

**Maulana Abul Kalam Azad University of  
Technology, West Bengal**

**Department of Food Science & Technology**

**M. Sc (Food Science & Technology) Syllabus 2019-20**

**M. Sc in Food Science and Technology  
(SYLLABUS)**

**Duration: 2 Years (Four Semesters)**

**Level: Post Graduate**

**Type: Degree**

**Admission Requirements:**

**B.Sc. in Food and Nutrition /B.Sc.in Food Science/ Bachelor's degree in any other branch of Science and Technology.**

**M.Sc. or Master of Food Science and Technology is a post graduate course. Food Science & Technology is the application of science and technology to the sorting, grading, processing, storage or preserving, refining , mixing, blending, heating, drying, manufacturing, handling, packaging, quality control, and distribution food materials , and also use of good quality, safe, nutritious, healthy, and wholesome food. Increasing technology for value addition of plant , animal, and agricultural resources has made food production extremely complex thus causing a need for a very specialised knowledge based and trained Food Science & Technology professional who can grasp and apply such expertise effectively.**

**In addition the course also includes a significant quantum of industrial learning giving students the opportunities to boost their specialist professional skills facilitate independent learning and implement a reflective and practical approach to practice.**

**Under this program students gain a close perspective of real-world problems to food science and technology. Students interested in more detailed learning of the subject can apply for higher education in national or international forum.**

**The Master degree course in Food Science & Technology is an important and careers oriented nature that opens a lot of job opportunities for the candidate in the position of Food technologist, Nutritional therapist, Product or Process development scientist, Quality control manager, Regulatory affairs officers or Food safety officers, Scientific laboratory technician, Production manager, Technical brewer, etc.**

**M.Sc. (Food Science & Technology) Syllabus, 2019-20**  
**Department of Food Science & Technology, MAKAUT, WB**

**Semester –I:**

<b>Code</b>	<b>Course Title</b>	<b>Contact Hrs./Wk</b>	<b>Credit</b>
<b>A</b>	<b>Theory</b>	<b>L-T-P</b>	
<b>MSUFT-101</b>	<b>Food Microbiology</b>	<b>3-0-0</b>	<b>3</b>
<b>MSUFT-102</b>	<b>Nutritional Biochemistry</b>	<b>3-0-0</b>	<b>3</b>
<b>MSUFT-103</b>	<b>Principles of Food Processing Technology</b>	<b>3-0-0</b>	<b>3</b>
<b>MSUFT-104</b>	<b>Fermentation Technology</b>	<b>3-0-0</b>	<b>3</b>
<b>MSUFT-105</b>	<b>Mathematical Techniques for Food Science</b>	<b>3-0-0</b>	<b>3</b>
<b>MSUFT-106</b>	<b>Analytical Techniques and research methodology</b>	<b>3-0-0</b>	<b>3</b>
<b>MSUFT-107</b>	<b>English communication skill(non-credit compulsory course)</b>	<b>0-0-0</b>	<b>0</b>
<b>B</b>	<b>Practical</b>		
<b>MSUFT-191</b>	<b>Microbiology</b>	<b>0-0-6</b>	<b>3</b>
<b>MSUFT-192</b>	<b>Biochemistry and Analytical Techniques Lab</b>	<b>0-0-6</b>	<b>3</b>
<b>Semester Total</b>			<b>24</b>

**Semester –II:**

<b>Code</b>	<b>Course Title</b>	<b>Contact Hrs./Wk.</b>	<b>Credit</b>
<b>A</b>	<b>Theory</b>	<b>L-T-P</b>	
<b>MSUFT-201</b>	<b>Food Chemistry</b>	<b>3-0-0</b>	<b>3</b>
<b>MSUFT-202</b>	<b>Technology of fruits and vegetables</b>	<b>3-0-0</b>	<b>3</b>
<b>MSUFT-203</b>	<b>Technology of cereals, pulses and oilseeds</b>	<b>3-0-0</b>	<b>3</b>
<b>MSUFT-204</b>	<b>Technology of milk and milk products</b>	<b>3-0-0</b>	<b>3</b>
<b>MSUFT-205</b>	<b>Waste Management of Food Industries</b>	<b>3-0-0</b>	<b>3</b>
<b>MSUFT-206</b>	<b>Statistical Techniques for Food Science</b>	<b>3-0-0</b>	<b>3</b>
<b>B</b>	<b>Practical</b>		
<b>MSUFT-291</b>	<b>Pickles and Fermented Food Lab</b>	<b>0-0-6</b>	<b>3</b>
<b>MSUFT-292</b>	<b>Food Process Technology Lab</b>	<b>3-0-0</b>	<b>3</b>
<b>Semester Total</b>			<b>24</b>

**Semester – III:**

Code	Course Title	Contact Hrs./Wk	Credit
<b>A</b>	<b>Theory</b>	<b>L-T-P</b>	
<b>MSUFT-301</b>	<b>Technology of meat, poultry and fish</b>	<b>3-0-0</b>	<b>3</b>
<b>MSUFT-302</b>	<b>Food Packaging Technology</b>	<b>3-0-0</b>	<b>3</b>
<b>MSUFT-303</b>	<b>Food safety and quality control</b>	<b>3-0-0</b>	<b>3</b>
<b>MSUFT-304</b>	<b>Process control and Instrumentation</b>	<b>3-0-0</b>	<b>3</b>
<b>MSUFT-305</b>	<b>Choice Based course (From Elective Basket-I)*</b>	<b>2-0-0</b>	<b>2</b>
<b>MSUFT-306</b>	<b>Choice Based course (From Elective Basket-II)**</b>	<b>2-0-0</b>	<b>2</b>
<b>B</b>	<b>Practical</b>		
<b>MSUFT-391</b>	<b>Milk and Milk product processing Lab</b>	<b>0-0-6</b>	<b>3</b>
<b>MSUFT-392</b>	<b>Meat and Fish Processing Lab</b>	<b>0-0-6</b>	<b>3</b>
<b>C</b>			
<b>MSUFT-381</b>	<b>Seminar</b>		<b>2</b>
<b>Semester Total</b>			<b>24</b>

**\*Elective Subjects Basket-I:**

Code	Subject
<b>MSUFT-305A</b>	<b>Food Biotechnology</b>
<b>MSUFT-305B</b>	<b>Speciality Food and Beverages</b>
<b>MSUFT-305C</b>	<b>Enzyme Technology</b>

**\*\*Elective Subjects Basket-II:**

Code	Subject
<b>MSUFT-306A</b>	<b>Entrepreneurship and Business Management</b>
<b>MSUFT-306B</b>	<b>Supply Chain and Retail Management</b>
<b>MSUFT-306C</b>	<b>IPR, Biosafety &amp; Bioethics</b>

**Semester –IV:**

Code	Course Title	Contact Hrs./Wk	Credit
	<b>Theory</b>	<b>L-T-P</b>	
<b>MSUFT-481</b>	<b>Project Work</b>		<b>20</b>
<b>MSUFT-482</b>	<b>Industry / Lab visit</b>		<b>1</b>
<b>MSUFT-483</b>	<b>Journal club and seminar presentation</b>		<b>1</b>
<b>MSUFT-491</b>	<b>Grand Viva</b>		<b>2</b>
<b>Total</b>			<b>24</b>
<b>Total Course Credit</b>			<b>96</b>

## SEMESTER I

### **MSUFT-101: Food Microbiology**

**Credit: 3 Marks: 100**

#### **Objective:**

**To have a clear understanding about microbial nutrition, growth, death and control methods. To make oneself acquainted with different groups of micro-organisms associated with food, their activities, destruction and detection in food and to give an introductory idea on Fermentation technology with some fermentation techniques for food & allied items.**

#### **Theory**

**MODULE I:** Microbial nutrition, macronutrients, micronutrients and growth factors; nutritional types of microorganisms based on sources of carbon, energy, and electron; uptake of nutrients by cell (passive and facilitated diffusion, active transport, group translocation, iron uptake); Culture media and culture techniques; Microbial growth curve, growth rate and generation time; measurement of cell number and cell mass; Continuous culture (chemostat, turbidostat); different environmental factors influencing microbial growth (water activity, pH, temperature, oxygen concentration, pressure, radiation); Biofilms.

