtration, Nano filtration and Reverse osmosis. Supercritical fluid extraction: Concept, property of near critical fluids NCF and extraction methods, Application of aerodynamic properties to the separation, pneumatic handling and conveying of food products. Material and energy balance of food process engineering. Food industry waste and their properties, Physical, Chemical and Biological method of treatment, Environmental standard.

#### TEXT BOOKS

1. Singh RP & Heldman DR. 1993. *Introduction to Food Engineering*. Academic Press.
2. Sahay KM & Singh KK. 1994. *Unit Operation of Agricultural Processing*. Visas Publ. House.

#### Suggested Readings

1. Batty, J.C. and Folkman, S.L. 1983. *Food Engineering Fundamentals*. John Wiley and Sons, New York.
2. Fennema O.R. Ed. 1985, *Principles of Food Science: Part-II Physical Principles of Food Preservation*. Marcel Dekker, New York.
3. Harper, J.C. 1975. *Elements of Food Engineering*. AVI, Westport.
4. Heldman, D.R. and Lund, D.B. Ed. 1992. *Handbook of Food Engineering* Marcel, Dekker, New York.
5. Brennan JG, Butter JR, Corell ND & Lilly AVE. 1990. *Food Engineering Operations*. Elsevier.
6. Charm SE, McCabe WL, Smith JC & Harriott P. 1993. *Unit Operations of Chemical Engineering*. McGraw Hills.
7. Earle RL. 1985. *Unit Operations in Food Processing*. Pergamon Press.
8. Fellows P. 1988. *Food Processing Technology*. VCH Ellis Horwood.
9. Heldman DR & Singh RP. 1995. *Food Process Engineering*. AVI Publ.
10. McCabe WL & Smith JC. 1971. *Fundamental of Food Engineering*. AVI Publ.
11. Sahay KM & Singh KK. 1994. *Unit Operation of Agricultural Processing*, Vikas Publ. House.
12. Singh RP & Heldman DR. 1993. *Introduction to Food Engineering*. Academic, Press.
13. Farral AW. 1979. *Food Engineering Systems*. Vols. I, II. AVI Publ.
14. Heldman & Singh. 1980. *Food Processing Engineering*. AVI Publ.
15. McCab & Smith 2001. *Unit Operations of Chemical Engineering*. McGrawHill.
16. Lewis MJ. 1987. *Physical Properties of Food processing Systems*. Lewis Publ.
17. Watson EL & Harper JC. 1989. *Elements of Food Engineering*. AVI Publ.

#### FST-623.

#### Marketing of Food products, Food safety and Food Laws:

4CH

#### UNIT I

Concept and functions of marketing of food products; Concepts and elements of marketing mix, Micro and macro environments; Consumer behavior; Marketing research and Marketing information systems. Market measurement- present and future demand; Market segmentation, targeting and positioning, Allocation and marketing resources, Product-mix; product line; product life cycle, New product development. Product brand & packaging decisions. Marketing channel decisions, Retailing, wholesaling and distribution, Pricing Decisions, Price determination and pricing policy of milk products in organized and unorganized sectors of dairy industry,

#### UNIT II

Promotion-mix decisions. Advertising; Deciding advertising objectives, advertising budget and advertising message, Media Planning, Personal Selling, Publicity; Sales Promotion, Food and Dairy Products Marketing. International Marketing and International Trade, Salient features of International Marketing, International marketing environment; Deciding which & how to enter international market; Exports- Direct exports, indirect exports, Licensing, Joint Ventures, Direct investment, deciding marketing Programme ; Product, Promotion, Price, Distribution Channels. Deciding the Market Organization.

#### UNIT III

Concept of quality: Quality attributes- physical, chemical, nutritional, microbial, and sensory; their measurement and evaluation; Sensory *vis-à-vis* instrumental methods for testing quality. Concepts of quality management: Objectives, importance and functions of quality control; Quality management systems in India; Sampling procedures and plans; Food Safety and Standards Act, 2006; Domestic regulations; Global Food safety Initiative; Various organizations dealing with inspection, traceability and authentication, certification and quality assurance (PFA, FPO, MMPO, MPO, AGMARK, BIS); Labeling issues; International scenario, International food standards.

