

## COURSE STRUCTURE FOR M.Sc. IN FOOD TECHNOLOGY

Semester	Paper	Course Title	Credit			
			L	T	P	Total (C)
I	FT 101	Principles of Food Processing & Preservation	3	0	0	3
	FT 102	Principles of Food Engineering	3	1	0	4
	FT 103	General Biochemistry & Nutrition	3	0	1	4
	FT 104	Food Microbiology	2	0	1	3
	FT 105	Food Chemistry	3	0	1	4
Elective-I	FT-151	Applied Mathematics *	3	0	0	3
	FT 152	Computer Applications	1	0	2	3
II	FT 201	Cereals, Pulses and Oilseeds Processing Technology	3	0	1	4
	FT 202	Horticultural Crops Processing Technology	3	0	1	4
	FT 203	Food Analytical Techniques	2	0	2	4
	FT 204	Meat, Fish and Poultry Processing	2	0	1	3
	FT 205	Industrial Training/Project	0	0	1	1
Elective-II	FT 251	Bakery and Confectionary Products	1	0	1	2
	FT 252	Food Product Development	2	0	0	2
	FT 253	Heat and Mass Transfer	3	0	0	3
III	FT 301	Processing of Milk and Milk Products	3	0	1	4
	FT 302	Food Rheology	2	0	0	2
	FT 303	Food Packaging Storage and Logistics	3	0	0	3
	FT 304	Food Safety and Quality	3	0	0	3
	FT 305	Food Plant layout and maintenance	2	0	0	2
	FT 306	Statistical Methods	2	0	1	3
	FT 307	Master's seminar	0	0	1	1
Elective –III	FT 351	Industrial Microbiology	2	0	0	2
	FT 352	Intellectual Property Right	2	0	0	2
	FT 353	Food Business Management	2	0	0	2
IV	FT 401	Scientific Writing	1	0	1	2
	FT 402	Dissertation/Thesis	0	0	20	20
Elective-IV	FT 451	Functional Foods & Nutraceuticals	2	0	0	2
	FT 452	By-product Management	2	0	0	2

Note: after reviewing the syllabus and comments we have proposed the following course structure. Practical of relevant subjects are clubbed with the respective theory papers. As per the guidelines of UGC Choice Based Credit System (CBCS), one theory (T ) credit is of one hour and one practical (P) credit is of two hours. Theory, Tutorial and Practical are denoted as L-T-P respectively.

Coding for Core Courses Sem–I 101-150; Coding for elective Courses Sem–I 151-160

Coding for Core Courses Sem–II 201-250; Coding for elective Courses Sem–II 251-260

Coding for Core Courses Sem–III 301-350; Coding for elective Courses Sem–III 351-360

Coding for Core Courses Sem–IV 401-450; Coding for elective Courses Sem–IV 451-460

## MINIMUM CREDIT REQUIREMENTS

**Degree Programme: M.Sc. IN FOOD TECHNOLOGY**

<b>Subjects</b>	<b>Credits</b>
Major	53
Elective	10
Master's seminar	01
Dissertation/Thesis	20
<b>TOTAL CREDITS</b>	<b>84</b>

**Note: One course from elective in each semester is compulsory**

# PRINCIPLES OF FOOD PROCESSING & PRESERVATION

COURSE CODE FT-101

CREDIT (3+0)

## Objectives:

1. To acquaint students with the industrial techniques used to preserve and process foods, extend their shelf-life and improve their palatability characteristics.
2. To familiarize students with advances in food processing techniques

### UNIT-I

Introduction and Historical Development of Food Preservation. Principles of Food Preservation. Water Activity and its significance in food preservation. Natural and Chemical Food Preservatives – *types, permissible limits, safety aspects*. Psychrometric charts. Preservation by heat; Principles of heat preservation, heat resistance of microorganisms and their spores. Thermal death time; Heat treatments- boiling, steam under pressure, pasteurization, canning; Heat penetration studies. Psychrometry, wet bulb temperature, dry bulb temperature, Psychrometry charts, humidification and dehumidification. Application of Psychrometry in drying of foods.