**MODULE II:** Pattern of microbial death, General Microbial control methods (physical agents, chemical agents, mechanical removal); basic approaches to food preservation (mechanical removal, low temperature, high temperature, water availability, chemical based preservation, radiation, microbial product based inhibition).

**MODULE III:** Intrinsic factors (pH, moisture content, water availability, oxidation-reduction potential, physical structure of the food, available nutrients, possible presence of antimicrobial agents) and extrinsic factors (storage conditions, temperature, relative humidity, modified atmosphere packaging) influencing microbial growth in foods, microbial growth and food spoilage (Milk and milk products, Meat and poultry, fruits and vegetables, Ready-to-serve food products) ;

**MODULE IV:** Microbes in food fermentation, putrefaction, lipolysis; Antagonism and synergism in microorganisms; Microbiology of fermented foods (Fermented milk, Cheese production, Meat and Fish, production of alcoholic beverages –Wines and Champagnes, Beer and Ales, Bread production, etc), Microorganisms as food (Prebiotics, probiotics and symbiotic-system) and food amendments.

**MODULE V:** Food borne diseases (Botulism, Salmonellosis, Listeriosis, Campylobacteriosis, Shigellosis, E.coli diarrhea and colitis, Cholera, Giardiasis, toxoplasmosis, viral gastroenteritis, cryptosporidiosis) and intoxication (botulinum toxin, aflatoxins, fumonisins, ergotism, major genera involved in food-borne intoxication), Food hygiene and sanitation: Contamination during handling and processing and its control; indicator organisms Detection of food-borne pathogens (selective culture media, antigen detection by ELISA, radioimmunoassay technique; molecular techniques using labelled probes linked to variety of enzymatic, isotopic, chromogenic or luminescent/fluorescent markers, serotype specific probes and PCR techniques, food-borne pathogen fingerprinting )

## **Suggested Readings:**

1. Microbiology. Prescott, Harley, and Klein's, 7th edition. McGraw-Hill publication. 2008
2. Fundamental Principles of Bacteriology. A.J. Salle, Tata McGraw-Hill Education. 1974
3. Banawart GJ. 1989. Basic Food Microbiology. 2nd Ed. AVI Publ. Frazier J & Westhoff DC. 1988.
4. Food Microbiology. 4th Ed. McGraw Hill. Garbutt J. 1997.
5. Essentials of Food Microbiology. Arnold Heinemann. Jay JM, Loessner MJ & Golden DA. 2005.
6. Modern Food Microbiology. 7th Ed. Springer. Ray B. 2004.
7. Fundamentals of Food Microbiology. 3rd Ed. CRC. Robinson RK. (Ed.). 1983. Dairy Microbiology. Applied Science. Steinkraus KS. 1996.

## **MSUFT-102 : Nutritional Biochemistry**

**Credit: 3 Marks: 100**

**Objective: To acquaint the students about importance of nutrition, balanced diets, therapeutic diets for maintenance of health and role of food and nutraceuticals in health promoting factors combating against diseases.**

**MODULE I:** Definition, Introduction to biomolecules, Introduction to biochemical and metabolic pathways. Functional aspects of dietary fibre, amino acids & peptides, lactic acid bacteria, antioxidants, vitamins, fatty acids etc. Assessment of nutritional quality of food. Importance of nutrition to health and growth; Relation of food and diseases; Nutritional requirement of human body & RDA.

**MODULE II:** Carbohydrate metabolism, Pathway of glycolysis & its regulation, Energetics & Role of hormone, Pathway of TCA cycle & its regulation, Energetics & Role of hormone, Glycogen metabolism & its regulation, Energetics & Role of hormones, HMP Shunt pathway & its regulation, Protein sparing action of carbohydrate, Inborn error of carbohydrate metabolism (galactosemia), Glycoprotein & Proteoglycan.

**MODULE III:** Lipid metabolism: digestion, absorption and functions. Oxidation of fatty acids. Biosynthesis of fatty acids and fats. Food emulsions. Lipid Metabolism Fatty acid synthesis, Lipoprotein synthesis,  $\beta$ -oxidation &  $\omega$ -oxidation Forward cholesterol, transportation (LDL & VLDL), Reverse cholesterol transportation (HDL), Disorders of lipid metabolism, Dyslipidemia & Lipid storage disease, Ketosis & Ketone body metabolism.

**MODULE IV:** Protein Metabolism, Deamination, Transamination & Transmethylation Urea cycle, Protein structure, Inborn error of amino acid metabolism, Nucleic acid Metabolism, Metabolism of Purine and Pyrimidine, Diseases due to abnormal nitrogen base metabolism, DNA replication, mutation, repair & recombination, Gene Expression, Gene expression in eukaryotes & its regulation (Normal), Translation & post translational modification, Inhibitors of protein biology, Gene expression in mitochondria.

**MODULE V:** Enzymes, Enzyme kinetics including inhibition in enzyme kinetics, Co-enzyme & Co-factors, Enzyme in clinical diagnosis, Vitamins, Free radical, ROS &

Oxidation, Xenobiotics & its Metabolism. Food components and nutrients affecting immune systems, behaviour and performance.

### **Suggested Readings**

1. Principles of biochemistry Lehninger
2. Principles of Biochemistry Voet
3. Bamji MS, Rao NP & Reddy V. 2003. Textbook of Human Nutrition. Oxford & IBH. Joshi SA.1999.
4. Nutrition and Dietetics. Tata McGraw Hill. Khanna K, Gupta S,Passi SJ, Seth R & Mahna R. 1997.
5. Nutrition and Dietetics. Phoenix Publ. Swaminathan M. 1974.
6. Essentials of Foods and Nutrition. Vol. II. Ganesh & Co.
7. Osner hawk's Practical Physiological Chemistry Hawk
8. Practical Biochemistry Thamiah

### **MSUFT-103: Principles of Food Processing Technology**

**Credit: 3 Marks: 100**

#### **Objective:**

**To acquaint with principles of different techniques used in processing and preservation of foods.**

#### **Theory:**

**MODULE I:** Scope of food processing; historical developments; principles of food processing and preservation.

**MODULE II:** Processing and preservation by heat – blanching, pasteurization, sterilization and UHT processing, canning, extrusion cooking, dielectric heating, microwave heating, baking, roasting and frying, etc.

**MODULE III:** Processing and preservation by low-temperature- refrigeration, freezing, CA, MA, and dehydro-freezing.

**MODULE IV:** Processing and preservation by drying, concentration and evaporation-types of dryers and evaporators and their suitability for different food products; ultra- filtration, reverse osmosis.

**MODULE V:** Processing and preservation by non-thermal methods, irradiation, high pressure, pulsed electric field, hurdle technology.

**MODULE VI:** Use and application of enzymes and microorganisms in processing and preservation of foods; food fermentations, pickling, smoking etc; Food additives: definition, types and functions, permissible limits and safety aspects.

#### **Suggested Readings:**

1. Arsdel WB, Copley MJ & Morgan AI. 1973. Food Dehydration. 2nd Ed. Vols. I, II. AVI Publ. Desrosier NW & James N.1977.
2. Technology of Food Preservation. 4th Ed. AVI. Publ. Fellows PJ. 2005.
3. Food Processing Technology: Principle and Practice. 2nd Ed. CRC. Jelen P. 1985. Introduction to Food Processing. Prentice Hall. Potter NN & Hotchkiss 1997.
4. Food Science. 5th Ed. CBS. Potty VH & Mulky MJ. 1993.
5. Food Processing. Oxford & IBH.