#### UNIT IV

Quality assurance, Total Quality Management; GMP/GHP; GLP, GAP; Sanitary and hygienic practices; HACCP; Quality manuals, documentation and audits; Indian & International quality systems and standards like ISO and Food Codex; Export import policy, export documentation; Laboratory quality procedures and assessment of laboratory performance; Applications in different food industries; Food adulteration and food safety. IPR and Patent.

**Text book**

1. Subash. C Jain, International Marketing, 6<sup>th</sup> edition.
2. Varshney, R.L and Bhattacharya, B International marketing management and Indian perspective, Sultan chand and sons, New Delhi.
3. Kohler P, Keller K.L, Koshy A, Jha M, 13<sup>th</sup> edition 2009, Marketing Management- A South Africa Perspective, Pearson Education, New Delhi.
4. Ramaswamy, V.S and Namakumari ,S.; 4<sup>th</sup> edition Marketing Management –Global Perspective-Indian Content, McMillan Publishers India Ltd, New Delhi.
5. Saxena, Rajan, 3<sup>rd</sup> edition; Marketing management, Tata McGraw Hill Publishing Company Ltd, New Delhi

**Suggested Readings**

1. Amerine MA, Pangborn RM & Rosslos EB. 1965. *Principles of Sensory Evaluation of Food*. Academic Press.
2. Early R.1995.*Guide to Quality Management Systems for Food Industries*. Blackie Academic.
3. Furia TE.1980. *Regulatory status of Direct Food Additives*. CRC Press. Florida.
4. Jellinek G. 1985. *Sensory Evaluation of Food - Theory and Practice*. EllisHorwood.
5. Krammer A & Twigg BA.1973. *Quality Control in Food Industry*. Vol. I,II. AVI Publ. Westport.
6. Macrae R, Roloson R & Sadlu MJ. 1994. *Encyclopedia of Food Science &Technology & Nutrition*. Vol. XVI. Academic Press.
7. Piggot J.R. 1984. *Sensory Evaluation of Foods*. Elbview Applied Science.
8. Ranganna S. 2001. *Handbook of Analysis and Quality Control for Fruit and Vegetable Products*. 2nd Ed. Tata-McGraw-Hill. New Delhi
9. Export/Import policy by Govt. of India.
10. Birk, G.G., Herman, J.G. and Parker, K.J. Ed. -1977. *Sensory Properties of Foods*.Applied Science, London.
11. Charalambous, G. and Inglett, G. 1981. *The Quality of Foods and Beverages*. (2 vol.set). Academic Press, New York.
12. Pattee, H.E. Ed. 1985. *Evaluation of Quality of Fruits and Vegetables*. AVI, Westport.
13. Tannenbaum, S.R. Ed. 1979. *Nutritional and Safety Aspects of Food Processing*, marcel Dekker, New York.
14. Branson, R.E. and Norvell, D.G. 1983. *Introduction to Agricultural Marketing* McGrawHill Book Comp., New York.
15. Chowdhry, N.K. and Aggarwal, J.C. 1994. *Dunkel Proposals*. Vol. III. Shipra Pub.,New Delhi.
16. Darrah, L.B. 1971. *Food Marketing*. The Ronald Press Comp. New York.
17. Kacker, M. Ed. 1982. *Marketing and Economic Development*, Deep and Deep Pub.,New Delhi.
18. Rich, S.U. 1970. *Marketing of Forest Products: Text and Cases*, McGraw Hill BookComp., New York.
19. Shepherd, G.S. 1947. *Marketing of Farm Products*. The Lows State College Press, Ames, Iowa.
20. Painy, F.A. and Painy, H.Y. 1983. *A Handbook of Food Packaging*. Leonard Hill, Glasgow, UK.
21. Scicharow, S. and Griffin, R.C. 1970. *Food Packaging*. AVI, Westport.