### UNIT-II

Preservation by low temperature- Low temperature storage, refrigeration and freezing. Basics of Psychrometry and Psychrometric chart. Preservation by drying; Phenomenon and methods of drying- dehydration by air drying, sun drying and freeze drying. Types of drying; Drying curve; Types of dryers: Changes in food due to drying Dehydro-freezing; Freezing curve; Factors determining freezing rate; Types of freezer; Thawing; Changes in foods during freezing; Changes in food during refrigeration storage. Intermediate and high moisture foods.

### UNIT-III

Preservation by food additives- antibiotics, chemicals, organic acids. Preservation by radiations; Ultraviolet and ionizing irradiations. Their effect on microorganisms, use in the treatment of food. Membrane separation in food processing and preservation, Types, construction material, configuration and modules, applications. Concentration: Technology of concentration, equipment, process, and changes in food during concentration.

### UNIT-IV

Microwave heating- Basics of microwave energy, Properties, mechanism, microwave generator and microwave food application. Introduction to hydrostatic pressure technology, ohmic heating and extrusion cooking. Use of ultrasounds and magnetic fields in food processing. Application of super critical fluid extraction in food processing, infrared drying: definition, advantages, mechanism of heat generation, inductive heating in food processing and preservation.

### UNIT-V

Hurdle Technology: Concept, chemical and biochemical hurdles- organic acids–plant derived antimicrobials, Antimicrobial enzymes, bacteriocin, applications of hurdle technology, Advanced Techniques in Food Processing: Application of technologies of high intensity light, Nanotechnology: Principles and mechanism Radio-frequency heating and drying applications; Hybrid drying technologies- combined microwave vacuum drying, combining microwave vacuum drying with other processes.

**Books recommended:**

1. Desrosier (2006). The Technology of Food Preservation, 4<sup>th</sup> edition, CBS Publishers & Distributers, New Delhi.
2. Potter and Hotchkiss (2006). Food Science, 5<sup>th</sup> edition, CBS Publishers & Distributers, New Delhi.
3. Zuehl (2005). Food Preservation Techniques, CBS Publishers & Distributers, New Delhi.
4. Non-destructive Evaluation of Food Quality: Theory and Practice (2010) Jha, Shyam N. (Ed.) Springer.
5. Manay, N. S., & Shadaksharaswamy M. (2002). Foods, facts and principles (second edition). New age international publishers, New Delhi.
6. Fellows, P. (2004). Food processing Technology: Principles & Practices, 2nd edition, CRC Press USA.
7. Bhat R, Alias AK, and Paliyath G. 2012. Progress in Food Preservation. First Edition. Wiley-Blackwell.
8. Food Processing Principle and Application by HS Ramaswamy and M Marcotte. Taylor and Francis (2006).
9. Food Science: Research and Technology by AK Haghi. Apple Academic Press (2011).
10. Handbook of Food Process Equipment by G Saravakos and AK Kostaropoulos. Springer (2016).
11. Frazier, W. C. & Westhoff, D. C. (1996). *Food Microbiology*, Tata McGraw Hill and Co.

**Learning outcomes:**

1. The student will be able to utilize the various preservative methods for food in industrial settings
2. The student will comprehend the processing techniques utilized in food industries

# PRINCIPLES OF FOOD ENGINEERING

COURSE CODE FT-102

CREDIT (3+1)

## Objectives:

1. To acquaint the students with principles of Food Engineering and its Processes.
2. To provide more depth and breadth to the masters students through theoretical studies in food processing and engineering.

### UNIT-I

Biomaterials and their properties in relation to processing, their role in the development of new products and processes. Physico-Chemical Characteristic, Dimension and physical Characteristics: shape, sphericity, size, volume, density, porosity, surface area, coefficients of friction, and angle of repose and influence of constituents on processing design of equipment's.