6. Ramaswamy H & Marcotte M. 2006. Food Processing: Principles and Applications. Taylor & Francis.

### **MSUFT-104: Fermentation Technology**

**Credit: 3 Marks: 100**

**Objective: To make the student acquainted with the science behind the fermentation process, designing pilot and industrial scale fermenter and the control and regulation of the factors influencing the process. Providing a basic knowledge of bioprocess, downstream processing, waste management and plant sanitation.**

**MODULE I:** Introduction to fermentation: Isolation, screening and maintenance of industrially important microbes; microbial growth kinetics, strain improvement for increased yield and other desirable characteristics. microbes and food fermentations, measurement and control in fermentation, Substrate utilization and product formation. Fermentation Kinetics.

**MODULE II:** Methods in fermentation- Batch, fed-batch and continuous operations; immobilized cell systems; media formulation and optimization; sterilization of media and air; oxygen transfer and  $k_La$  in fermentation. Fermenter design, instruments and operation; Aeration and agitation in fermentation: Types of fermentation, sub-merged and solid state. Types of fermenters, Batch and continuous fermentation, scale up in fermentation,

**MODULE III:** Downstream processing for microbial products- Separation of insoluble products: filtration, centrifugation, sedimentation, flocculation; cell disruption; Separation of soluble products: liquid- liquid extraction, precipitation, chromatography, reverse osmosis, crystallization, ultra and micro filtration; drying and packaging.

**MODULE IV:** Fermented foods and beverages- Food ingredients and additives by fermentation; fermentation as a method of preparing and preserving foods; microbes and their use in pickling, producing colours, flavours and alcoholic beverages; process wastes- whey, molasses, starch substrates and other food wastes for bioconversion to useful products; bacteriocins from lactic acid bacteria. Food Fermentations; Traditional fermented foods of India and other Asian countries; sauerkraut, youghurt, miso, tempeh, idli, dosa.

**MODULE V:** Biological waste treatment, plant sanitation, application of enzymes in food industry, production of food flavour, colour, enzymes, Immobilised enzymes. Regulatory and social aspects of biotechnology of foods.

#### **Suggested Readings:**

1. Indigenous Fermented Foods of South Asia. Marcel Dekker, edited by V. K. Joshi, CRC press-Taylor and Francis group, 2016

#### **Suggested Reading:**

1. S.M. Reddy, Basic Fermentation Technology, New Age Internationals Publisher
2. Peter F Stanbury Allan Whitaker Stephen J Hall. Principles of Fermentation Technology.
3. Syed Sajeed Ali, FERMENTATION AND INDUSTRIAL MICROBIOLOGY
4. Fermentation Microbiology and Biotechnology,  
E. M. T. El-Mansi, C. F. A. Bryce , Arnold L. Demain , A.R. Allman , CRC Press.
5. Casida L.E.J.R. Industrial Microbiology, Wiley Eastern Limited, New Delhi.



6. S. John Pirt, Principles of Microbes and Cell Cultivation, Blackwell Scientific Publications, Oxford, London.
7. Mittal G.S., Food Biotechnology: Techniques and Applications, Technomic, Lancaster, PA.
8. Prescott S.C. & Dunn C.G, Industrial Microbiology, McGraw hill Book Company, INC, New York.
9. Shular, M L and Kargi, F. Bioprocess Engineering, Basic Concepts, Prentice-Hall, Englewood Cliffs, NJ.
10. Aiba, Shuichi, Humphrey Arthur E. and Millis, Nancy. F. Biochemical Engineering, Academic Press INC, , New York.
11. Maiti, B.R. Principles of Bioreactor Design, Viva Books Pvt. Ltd., New Delhi.

### **MSUFT-105: Mathematical Techniques for Food Science**

**Credit: 3 Marks:100**

**MODULE I:** Linear Algebra: Basics, Vectors, matrices, determinants; Matrix addition and multiplication.

**MODULE II:** Differential Calculus: Basic concept of functions, limits & continuity with simple applications. Concepts of derivatives of functions and its Simple applications. Fundamental Concepts of Maxima and Minima; Basics of Partial Derivatives; Gradient and Directional derivatives.

**MODULE III:** Integral calculus: Basic concept of integral calculus with respect to Differential Calculus, integration techniques of some simple basic derivatives, Simple applications of integration for calculation of area & volume. Simpson Rule for graphical integration.

**MODULE IV:** Differential Equations: Examples of 1st & 2nd order differential equations and their techniques of solutions. Partial derivatives and simple applications.

MODULE V: Numerical techniques for solutions of Mathematical problems.

(To be embedded in Module II through Module IV)

#### **Suggested Readings:**

1. G. B. Thomas and R. L. Finney, Calculus and Analytic Geometry, 9th Edition, ISE Reprint, Addison-Wesley, 1998.
2. E. Kreyszig, Advanced engineering mathematics, 8th Edition, JohnWiley, 1999.
3. W. E. Boyce and R. DiPrima, Elementary Differential Equations, 8th Edition, JohnWiley

### **MSUFT-106: Analytical techniques and Research methodology**

**Credit: 3 Marks:100**

#### **Objective**

**To familiarize with the conventional analysis of raw and processed food products of all commodity technologies used for routine quality control in food industry, and their role on nutritional labelling.**

#### **Theory:**

**MODULE I:** Sampling techniques; Water activity, its measurements and significance in food quality; Calibration and standardization of different instruments.

**MODULE II:** Spectroscopic techniques using UV/Vis, fluorescence, IR, FTIR, NIR, NMR, atomic absorption, ICP, polarimetry, refractometry, microscopic techniques in food analysis (light microscopy, SEM, TEM, XRD, particle size analysis, image analysis etc.).

**MODULE III:** Chromatographic techniques: Adsorption, column, partition, affinity, ion exchange, size exclusion, GC, GLC, HPLC, HPTLC, GCMS, LCMS.

**MODULE IV:** Separation techniques: Gel filtration, dialysis, electrophoresis, sedimentation, ultrafiltration and ultracentrifugation, solid phase extraction, supercritical fluid extraction, isoelectric focusing, isotopic techniques, manometric techniques.

**MODULE V:** Special techniques: Immunoassay techniques; Isotopic, non-isotopic and enzyme immunoassays; surface tension; enzymatic methods of food analysis; thermal methods in food analysis (Differential scanning calorimetry and others).

### **Suggested Readings:**

1. AOAC International. 2003. Official methods of analysis of AOAC International. 17th Ed. Gaithersburg, MD, USA, Association of Analytical Communities. Kirk RS & Sawyer R. 1991.
2. Pearson's Chemical Analysis of Foods. 9th Ed. Longman Scientific & Technical. Leo ML. 2004.
3. Handbook of Food Analysis. 2nd Ed. Vols. I-III. Linden G. 1996.
4. Analytical Techniques for Foods and Agricultural Products. VCH. Macleod AJ. 1973.
5. Instrumental Methods of Food Analysis. Elek Sci. Marcel Dekker. 24 Nielsen S. (Eds.). 1994. Introduction to Chemical Analysis of Foods. Jones & Bartlett. Pomrenz Y & Melon CE. 1996.
6. Food Analysis – Theory and Practice. 3rd Ed. CBS. Ranganna S. 2001.
7. Handbook of Analysis and Quality Control for Fruit and Vegetable Products. 2nd Ed. Tata-McGraw-Hill. Robinson JW. 1970.
8. Undergraduate Instrumental Analysis. Marcel Dekker.

### **MSUFT-191: Microbiology Lab      0-0-6, 3**

1. Microscope and its operation, Microscopic examination of bacteria, yeast and molds; Staining
2. Media Preparation, Autoclave operation, Aseptic transfer
3. Standard plate count; Yeast and mould count; Spore count;
4. Detection and enumeration of pathogenic and indicator organisms in food; MPN of coli forms;
5. Enumeration of physiological groups- psychrophilic, thermophilic, osmophiles and halophiles. Evaluation of microbiological quality of commonly consumed street foods. Production of Ethanol and vinegar by Fermentation.