**ELECTIVE PAPERS (ANY ONE)****FST-624a. Protein Technology;****4CH****UNIT I**

Protein structure and chemistry: Primary, Secondary, Tertiary and Quarternary structure of protein; Simple and Globular Proteins, Protein-Protein interactions, methods of evaluation of protein quality and amount, Conventional and novel sources of protein. Nutritional and commercial importance of proteins. Commercial sources of proteins.

**UNIT II**

Protein concentrates and isolates- introduction, process of making protein isolates and concentrates, factors affecting quality of isolates and concentrates. Treatment to isolate andconcentrates. Production of proteins, protein concentrates/isolates from legumes,oilseeds, fish, seafood, leaf, microbes. Packaging of protein isolates and concentrates. Food as well as non-food uses of isolates and concentrates.

**UNIT III**

Functional properties of proteins and their applications; Structure-function relationships of different food proteins, textured vegetable proteins and different methods of texturization. High protein food formulations, Modification of proteins by enzymatic (manufacture of protein hydrolysates, their characterization and applications), chemical and physical methods.

**UNIT IV**

Interactions of proteins with flavors, polysaccharides, lipids and their technological effects, Protein-based fat substitutes, Protein engineering, Site director mutagenesis for specific protein function, basic concepts of design of a new protein / enzyme molecule, specific example of protein engineering for food quality.



### Suggested Readings

1. Altschul, A.M. and Wilcke, H.L. Ed. 1978. New Protein Foods. Vol. III. Academic Press, New York.
2. Bodwell, C.E. Ed. 1977. Evaluation of Proteins for Humans. AVI, Westport.
3. Milner, M., Scrimshaw, N.S. and Wang, D.I.C. Ed. 1978. Protein Resources and Technology. AVI, Westport.
4. Salunkhe, O.K. and Kadam, S.S. Eds. 1999. Handbook of World Legumes: Nutritional Chemistry, Processing Technology and Utilization. Volume I to III. CRC Press, Florida.
5. Salunkhe, D.K. Chavan, J.K., Adsule, R.N. Kadam, S.S. 1992. World Oilseeds: Chemistry, Technology and Utilization, Van Nostrand Reinhold, New York.

### FST-624b. Technology of Dairy Products:

4CH

#### UNIT I

Present status of milk & milk products in India and Abroad; market milk- Composition of milk of various species, quality evaluation and testing of milk, procurement, transportation and processing of market milk, cleaning & sanitization of dairy equipments. Special milks such as flavoured, sterilized, recombined & reconstituted toned & double toned.

#### UNIT II

Condensed milk- Definition, methods of manufacture, evaluation of condensed & evaporated milk; dried milk- Definition, methods of manufacture of skim & whole milk powder, instantiation, physiochemical properties, evaluation, defects in dried milk powder.

#### UNIT III

Cream- Definition, classification, composition, cream separation, sampling, neutralization, sterilization, pasteurization & cooling of cream, evaluation, defects in cream; Butter- Definition, composition, classification, methods of manufacture, theories of churning, evaluation, defects in butter. Ice cream- Definition, composition and standards, nutritive value, classification, methods of manufacture, evaluation, defects in ice cream, and technology aspects of softy manufacture.

#### UNIT IV

Cheese: Definition, composition, classification, methods of manufacture, cheddar, Gouda, cottage and processed cheese, evaluation, defects in cheese. Indigenous milk products - Present status, method of manufacture of *yoghurt, dahi, khoa, burfi, kalakand, gulabjamun, rosogolla, srikhand, chhana, paneer, ghee, lassi* etc; probiotic milk products.