### UNIT-II

Introduction to modes of heat mass and momentum transfer and their analogues behavior, radiation, unsteady state condition equation, unsteady state heat conduction in rectangular solids, cylinder and spheres. Molecular diffusion in gases, liquids and solids; unsteady state mass transfer and mass transfer coefficient. Overall momentum balance, differential equation of momentum transfer.

### UNIT- III

Fluid flow handling systems for Newtonian liquids, force balance on a fluid element flowing in a pipe—derivation of Bernoulli equation velocity profiles, Flow measurement: measurement of viscosity. Capillary tube viscometer. Flow characteristics of non-newtonian fluids. Properties of non-Newtonian fluids. Velocity profile of a power law fluid. Volumetric flow rate of a power law fluid. Average velocity in a power law.

### UNIT-IV

Size reduction: Size reduction of solid food and liquid foods, theory, equipment, effects on foods. Separation: Centrifugation, mixing, expression, filtration, microfiltration/ ultra-filtration, Nano Filtration and reverse osmosis. Selection and types of membranes and their properties. Application and use in food industry. Evaporation: types of evaporators and their design. Extrusion and its types, Dehydration, basic drying process, dehydration systems and equipment design.

### UNIT-V

Refrigeration: Steam tables and related charts, Selection of refrigerant, components of refrigeration system, pressure enthalpy charts. Food freezing: freezing system, frozen food properties, freezing time calculation by different methods, thawing, frozen food storage, quality changes during frozen storage. Design example of a cold store.

## Books recommended:

1. P J Fellows 2000. Food Processing Technology, Principles and Practice.
2. Cheryan M. 1998. Ultra-filtration and Micro-filtration Handbook.
3. Rockland LB & Stewart GF. 1991. UHP Treatments of Foods.
4. KA/PP Publ. Mohsenin NN. 1986. Physical Properties of Plant and Animal

- Materials.Gordon & Breach Science Publ.
5. Rao MA & Rizvi SS.1986. Engineering Properties of Foods.
  6. Marcel Dekker. Robertson GL. 1992. Food Packaging (Principles and Practices). Marcel Dekker.
  7. Watson EL & Harper JC.1989. Elements of Food Engineering. AVI Publ.
  8. Figura, L.O And Teixeira, A.A. 2007. Food Physics. Springer.
  9. Sahin S. and Sumun S.G (2006) Physical Properties of Food . Springer
  10. Steffe J. 1996. Rheological Methods in Food Process Engineering. Freeman Press. East Lansing, MI USA. Available Online WWW,egr.msu.edu/~steffe/
  11. Rao M.A.; Rizvi, S.S H.; Datta, Ashim K.2005, Engineering properties of Foods. Taylor & Francis

**Learning Outcomes:**

On successful completion of the subject, the students will be able to:

1. Understand mass and energy balance mechanisms and heat transfer mechanisms for food industries.
2. Explore fluid flow technique and behaviour of liquid food lines.
3. Grasp the thermodynamic properties of foods.
4. Identify food spoilage factors and thermal process calculations for shelf life of food products.

# GENERAL BIOCHEMISTRY AND NUTRITION

**COURSE CODE FT-103**

**CREDITS (3+1)**

## **Objectives:**

1. To acquaint students with the chemical constituents, their interactions and their evaluation
2. To familiarize students with the classification of nutrients, and their metabolism in the human body

### **UNIT-I**

Chemical Constituents of Life, Biomolecules and the cell, structural hierarchy of an organism, Carbohydrates, classification of carbohydrates and their structure, reaction of monosaccharide's. Lipids, saturated and unsaturated fatty acids and their nomenclature. Proteins and amino acids, classification, structural hierarchy, protein quality evaluation, functional and structural properties of proteins, protein modification, different approaches of protein modification. Nucleic acids and nucleotides, general structure, pyrimidines and purines, hydrolysis.