### **MSUFT-192: Biochemistry and Analytical Techniques Lab      0-0-63**

**(Credit: 3, Mark: 100)**

1. Proximate analysis of content of protein and fat in foods;
2. Nitrogen value determination and calculation of calorific value of foods;
3. TSS; pH; acidity in foods and Food Products;
4. Estimation of browning intensity;

5. Determination of vitamin C and beta-carotene, sugars;
6. Estimation of calcium, phosphorus and iron; anti-nutritional factors in foods.
7. Detection of common adulterants in food:

## SEMESTER II

### MSUFT-201: Food Chemistry

**Credit:3 Marks:100**

#### **Objective:**

**To acquaint with properties and role of various constituents in foods, interaction and changes during processing.**

#### **Theory:**

**MODULE I:** Definition and importance; major food constituents and their physicochemical properties; role of water in food. Minerals of Foods: Calcium, phosphorus, iron, copper, lead, zinc & arsenic.

**MODULE II:** Carbohydrates, proteins and lipids: classification, physical, chemical, nutritional, and functional properties and their structural correlations; auto-oxidation of lipids and rancidity.

**Carbohydrates:** Structural, analytical, physicochemical, nutritional and functional aspects of small mol. Wt. carbohydrates, mono, di and polysaccharides, oligosaccharides and prebiotics of plant and microbial origin.

**Lipids:** Occurrence, composition classification, and use of lipids in foods, physical and chemical properties, effects of processing on functional properties and nutritive value. Rancidity and flavor, inversion processing of oil bearing materials, refining of oils and fats, splitting & esterification hydrogenation, shortenings and low fat spreads. Essential Oils: Occurrence, structure, biosynthesis, monoterpene sesquiterpenes, oxygenated terpenes, extraction of essential oils, terpenless oils, and uses in foods.

**Protein and amino acids:** Physical and chemical properties, distribution, amount and functions of proteins in foods, functional properties, effect of processing.-Losses of vitamins and minerals due to processing.

**MODULE III:** Properties of minerals, vitamins, pigments, anti-oxidants, flavour components, allergens, toxins and anti-nutritional factors in foods; Interaction of constituents in food systems; Changes during storage and processing; Browning reactions in foods.

Pectic Substances its occurrence, structure, properties and uses in foods. Enzymes in foods, and food industry, bio-deterioration of foods, food contaminants, additives and toxicants.

**MODULE IV:** Food groups and their typical composition; essential nutrients- sources, functions, deficiency diseases; requirements and recommended dietary allowances; digestion, absorption, transport and metabolism of nutrients in human system; protein quality evaluation.

#### **Suggested Readings:**

1. Principles of Food Chemistry. John M. deMan, Springer Publ., 3rd edition, 1999.
2. Food Chemistry. Fennema Owen R., Food Science & Technology series, CRC press, New York, 4th edition, 2007.
3. Food Chemistry. Lillian Hoagland Meyer, CBS publication, New Delhi, 2nd edition, 2006.

4. Food Science Chemistry & Experimental Foods. M. Swaminathan, Bappco publ., 2nd edition, 2001.
5. Food Chemistry. S. Yadav, Anmol Publications, 1st edition, 1997.

## **MSUFT-202 Technology of fruits and vegetables Credit: 3 Marks: 100**

### **Objective:**

**To acquaint with principles and methods of preservation of fruits and vegetables into various products.**

### **Theory:**

**MODULE I:** Importance & scope of post-harvest management of fruits and vegetables in Indian economy. 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.

**MODULE II:** 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 pre-treatments - chemicals, wax coating, pre-packaging, VHT and irradiation.

**MODULE III:** Indian and global scenario on production and processing of fruits and vegetable; Quality requirements of raw materials for processing; sourcing and receiving at processing plants; primary processing: grading, sorting, cleaning, washing, peeling, slicing and blanching; minimal processing. Processing for pulp, puree and concentrates, especially from mango, tomato, guava, papaya, apple, pineapple, pomegranate, grapes etc. using aseptic packaging, canning, RTS fruit beverages, IQF and frozen fruits and vegetables; for peas, mango pulps etc.

**MODULE IV:** Technology for processed products like pickles, chutneys, sauces particularly from raw mango, lime and other regional fruits and vegetables of importance.

**MODULE V:** Dehydration of fruits and vegetables using various drying technologies like sun drying, solar drying (natural and forced convection), osmotic, tunnel drying, fluidized bed drying, freeze drying, convectional and adiabatic drying; applications to raisins, dried figs, vegetables, intermediate moisture fruits and vegetables. Fruit powders using spray drying. Processing of fruits for candies, bars, toffees, jams and jellies, squashes and syrups using locally available fruits like papaya, mango, aonla and other under-utilized fruits.

### **Suggested Readings**

1. Barret DM, Somogyi LP & Ramaswamy H. 2005. Processing of Fruits. CRC Press FAO. 2007.
2. Handling and Preservation of Fruits and Vegetables by Combined Methods for Rural Areas- Technical Manual. FAO Agr. Ser. Bull., 149. Fellows P. 2007.
3. Guidelines for Small-Scale Fruit and Vegetables Processors. FAO Agr. Ser. Bull., 127. Lal G, Siddappa GS & Tandon GL. 1998.
4. Preservation of Fruits and Vegetables. ICAR. Salunkhe DK & Kadam SS. 1995. Handbook of Fruit Science & Technology: Production, Composition and Processing. Marcel Dekker. Salunkhe DK & Kadam SS. 1995.

5. Handbook of Vegetables Science & Technology: Production, Composition, Storage and Processing. Marcel Dekker. Somogyi LP. et al. 1996.
6. Processing Fruits - Science and Technology. Vols I, II. Technomic Publ. Srivastava RP & Kumar S. 2003.
7. Fruit and Vegetable Preservation - Principles and Practices. International Book Distributors. Verma LR & Joshi VK. 2000.
8. Post-Harvest Technology of Fruits and Vegetables. Indus Publ.

### **MSUFT-203: Technology of cereals, pulses and oilseeds**

**Credit:3 Marks:100**

#### **Objective:**

**To acquaint with production and consumption trends, structure, composition, quality evaluation, and processing technologies for product development and value addition of various cereals, pulses and oilseeds.**

#### **Theory:**

**MODULE I:** General introduction and production and utilization trends; Structure and composition of common cereals, pulses and oilseeds.

**MODULE II:** Wheat: Types and physicochemical characteristics; wheat milling - products and by-products; 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. 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, interpretation of the data.

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.

**MODULE III:** 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.

**MODULE IV:** Corn: Types and nutritive value; dry and wet milling, manufacture of value-added products; processing of barley, oats, sorghum and millets.

**MODULE V:** 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.

#### **Suggested Readings:**

1. Chakrabarty MM. 2003. Chemistry and Technology of Oils and Fats. Prentice Hall. Dendy DAV & Dobraszczyk BJ. 2001.
2. Cereal and Cereal Products. Aspen. Hamilton RJ & Bhati A. 1980.

3. Fats and Oils - Chemistry and Technology. App. Sci. Publ. Hosenev RS. 1994.
- Principles of Cereal Science and Technology. 2nd Ed. AACC. Kay DE. 1979.
4. Food Legumes. Tropical Products Institute. Kent NL. 1983. Technology of Cereals. 4th Ed. Pergamon Press. Kulp K & Ponte GJ. 2000.
5. Handbook of Cereal Science and Technology. 2nd Ed. Marcel Dekker. Lorenz KL.1991.
6. Handbook of Cereal Science and Technology. Marcel Dekker. Marshall WE & Wadsworth JI. 1994.
7. Rice Science and Technology. Marcel Dekker. Mathews RH. 1989.
8. Legumes Chemistry, Technology and Human Nutrition. Marcel Dekker. Matz SA. 1969. Cereal Science. AVI Publ. Paquot C. 1979.
9. Standard Methods of Analysis of Oils, Fats and Derivatives. Pergamon Press. Pomeranz Y. 1987.
10. Modern Cereal Science & Technology. VCH Publ. Salunkhe DK.1992.
11. World Oilseeds: Chemistry, Technology and Utilization. VNR. Swern D. 1964.
12. Bailey's Industrial Oil and Fat Products. InnterSci. Publ. 28 Watson SA & Ramstad PE.1987. Corn; Chemistry and Technology. AACC.