### Suggested Readings

1. Aneja RP, Mathur BN, Chandan RC & Banerjee AK. 2002. *Technology of Indian Milk Products*. Dairy India Publ.
2. Dey. S. 1980. *Outlines of Dairy Technology*. Oxford Univ. Press. New Delhi
3. Henderson JL. 1971. *Fluid Milk Industry*. AVI Publ.
4. Rathore NS *et al.* 2008. *Fundamentals of Dairy Technology - Theory & Practices*. Himanshu Publ
5. Spreer E. 1993. *Milk and Dairy Products*. Marcel Dekker.
6. Walstra P. 1999. *Dairy Technology*. Marcel Dekker.
7. Walstra P. (Ed.). 2006. *Dairy Science and Technology*. 2nd Ed. Taylor & Francis.
8. Web BH, Johnson AH & Lford JA. 1987. *Fundamental of Dairy Chemistry*. 3rd Ed. AVI Publ.
9. Considine, D.M. Ed. 1982. Foods and Food Production Encyclopaedia, VNR, New York.
10. MacCrae, R., Robinson, R.K. and Sadler, M.J. Ed. 1993. Encyclopedia of Food Science, Food Technology and Nutrition Academic Press, London.
11. Robinson, R.K. (2 vol. set). 1986. Modern Dairy Technology Elsevier Applied Science, UK.
12. Rosenthal, I. 1991. Milk and Milk Products. VCH, New York.
13. Warner, J.M. 1976. Principles of Dairy Processing. Wiley Eastern Ltd. New Delhi.
14. Yarpar, WJ. and Hall, C.W. 1975. Dairy Technology and Engineering AVI, Westport.

### FST-624c. Technology of cereals, pulses and oilseeds:

4CH

#### UNIT I

Structure and composition of common cereals, pulses and oilseeds. 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.

#### UNIT II

Rice: Classification, physicochemical characteristics; cooking quality; rice milling technology; by- products of rice milling and their utilization; Parboiling of rice- technology and effect on quality characteristics; aging of rice - quality changes; processed products based on rice. Corn: Types and nutritive value; dry and wet milling, manufacture of value-added products; processing of barley, oats, sorghum and millets.

### UNIT III

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.

### UNIT-IV

Basic processing of fats and oils - oil extraction, degumming, refining, bleaching, hydrogenation, fractional crystallization, interesterification, glycerolysis, molecular distillation, plasticizing and tempering. Chemical adjuncts- lecithins, monoglycerides and derivatives, propylene glycol esters, polyglycoesters. Shortening- introduction, manufacturing and uses of shortening, types of shortening. Mayonnaise and salad dressings. Confectionery coatings. Packing and storage of fats and oils, cocoa butter, fat substitutes.

#### Suggested Readings

1. Blanshard J.M.V., Frazier, P.J. and Galliard, T. Ed. 1986. Chemistry and Physics of Baking. Royal Society of Chemistry, London.
2. Chakraverty, A. 1988. Post harvest Technology of Cereals, Pulses and oilseeds. Oxford and IBH, New Delhi.
3. Durbey, S.C. 1979. Basic Baking: Science and Craft. Gujarat Agricultural University, Anand (Gujrat).
4. Kent, N.L. 1983. Technology of Cereals. 3rd Edn. Pergamon Press, Oxford, UK.
5. Mathews, R.H. Ed. 1989. Legumes: Chemistry, Technology and Human Nutrition. Marcel Dekker, New York.
6. Pomeranz, Y. Ed. 1978. Wheat: Chemistry and Technology. Am. Assoc. of Cereal Chemist. St. Paul, Minnesota.
7. Pomeranz, Y. 1987. Modern Cereal Science and Technology. VCH Pub., New York.
8. Salunkhe, D.K., Kadam, S.S. and Austin A. Ed. 1986. Quality of Wheat and Wheat Products. Metropolitan Book Co., New Delhi.
9. Salunkhe, D.K., Kadam, S.S. Ed. 1989. Handbook of World Food Legumes: Chemistry, Processing and Utilization, (3 vol. set). CRC Press, Florida.
10. Chakrabarty MM. 2003. *Chemistry and Technology of Oils and Fats*. Prentice Hall.
11. Dendy DAV & Dobraszczyk BJ. 2001. *Cereal and Cereal Products*. Aspen.
12. Hamilton RJ & Bhati A. 1980. *Fats and Oils - Chemistry and Technology*. App. Sci. Publ.
13. Hosney RS. 1994. *Principles of Cereal Science and Technology*. 2nd Ed. AACC.
14. Kay DE. 1979. *Food Legumes*. Tropical Products Institute.
15. Kulp K & Ponte GJ. 2000. *Handbook of Cereal Science and Technology*. 2nd Ed. Marcel Dekker.
16. Lorenz KL. 1991. *Handbook of Cereal Science and Technology*. Marcel Dekker.
17. Marshall WE & Wadsworth JI. 1994. *Rice Science and Technology*. Marcel Dekker.
18. Matz SA. 1969. *Cereal Science*. AVI Publ.
19. Paquot C. 1979. *Standard Methods of Analysis of Oils, Fats and Derivatives*. Pergamon Press.
20. Salunkhe DK. 1992. *World Oilseeds: Chemistry, Technology and Utilization*. VNR.
21. Swern D. 1964. *Bailey's Industrial Oil and Fat Products*. InterSci. Publ.
21. Watson SA & Ramstad PE. 1987. *Corn; Chemistry and Technology*. AACC.

### FST-624d. Post harvest Management of fruits and vegetables;

4CH

#### UNIT I

Importance & scope of post harvest management of fruits and vegetables in Indian economy. Morphology, structure and composition of fruits and vegetables; maturity indices and standards for selected fruits and vegetables; methods of maturity determinations.

#### UNIT II

Harvesting and handling of important fruits and vegetables, Harvesting tools and their design aspects; Field heat of fruits and vegetables and primary processing for sorting and grading at farm and cluster level; factors affecting post harvest losses; Standards and specifications for fresh fruits and vegetable.

#### UNIT III

Post-harvest physiological and biochemical changes in fruits and vegetables; ripening of climacteric and non-climacteric fruits; regulations, methods; Storage practices: CA and MA, hypobaric storage, pre-cooling and cold storage, Zero energy cool chamber; Commodity pretreatments - chemicals, wax coating, prepackaging, VHT and irradiation.

#### UNIT IV

Physiological post harvest disorders - chilling injury and disease; prevention of post harvest diseases and infestation; Handling and packaging of fruits and vegetables; Post Harvest handling system for fruits and vegetables of regional importance such as citrus, mango, banana, pomegranate, tomato, papaya and carrot etc., packaging house operations; principles of transport and commercial transport operations.

#### Suggested Readings

1. Bose, T.K. Ed. 1985. Fruits of India: Tropical and Sub-tropical. Naya Prokash, Calcutta.
2. Dauthy, M.E. 1997. Fruit and Vegetable Processing. International Book Distributing Co. Lucknow, India.
3. Hamson, L.P. 1975. Commercial Processing of Vegetables. Noyes Data Corporation, New Jersey.