#### **MSUFT-204 Technology of milk and milk products**

**Credit: 3 Marks: 100**

##### **Objective:**

**To acquaint with techniques and technologies of testing and processing of milk into various products and by products.**

**MODULE 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.

**MODULE 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. 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.

**MODULE III:** Ice cream- Definition, composition and standards, nutritive value, classification, methods of manufacture, evaluation, defects in ice cream, and technology aspects of softy manufacture.

**MODULE IV:** Cheese: Definition, composition, classification, methods of manufacture, cheddar, Gouda, cottage and processed cheese, evaluation, defects in cheese.

**MODULE V:** 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.

## **MSUFT-205 Waste Management of Food Industries**

**(CREDITS: 3 Marks: 100)**

### **MODULE I:**

**Introduction:** Classification and characterization of food industrial wastes from Fruit and Vegetable processing industry, Beverage industry; Fish, Meat & Poultry industry, Sugar industry and Dairy industry; Waste disposal methods – Physical, Chemical & Biological; Economical aspects of waste treatment and disposal.

### **MODULE II:**

Treatment methods for liquid wastes from food process industries; Design of Activated Sludge Process, Rotating Biological Contactors, Tricking Filters, UASB, Biogas Plant.

### **MODULE III:**

Treatment methods of solid wastes: Biological composting, drying and incineration; Design of Solid Waste Management System: Landfill Digester, Vermicomposting Pit.

### **MODULE IV:**

Biofilters and Bioclarifiers, Ion exchange treatment of waste water, Drinking-Water treatment, Recovery of useful materials from effluents by different methods.

### **Suggested Readings:**

1. Food Industry Wastes: Disposal and Recovery; Herzka A & Booth RG; 1981, Applied Science Pub Ltd.
2. Water & Wastewater Engineering; Fair GM, Geyer JC & Okun DA; 1986, John Wiley & Sons, Inc.
3. Wastewater Treatment; Bartlett RE; Applied Science Pub Ltd.
4. Symposium: Processing Agricultural & Municipal Wastes; Inglett GE; 1973, AVI.
5. Food Processing Waste Management; Green JH & Kramer A; 1979, AVI.
6. Environmental Biotechnology: Principles and Applications; Rittmann BE & McCarty PL; 2001, Mc-Grow-Hill International editions.
7. Environmental Biotechnology; Bhattacharyya B C & Banerjee R; Oxford University Press.

## **MSUFT-206: Statistical Techniques for Food Science**

**Credits: 3**

**Marks: 100**

**MODULE I:** Statistical Techniques - Definition of Probability, Relative frequency, Probability distribution with simple examples.

**MODULE II:** Statistics - Measure of central tendency – Mean (for grouped & ungrouped data); Measure of dispersion- Standard Deviation (for grouped & Ungrouped data);

**MODULE III:** Sampling theory –Statistical population, Sample from population, Random sample; Statistical Hypothesis - Test of significance, Test for proportion, means & standard deviations, Chi-square test of goodness of fit, t-test, F-test. Correlation & Regression (linear) - Associated test of significance, simple problems.

MODULE IV: Fundamental concepts in applied probability - Exploratory data analysis and statistical inference; Probability and analysis of one and two way samples; discrete and continuous probability models;

MODULE V: Hypothesis; Critical region and error probabilities; Tests for proportion; Equality of proportions; equality of means of normal populations (variance known, variance unknown); P-value of the statistic; Confidence limits; Introduction to one way and two-way analysis of variance; Data transformation Corrector methods;

Module VI: Exposure to software packages like Matlab or Scilab, R, Python, Statistica, SPSS. Solving real life application problem related to food science and technology field (data analytic concept with the help of some language like R, Python).

### **Suggested Readings:**

1. Fundamentals of Statistics 7th Edition, S. C. Gupta, Publisher: Himalaya Publishing House Pvt. Ltd
2. Statistical Methods 43rd Edition, S. P. Gupta, Publisher: Sultan Chand and Sons.
3. The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Trevor Hastie (Author), Robert Tibshirani (Author), Jerome Friedman (Author) Publisher : Springer Series in Statistics .
4. Cambridge International AS & A Level Mathematics: Probability & Statistics 1 Course book , Dean Chalmers (Author), Julian Gilbey (Editor), Publisher Cambridge Assessment International Education ,

### **MSUFT-291: Pickles and Fermented Food Lab (Credit: 3, Mark:100)**

1. Evaluation of pectin grade; canning of mango/guava/papaya;
2. Preparation and quality evaluation of fruit jam: apple/ mango/ guava /papaya / strawberry and fruits of regional importance; fruit jelly, wood apple, sweet orange/mandarin/guava,/tamarind; fruit marmalade: ginner marmalade;
3. Fruit preserve and candy; fruit RTS, squash, syrup and candy;
4. Preparation of grape raisin, dried fig and dried banana;
5. Processing of tomato products; preparation of anardana;
6. Preparation of papain /guava jam, jelly and marmalade;
7. Preparation of pickle, mixed pickle;
8. Preparation of dried ginger; preparation of amchur;
9. Preparation of dried onion and garlic;
10. Preparation of banana and potato wafers;
11. Preparation of dehydrated vegetables.

### **MSUFT-292 Food Process Technology Lab**

**Credits: 3 Marks: 100**

1. Determination of thermal inactivation time of enzymes;
2. Thermal processing of foods; Dehydration of foods;
3. Refrigeration Freezing of foods; Concentration of foods;
4. Use of chemicals in preservation of foods;
5. Extrusion cooking of foods;



## **SEMESTER III**

### **MSUFT-301: Technology of meat, poultry and fish Credit: 3 Marks: 100**

#### **Objective:**

To provide an understanding of the technology for handling, processing, preservation and bi-product utilization of meat, poultry and fish products processing.

**MODULE I:** Meat composition from different sources; muscle structure and compositions; post-mortem muscle chemistry; meat colour and flavours; meat microbiology and safety, Effect of processing on meat tenderisation, fish harvest, freezing and processing techniques.

**MODULE II:** Chilling and freezing of carcass fish and meat; canning, cooking, drying, pickling, curing and smoking; prepared fish and meat products like salami, kebabs, sausages, sliced, minced, corned; intermediate moisture and dried meat products; meat plant hygiene – GMP and HACCP; Packaging of meat products.

**MODULE III:** Poultry industry in India, microbiology of poultry meat, spoilage factors; Lay-out and design of poultry processing plants, Plant sanitation; Poultry meat processing operations, equipment used. Packaging of poultry products, refrigerated storage of poultry meat, by products – eggs, egg products, Whole egg powder, Egg yolk products, their manufacture, packaging and storage.

**MODULE IV:** Commercially important marine products from India; product export and its sustenance; basic biochemistry and microbiology; preservation of postharvest fish freshness; cold chain transportation in refrigerated vehicles; preservation of shell fish; pickling and preparation of fish protein concentrate, fish oil and other by products. Handling of fish and meat waste by-products.

#### **Suggested Readings**

1. Forrest JC. 1975. Principles of Meat Science. Freeman. Govindan TK. 1985.
2. Fish Processing Technology. Oxford & IBH. Hui YH. 2001.
3. Meat Science and Applications. Marcel Dekker. 32 Kerry J. et al. 2002.
4. Meat Processing. Woodhead Publ. CRC Press. Levie A. 1984.
5. Meat Hand Book. 4th Ed. AVI Publ. Mead M. 2004.
6. Poultry Meat Processing and Quality. Woodhead Publ. Mead GC. 1989. Processing of Poultry. Elsevier. Pearson AM & Gillett TA. 1996.
7. Processed Meat. 3rd Ed. Chapman & Hall. Stadelman WJ & Cotterill OJ. 2002. Egg Science and Technology. 4th Ed. CBS.