4. Jagtiani J., Chan, H.T. and Sakal, W.S. Ed. 1988. Tropical Fruit Processing Academic, Press, London.
5. Kadar, A. A. 1992. Postharvest Technology of Horticultural Crops. 2nd Ed. University of California.
6. Lai, G., Siddappa, G. and Tondon G.L. 1986. Preservation of Fruits and Vegetables, Indian Council of Agril. Research, New Delhi.
7. Salunkhe, D.K. and Kadam, S.S. Ed. 1995. Handbook of Fruit Science and Technology: Production, Composition and Processing. Marcel Dekker, New York.
8. Salunkhe, D.K. and Kadam, S.S. Ed. 1995. Handbook of Vegetable Science and Technology. Production, Composition, Storage and processing Marcel Dekker, New York.
9. Seymour, G.B., Taylor, J.E. and Tucker, G.A. Ed. 1993. Biochemistry of Fruit, Ripening. Chapman and Hall, London.
10. Srivastava, R.P. and Kumar, S. 2003. Fruit and Vegetable Preservation: Principles and Practices. 2nd Ed. International Book Distributing Co. Lucknow.
11. Ting, S.V. and Roussett, R.L. 1986. Citrus Fruits and Their Products. Marcel Dekker, New York.
12. Thurme S. Ed. 1991. Food Irradiation. Elsevier Applied Science, London.
13. Wills, R.B.H., McGlasson, W.B., Graham, W.B., Lee, T.H. and Hall, E.G. 1981. Postharvest: An Introduction to the Physiology and Handling of Fruits and Vegetables. Granada, U.K.
14. Barret DM, Somogyi LP & Ramaswamy H. 2005. *Processing of Fruits*. CRC Press
15. FAO. 2007. *Handling and Preservation of Fruits and Vegetables by Combined Methods for Rural Areas- Technical Manual*. FAO Agr. Ser. Bull., 149.
16. Fellows P. 2007. *Guidelines for Small-Scale Fruit and Vegetables Processors*. FAO Agr. Ser. Bull., 127.
17. Somogyi LP. et al. 1996. *Processing Fruits - Science and Technology*. Vols I, II. Technomic Publ.
18. Verma LR & Joshi VK. 2000. *Post Harvest Technology of Fruits and Vegetables*. Indus Publ.

**FST-624e. Bakery and confectionary Technology:**

**4CH**

**UNIT I**

Bakery and confectionary industry; raw materials and quality parameters; dough development; methods of dough mixing; dough chemistry; rheological testing of dough-Farinograph, Mixograph, Extensograph, Amylograph / Rapid Visco Analyzer, Falling number, Hosney's dough stickiness tester and interpretation of the data.

**UNIT II**

Technology for the manufacture of bakery products-bread, biscuits, cakes and the effect of variations in formulation and process parameters on the quality of the finished product; quality consideration and parameters; Staling and losses in baking; machineries used in bakery industry.

**UNIT III**

Chocolate Processing Technology, Compound Coatings & Candy Bars, Tempering technology, Chocolate hollow figures, Chocolate shells, Enrobing technology, Manufacture of candy bars, Presentation and application of vegetable fats. Production of chocolate mass. Sugar Confectionery manufacture, General technical aspects of industrial sugar confectionery manufacture, Manufacture of high boiled sweets— Ingredients, Methods of manufacture—Types—Center—filled, lollipops, coextruded products. Manufacture of gums and jellies—Quality aspects.

**UNIT IV**

Quality characteristics of confectionery ingredients; technology for manufacture of flour, fruit, milk, sugar, chocolate, and special confectionary products; colour, flavour and texture of confectionary; standards and regulations; machineries used in confectionery industry. Manufacture of Miscellaneous Products, Caramel, Toffee and fudge— Liquorices paste and aerated confectionery, Lozenges, sugar panning and Chewing gum, Count lines Quality aspects, fruit confections.

**Suggested Readings**

1. Dubey SC. 2002. *Basic Baking*. The Society of Indian Bakers, New Delhi.
2. Francis FJ. 2000. *Wiley Encyclopedia of Food Science & Technology*. John Wiley & Sons.
3. Manley D. 2000. *Technology of Biscuits, Crackers & Cookies*. 2nd Ed. CRC Press.
4. Pylar EJ. *Bakery Science & Technology*. 3rd Ed. Vols. I, II. Sosland Publ.
5. Qarooni J. 1996. *Flat Bread Technology*. Chapman & Hall.
6. Handbook of Food Products Manufacturing: Principles, Bakery, Beverages, Cereals, Cheese, Confectionary, Fats, Fruits, and Functional Foods v. 1 (Hardcover) edited by Y. H. Hui Ph.D., Ramesh C. Chandan, Stephanie Clark, Nanna A. Cross, Joannie C. Dobbs, William J. Hurst, Leo M.L. Nollet PhD, Eyal Shimoni, Nirmal Sinha Ph.D., Erika B. Smith, Somjit Surapat, Alan Titchenal, Fidel Toldrá, John Wiley and sons, 2007.