### **MSUFT-302: Food Packaging Technology**

**(Credit: 3 Marks: 100)**

#### **Objective:**

**To acquaint the students with packaging methods, packaging materials, packaging machineries, modern packaging techniques etc.**

**MODULE I :** Definitions, objectives and functions of packaging and packaging materials; Packaging requirements and selection of packaging materials; Types of packaging materials: Paper: pulping, fibrillation and beating, types of papers and their testing methods; Glass:

composition, properties, types of closures, methods of bottle making; Metals: Tinsplate containers, tinning process, components of tinsplate, tin free steel (TFS), types of cans, aluminum containers, lacquers; Plastics: types of plastic films, laminated plastic materials, co-extrusion, edible films, biodegradable plastics.

**MODULE II :** Properties of materials such as tensile strength, bursting strength, tearing resistance, puncture resistance, impact strength, tear strength, their methods of testing and evaluation; Barrier properties of packaging materials: Theory of permeability, factors affecting permeability, permeability coefficient, gas transmission rate (GTR) and its measurement, water vapour transmission rate (WVTR) and its measurement, prediction of shelf life of foods, selection and design of packaging material for different foods.

**MODULE III:** Food packaging systems: Different forms of packaging such as rigid, semirigid, flexible forms and different packaging system for (a) dehydrated foods (b) frozen foods (c) dairy products (d) fresh fruits and vegetables (e) meat, poultry and sea foods.

**MODULE IV:** Packaging equipment and machinery: Vacuum, CA and MA packaging machine; gas packaging machine; seal and shrink packaging machine; form and fill sealing machine; aseptic packaging systems; bottling machines; carton making machines.

**MODULE V:** 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.

**Suggested Readings:**

1. Crosby NT.1981. Food Packaging: Aspects of Analysis and Migration Contaminants. App. Sci. Publ. Kadoya T. (Ed). 1990.
2. Food Packaging. Academic Press. Mahadeviah M & Gowramma RV. 1996.
3. Food Packaging Materials. Tata McGraw Hill. Palling SJ. (Ed). 1980. Developments in Food Packaging. App. Sci. Publ. Painy FA. 1992.
4. A Handbook of Food Packaging. Blackie Academic. Sacharow S & Griffin RC. 1980.
5. Principles of Food Packaging. AVI Publ. Stanley S & Roger CG.1970.
6. Food Packaging. AVI Publ. 22 FST 506

**MSUFT-303 Food safety and quality control**

**Credit: 3 Marks: 100**

**Objective:**

**To acquaint with food quality parameters and control systems, food standards, regulations, specifications.**

**Theory:**

**MODULE I:** Concept of quality: Quality attributes- physical, chemical, nutritional, microbial, and sensory; their measurement and evaluation; Sensory vis-à-vis instrumental methods for testing quality.

**MODULE II :** 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.

**MODULE III:** 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;

**MODULE IV:** 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.

**Suggested Readings:**

1. Amerine MA, Pangborn RM & Rosslos EB. 1965. Principles of Sensory Evaluation of Food. Academic Press. Early R.1995.
2. Guide to Quality Management Systems for Food Industries. Blackie Academic. Furia TE.1980.
3. Regulatory status of Direct Food Additives. CRC Press. Jellinek G. 1985.
4. Sensory Evaluation of Food - Theory and Practice. Ellis Horwood. Krammer A & Twigg BA.1973.
5. Quality Control in Food Industry. Vol. I, II. AVI Publ. Macrae R, Roloson R & Sadlu MJ. 1994.
6. Encyclopedia of Food Science & Technology & Nutrition. Vol. XVI. Academic Press. Piggot J.R. 1984.
7. Sensory Evaluation of Foods. Elbview Applied Science. Ranganna S. 2001. Handbook of Analysis and Quality Control for Fruit and Vegetable Products. 2nd Ed. Tata-McGraw-Hill.
8. Export/Import policy by Govt. of India.

**MSUFT-304: Process Control and Instrumentation**

**Credit: 3 Marks: 100**

**Objective:**

**MODULE I:** Process variables: Need for their measurement and control pressure measurement by mechanical and electrical transducers. Low pressure measurement by McLeod Gauge and Pirani gauge. Temperature measurement by bi-metal thermometers, resistance thermometer thermistors, thermocouples. Radiation and optical pyrometers.

**MODULE II:** Flow measurement by Hot – Wire anemometer and magnetic flow meters. Visualization by shadow-graph and interferometer. Liquid level measurement in open vessels and in pressure vessels.

**MODULE III:** Thermal conductivity measurement of solids, liquids and gases. Measurement of diffusivity in gases. Block diagrams. Transfer function closed-loop and open-loop control systems. Response of first order systems and first order systems. Response of time constant.

**MODULE IV:** Different types of controllers. Final control elements. Closed loop transfer functions. Stability Root locus method. Frequency response. Level control. Flow control. Dynamics and control of heat exchangers and distillation columns.

**MODULE V: case study**

## **Suggested Readings:**

1. Process Dynamics and Control, By Dale E Seborg, Duncan A. Mellichamp and Thomas F, Edgar, John Wiley & Sons, 2006.
2. Process Control: A Practical Approach by Myke King, John Wiley & Sons, 2010.
3. Process Control Instrumentation Technology, by Curtis D Johnson, Prentice Hall, 1997.
4. Instrumentation and Process Control, by Thomas A. Weedon, American Technical Publishers, 2014.
5. Fundamentals of Automatic Process Control, By Ray Chaudhuri, CRC Press.

## **MSUFT-305A : Food Biotechnology(Elective)**

**(Credit: 3 Marks: 100)**

### **Objective:**

**To provide knowledge of current practices in the sector of food technology which can acquaint the students more about the latest developments and waste utilisation**

**MODULE I:** Biotechnology- definition, scope and applications, Application of Biotechnology in food (Food industries), pharmaceuticals and agriculture, Application of biotechnology for food plant waste utilization, biogas plants.

**MODULE II:** Introduction to nutraceuticals and functional foods, definitions, basis of claims for a compound as a nutraceutical, regulatory issues for nutraceuticals including CODEX. Nutraceuticals for different human metabolic disorders, dosage levels, contraindications if any etc.

**MODULE III:** Manufacturing aspects of selected nutraceuticals such as lycopene, isoflavonoids, glucosamine, phytosterols etc.; formulation of functional foods containing nutraceuticals – stability and analytical issues, labelling issues.

**MODULE IV:** Prebiotics, Probiotics, preparation and their mechanism of action . 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.

**MODULE V:** GMO, genetic recombination mechanisms and technique used for improvement in microbial strains, Recombinant-DNA technology (plasmids and cloning), Expression of foreign genes, Promoters (Enzyme), Biomass production by using various microorganisms.

**MODULE VI:** Enzymes for production of protein hydrolysates and bioactive peptides, maltodextrins and corn syrup solids (liquefaction, saccharification, dextrinization, isomerization for production of high-fructose-corn-syrup), fructose and fructo-oligosaccharides. Enzymes as processing aids: Role of enzymes in cheese making and whey processing; fruit juices (cell wall degrading enzymes for liquefaction, clarification, peeling, debittering, decolourization of very dark coloured juices such as anthocyanases); baking (fungal  $\alpha$ -amylase for bread making; maltogenic  $\alpha$ -amylases for anti-staling; xylanases and pentosanases as dough conditioners; lipases or dough conditioning; oxidases as replacers of chemical oxidants; synergistic effect of enzymes); meat and meat processing (meat tenderization); egg processing.

### **Suggested Readings:**

1. Flickinger MC & Drew SW. 1999. Encyclopedia of Bioprocess Technology. A Wiley- Inter Science Publ. Kruger JE. et al. 1987.
2. Enzymes and their Role in Cereal Technology. American Association of Cereal Chemists Inc. Nagodawithana T & Reed G. 1993.
3. Enzymes in Food Processing. Academic Press. Tucker GA & Woods LFJ. 1991. Enzymes in Food Processing. Whitehurst R & Law B. 2002; Brigelius-Flohé, J & Joost HG. 2006.
4. Nutritional Genomics: Impact on Health and Disease. Wiley VCH. Cupp J & Tracy TS. 2003.
5. Dietary Supplements: Toxicology and Clinical Pharmacology. Humana Press. Gibson GR & William CM. 2000.
6. Functional Foods - Concept to Product. Goldberg I. 1994.
7. Functional Foods: Designer Foods, Pharma Foods. Losso JN. 2007.
8. Anti-angiogenic Functional and Medicinal Foods. CRC Press. Manson P.2001. Dietary Supplements. 2nd Ed. Pharmaceutical Press. Campbell JE & Summers JL. 2004.
9. Dietary Supplement Labeling Compliance. Neeser JR & German BJ. 2004. Bioprocesses and Biotechnology for Nutraceuticals. Chapman & Hall. Robert EC. 2006.
10. Handbook of Nutraceuticals and Functional Foods. 2nd Ed. Wildman. Shi J. (Ed.). 2006.
11. Functional Food Ingredients and Nutraceuticals: Processing Technologies. CRC Press. Webb GP. 2006.
12. Dietary Supplements and Functional Foods. Blackwell Publ. Enzymes in Food Technology. Blackwell Publ. FST.

### **MSUFT-305B: Speciality Food and Beverages(Elective)**

**(Credit: 3 Marks: 100)**

#### **Objective:**

**To impart basic and applied technology of baking and confectionary, beverages and acquaint with the manufacturing technology of different food products.**

**MODULE I:** 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.

**MODULE II:** Technology for fruit and vegetable based snacks: Chips, wafers; Technology for coated nuts – salted, spiced and sweetened; chikkis . 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.

**MODULE III:** Extruded snack foods: Formulation and processing technology, colouring, flavouring and packaging. Specialty beverages based on tea, coffee, cocoa, spices, plant extracts, herbs, nuts, dairy and imitation dairy-based beverages.

**MODULE IV :** 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.

**MODULE V:** Equipment for frying, Baking and drying, toasting, roasting and flaking, popping, blending, Coating, chipping.

**Suggested Readings:**

1. Edmund WL. Snack Foods Processing. AVI Publ. Frame ND .1994.
2. The Technology of Extrusion Cooking. Blackie Academic. Gordon BR.1997
3. Snack Food.AVI Publ Samuel AM.1976. Snack.
4. Handbook of Brewing. Marcel Dekker. Hui YH. et al 2004.

**MSUFT-305C: Enzyme Technology(Elective)**

**Credit:2**

**Unit Module I: Enzymes:** Classification, mode of action, activation, specificity, Source of enzymes; production, isolation and purification of enzymes; Characterization in terms of pH, temperature, ionic strength, substrate and product tolerance, effects of metal ions; Coenzymes and cofactors: Coenzymes, classification of vitamins, role and mechanism of action of some important coenzyme (NAD<sup>+</sup>/NADP<sup>+</sup>, FAD, lipoic acid, tetrahydrofolate, B12-coenzyme), role of cofactors with specific examples.

**Module II:Enzyme kinetics**

Enzyme as biological catalysts; Enzyme action, active site, functional group, enzyme substrate complex, cofactors, Michaelis-Menten equation,  $K_m$  and  $V_{max}$ , enzyme inhibition; order of reaction, methods of plotting enzyme kinetics data; Enzyme turnover number. competitive, non-competitive, uncompetitive, irreversible; order of reaction, methods of plotting enzyme kinetics data; determination of  $K_{cat}$ ,  $K_m$ ,  $V_{max}$ ,  $K_i$ , Half life, activation and deactivation energy etc, Cross-linked enzyme aggregates, Cross linked enzymes, enzyme crystals, their use and preparation; Solution of numerical problems; Energy yielding and energy-requiring reactions; Calculation of equilibrium constants; Activation energy etc.; Multi-substrate enzymes and kinetics mechanisms; Enzyme induction, repression, covalent modification, Isoenzymes, allosteric effects.

**Module III: Applications of enzyme technology**

Immobilized enzyme technology: Different techniques of immobilization of enzymes and whole cells; Advantages and disadvantages of immobilization; Kinetics of immobilized enzymes, design and operation of immobilized enzymes reactors; Type of reactors, classification, retention of enzymes in a reactor, kinetics of enzyme reactors; Reactor performance with inhibition, operation of enzyme reactors; case studies; starch conversion; APA production, bio-transformations using soluble as well as immobilized enzymes; Calculation of diffusional resistances and Thiele's modulus, multi-step immobilized enzyme

systems; Solution of numerical problems; Application and future of immobilized enzyme technology; Enzyme in organic solvents and ionic liquids: Various organic solvents and ionic liquids used in biocatalysis; Potential in organic solvents and ionic liquids; Applications of enzymes in analysis.

### **Text/References**

1. Stryer, L. (2002). Biochemistry. Freeman. New York.
2. Lehninger, A. L. (2004). Principles of Biochemistry (4th ed.). Worth. New York, NY
3. Voet, D., & Voet, J. G. (2004). Biochemistry (4th ed.). Wiley & Sons. Hoboken, NJ: J
4. Rehm, H. & J. Reed, G., (1986). Enzyme Technology. Volume 7a. John Wiley & Sons.
5. Irwin H. Segel, (1976). Biochemical Calculations: How to Solve Mathematical Problems in General Biochemistry, 2nd revised Ed. John Wiley & Sons.
6. Biotol, (1992). Bioreactor Design & Product Yield. Butterworth-Heinemann
7. Wang, D. I. C. (1979). Fermentation and Enzyme Technology. Wiley. New York.

### **\*\*Elective Subjects Basket-II:**

#### **MSUFT-306A: Entrepreneurship and Business Management (Elective)**

**(Credit: 3 Marks: 100)**

#### **Objective:**

**To acquire the knowledge and techniques of Business Management & International Trade for Entrepreneurship in food sector.**

**Theory:** Introduction to Entrepreneurship: Meaning and concept of entrepreneurship, the history of entrepreneurship development, role of entrepreneurship in economic development, agencies in entrepreneurship management and future of entrepreneurship. The Entrepreneur: Meaning of entrepreneur, the skills required to be an entrepreneur, the entrepreneurial decision process, and role models, mentors and support system. Business Opportunity Identification: Business ideas, methods of generating ideas, and opportunity recognition. Preparing a Business Plan: Meaning and significance of a business plan, components of a business plan, and feasibility study . Financing the New Venture: Importance of new venture financing, types of ownership securities, venture capital, types of debt securities, determining ideal debt-equity mix, and financial institutions and banks. Launching the New Venture: Choosing the legal form of new venture, protection of intellectual property, and marketing the new venture. Managing Growth in New Venture: Characteristics of high growth new ventures, strategies for growth, and building the new venture capital. Harvesting Rewards: Exit strategies for entrepreneurs, bankruptcy, and succession and harvesting strategy.

**MODULE I:** Concept and functions of marketing; concepts and scope of marketing management; concepts and elements of marketing mix.

**MODULE II:** Concept of market structure, micro and macro environments; Consumer behaviour; consumerism; Marketing opportunities- Analysis, marketing research and marketing information systems.

**MODULE III :** Market measurement- present and future demand; Market forecasting; market segmentation, targeting and positioning, Allocation and marketing resources,

Marketing Planning Process, Product policy and planning: Product-mix; product line; product life cycle, New product development process. Product brand, packaging, services 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, Promotion-mix decisions.

**MODULE IV:** Advertising; how advertising works? Deciding advertising objectives, advertising budget and advertising message, Media Planning, Personal Selling, Publicity; Sales Promotion, Food and Dairy Products Marketing.