**FST-624f. Beverages & Snack food Technology:**

**4CH**

**UNIT-I**

Types of beverages and their importance; status of beverage industry in India; Manufacturing technology for juice-based beverages; synthetic beverages; technology of still, carbonated, low-calorie and dry beverages; isotonic and sports drinks; role of various ingredients of soft drinks, carbonation of soft drinks. Specialty

beverages based on tea, coffee, cocoa, spices, plant extracts, herbs, nuts, dairy and imitation dairy-based beverages.

#### **UNIT II**

Alcoholic beverages- types, manufacture and quality evaluation; the role of yeast in beer and other alcoholic beverages, ale type beer, lager type beer, technology of brewing process, equipments used for brewing and distillation, wine and related beverages, distilled spirits. Packaged drinking water- definition, types, manufacturing processes, quality evaluation and raw and processed water, methods of water treatment, BIS quality standards of bottled water; mineral water, natural spring water, flavoured water, carbonated water.

#### **UNIT III**

Technology for grain-based snacks: whole grains – roasted, toasted, puffed, popped and flakes, coated grains-salted, spiced and sweetened; flour based – batter and dough based products; *savoury* and *farsans*; formulated chips and wafers, papads, instant premixes of traditional Indian snack foods.

#### **UNIT IV**

Technology for fruit and vegetable based snacks: Chips, wafers; Technology for coated nuts – salted, spiced and sweetened; *chikkis*. Extruded snack foods: Formulation and processing technology, colouring, flavouring and packaging. Equipments for frying, Baking and drying, toasting, roasting and flaking, popping, blending, Coating, chipping.

#### **Suggested Readings**

1. Edmund WL. *Snack Foods Processing*. AVI Publ.
2. Frame ND. 1994. *The Technology of Extrusion Cooking*. Blackie Academic.
3. Gordon BR. 1997 *Snack Food*. AVI Publ
4. Samuel AM. 1976. *Snack Food Technology*. AVI Publ.
5. Hardwick WA. 1995. *Handbook of Brewing*. Marcel Dekker.
6. Hui YH. *et al* 2004. *Handbook of Food and Beverage Fermentation Technology*. Marcel Dekker.
7. Priest FG & Stewart GG. 2006. *Handbook of Brewing*. 2nd Ed. CRC.
8. Richard P Vine. 1981. *Commercial Wine Making - Processing and Controls*. AVI Publ.
9. Varnam AH & Sutherland JP. 1994. *Beverages: Technology, Chemistry and Microbiology*. Chapman & Hall.
10. Woodroof JG & Phillips GF. 1974. *Beverages: Carbonated and NonCarbonated*. AVI Publ.

<b>FST-625</b>	<b>Practicals Related to FST-621</b>	<b>02CH</b>
<b>FST-626</b>	<b>Practicals Related to FST-622</b>	<b>02CH</b>

### **THIRD SEMESTER**

<b>FST-711</b>	<b>Term Paper</b>	<b>06CH</b>
<b>FST-712</b>	<b>Industrial Tour Report</b>	<b>06CH</b>
<b>FST-713</b>	<b>Seminar</b>	<b>03CH</b>
<b>FST-714</b>	<b>Interim Project Report</b>	<b>05CH</b>

### **FOURTH SEMESTER**

<b>FST-721</b>	<b>Project Report and Evaluation</b>	<b>15CH</b>
<b>FST-722</b>	<b>Project Presentation</b>	<b>03CH</b>
<b>FST-723</b>	<b>Comprehensive Viva-voce</b>	<b>02CH</b>