**MODULE V :** International Marketing and International Trade, Salient features of International Marketing, Composition & direction of Indian exports; International marketing environment; Deciding which & how to enter international market; Exports- Direct exports, indirect exports, Licensing, Joint Ventures, Direct investment & internationalization process, Deciding marketing Programme; Product, Promotion, Price, Distribution Channels. Deciding the Market Organization; World Trade Organization (WTO).

**Suggested Readings:**

1. Chhabra TN & Suria RK. 2001. Management Process and Perspectives. Kitab Mahal. Jhingan ML. 2005.
2. International Economics. 5th Ed. Virnda Publ. Kotler P. 2000.
3. Marketing Management. Prentice Hall. Reddy SS, Ram PR, Sastry TVN & Bhavani ID. 2004.
4. Agricultural Economics. Oxford & IBH.

**MSUFT-306B: Supply Chain and Retail Management (Elective)**

**(Credit: 3 Marks: 100)**

**MODULE-I: Introduction: Introduction to supply chains in India, Types of food Chain, Factors Influencing Food Supply Chains, Case studies in food supply chain.**

**MODULE II:** Food Production: Entities in agriculture supply chain, Agriculture and poverty alleviation, barriers in development of agri-industry, future steps for agriculture industry. Case studies on farmer empowerment by Industry. Food Manufacturing: Importance of food processing, market conditions, food processing and packaging, Inventory management, food safety, procurement, Case studies Food retailing: The retail environment, Online retailing of food, Future challenges in food retailing Food Logistics: movement of Food, Trends in food logistics, packaging in logistics, temperature controlled in supply chains, Case studies

**MODULE III:** Challenges in International food supply chains: International food supply chains, Factor affecting international food supply, International politics and food, Case studies Food Sourcing and Procurement: sourcing, sourcing models, purchasing models, supplier segmentation, supplier development, strategic sourcing, sustainable procurement, case example Risk Management: Risk management and uncertainty, Risks in the supply chain, Risks in the food supply chain, managing supply chain risks, managing risks in food supply chains, Case examples.

**MODULE IV:** Trends in Food Supply Chains: Traceability and use of technology, food production, food processing in as technological context, food packaging in a technological context, food logistics. Cold Chain technology and Management: Food regulation, safety and



quality: Attributes to consider when designing food supply chains, food regulation and its effect on safety, food laws and regulation, Reference standards, compatibility standards, private food standards, other initiatives within the food supply chains, case examples.

**MODULE V:** Sustainability challenges in food supply chain: Introduction to sustainability, sustainable supply chains, sustainable food supply chains, measuring sustainability, developing sustainability within food supply chains, case studies

**Suggested Readings:**

1. Food Supply Chain Management and Logistics from Farm to fork. Samir Dani, Kogan Page
2. Food Supply Chain Management. Michael A. Bourlakis (Editor), Paul W. H. Weightman (Editor), Wiley-Blackwell.
3. Food Safety Regulatory Compliance: Catalyst for a Lean and Sustainable Food Supply Chain, by Preston W. Blevins

**MSUFT-306C IPR, Biosafety & Bioethics (Elective)**

**credits: 3**

**Module I: Intellectual property rights**

Intellectual property right and Intellectual its importance. Types of IPR. PATENTS Macro economic impact of the patent system Patent and kind of inventions protected by a patent. Patent document and protection inventions. Granting of patent Rights of a patent. Searching a patent. Drafting of a patent. Filing of a patent. The different layers of the international patent system (national, regional and international options) COPYRIGHT General Additional Reading: Latest editions of Designs Act, Copyright RELATED RIGHTS. Distinction between related rights and copyright. Rights covered by copyright.

TRADEMARKS and its importance, Rights of trademark, Industrial design. Protection provided by industrial designs.

**Module II: Bioethics**

Introduction, ethical conflicts in biological sciences - interference with nature, bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy, transplantation. Bioethics in research – cloning and stem cell research, Human and animal experimentation, animal rights/welfare, Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations - Protection of environment and biodiversity – bio-piracy. Bio-weapons.

**Module III: Biosafety**

Biosafety and Biosecurity - introduction; historical background; Introduction to biological safety cabinets; primary containment for biohazards; biosafety levels, biosafety levels of specific microorganisms; recommended biosafety levels for infectious agents and infected animals; definition of GMOs & LMOs; principles of safety assessment of transgenic plants – sequential steps in risk assessment; concepts of familiarity and substantial equivalence; risk – environmental risk assessment and food and feed safety assessment; problem formulation – protection goals, compilation of relevant information, risk characterization and development of analysis plan; risk assessment of transgenic crops vs cisgenic plants or products derived from RNAi, genome editing tools.

**Suggested Readings:**

1. Ganguli, P. (2001). Intellectual Property Rights: Unleashing the Knowledge Economy. New Delhi: Tata McGraw-Hill Pub.
2. National IPR Policy, Department of Industrial Policy & Promotion, Ministry of Commerce, GoI
3. Complete Reference to Intellectual Property Rights Laws. (2007). Snow White Publication Oct.
4. Kuhse, H. (2010). Bioethics: an Anthology. Malden, MA: Blackwell.

**MSUFT-391 Milk and Milk product processing Lab 0-0-6 3**

1. Study on basics of reception of milk at the plant; platform tests in milk; estimation and fat and SNF in milk;
2. Operation of LTLT & HTST Pasteurization;
3. Preparation of special milks;
4. Cream separation & standardization of milk;
5. Preparation and evaluation of table butter, icecream, cheese and indigenous milk product such as khoa, chhana, paneer, ghee, rosogolla, gulab jamun, shrikhand, lassi, burfi etc.;
6. Visit to dairy plants.

**MSUFT-392 Meat and Fish Processing Lab 0-0-6 3**

1. Slaughtering and dressing of meat animals;
2. Study of post-mortem changes; meat cutting and handling; pickled meat and fish products,
3. Pre-evaluation of meat quality;
4. Preservation by dehydration, freezing, canning, curing, smoking and pickling of fish and meat; shelf-life studies on processed meat products;
5. Evaluation of quality of eggs; preservation of shell eggs;
6. Estimation of meat: bone ratios; preparation of meat products- barbecued sausages, loaves, burger, and fish finger;
7. Visit to meat processing plants.

## SEMESTER IV

**MSUFT-481: Project Work : seminar and report submission**

**Credit:20**

**Objective:**

Students will be assigned with an objective oriented industrial problem related Food Industries and a comprehensive project to be prepared highlighting techno-economic feasibility and sustainability

A time period of 2 months will be allowed to each student for completing their project work. It is expected from the students to make prior planning in the beginning of the semester to get associated with any Research Laboratory/ industry/organization/ individual-manoeuvre and utilize this limited time frame to complete the project. Students will get acquainted with the principle, theory, work flow, experimentation, proper referencing and acknowledgement. The evaluation will be based upon the depth of understanding of the project work, efforts and project presentation skills before the quorum panel.

**MSUFT-482: Industrial/Laboratory visit: report-documentation**

**Credit:1**

**Objective:** A guided academic-excursion to an industry/laboratory, significant to the course work. The individual will make a report based upon his visit and will be evaluated by the way the facts, techniques and other information are documented.

**MSUFT-483 Journal Club and seminar presentation:**

**Credit:1**

Under the guidance of a professor an individual will do a thorough study of a scientific journal of his choice and interest. The evaluation will be based upon the depth of understanding of the journal and paper presentation skills before the quorum panel.

**FST 633: Process & Product based Training and Project**

**Credit: 10 Mark: 100**

**Objective:**

Students will be assigned with an objective oriented industrial problem related Food Industries and a comprehensive project to be prepared highlighting techno-economic feasibility and sustainability

**MSUFT-491 Grand Viva**

**Credit:2**

**Objective:** To make an overall evaluation of the student's in depth knowledge and skills learned in this course work.