### **UNIT-II**

Physiological Biochemistry, Digestion and absorption, Plasma proteins, Hemoglobin and porphyrins, Biological oxidation, active transport across membranes,

### **UNIT-III**

Metabolisms, Introduction to metabolism, Metabolism of carbohydrates, Metabolism of lipids, Metabolism of amino acids, Integration of metabolism, Metabolism of nucleotides Mineral metabolism. ATP cycle, Glycolysis, TCA cycle and phosphogluconate pathway, oxidative phosphorylation.

### **UNIT-IV**

Enzymes: nomenclature and classification, cofactors, chemical kinetics, activation energy, enzyme catalyzed reactions, effect of pH and temperature on enzyme activity, enzyme purification, substrate and specificity, factors contributing to catalytic efficiency, reaction mechanisms. Enzymes in food industry: commercial enzyme processes, alternative method to use the enzymes, types of reaction. Sources of enzymes, legal and safety implications. Minerals and their role in human nutrition.

### **UNIT-V**

Human genome project, Gene therapy, Bioinformatics, Metabolism of xenobiotics (detoxification), Prostaglandins and related compounds, Biological membranes and transport, Free radicals and antioxidants, Environmental biochemistry, Insulin, glucose homeostasis, and diabetes mellitus, Cancer, Acquired immunodeficiency, syndrome (AIDS), Clinical Biochemistry and Nutrition: Hormones, Organ function tests, Water, electrolyte and, acid-base balance, Tissue proteins and body fluids, Nutrition

## **Practical:**

1. Calculation, preparation of normal, molar and percentage solutions.
2. Calibration of volumetric glasswares (Burette, pipette and measuring cylinder).

3. Preparation of standard Sodium carbonate solution, standardization of HCl (Methyl orange) and estimation of NaOH in the given solution. (methyl orange or phenolphthalein).
4. Preparation of standard Oxalic acid. Standardization of NaOH and estimation of  $\text{H}_2\text{SO}_4$  in the given solution (phenolphthalein).
5. Preparation of standard Oxalic acid. Standardization of  $\text{KMnO}_4$  and estimation of  $\text{H}_2\text{O}_2$  in the given solution.
6. Preparation of standard  $\text{K}_2\text{Cr}_2\text{O}_7$ . Standardization of  $\text{Na}_2\text{S}_2\text{O}_3$  and estimation of  $\text{CuSO}_4$  in the given solution.
7. Preparation of  $\text{ZnSO}_4$ . Standardization of EDTA and estimation of total hardness of water using Eriochrome black-T indicator.
8. Preparation of standard potassium biphthalate. Standardization of NaOH and estimation of HCl in the given solution. (Phenolphthalein).
9. Determination of rate constant of decomposition of  $\text{H}_2\text{O}_2$  using  $\text{KMnO}_4$  by volumetric analysis method.
10. Demonstration: i) Determination of density and viscosity of the given liquid using specific gravity bottle and Ostwald's viscometer
11. Extraction of Biomolecules: Starch from potato, Casein from milk, Caffeine from tea leaves, Oil from oil seeds, Glycogen from liver, Cellulose from plant material

**Books recommended:**

1. Lehninger: General Biochemistry
2. Conn & Stump: Outlines of Biochemistry
3. Davis, I. D. H. (2006). Fundamentals of biochemistry. *Instructor*.
4. Voet, D., Voet, J. G., & Pratt, C. W. (2013). *Fundamentals of biochemistry: life at the molecular level* (No. 577.1 VOE).
5. Champe, P. C., Harvey, R. A., & Ferrier, D. R. (2005). *Biochemistry*. Lippincott Williams & Wilkins.
6. Schowen, R. L. (1993). Principles of biochemistry 2nd ed.(Lehninger, Albert L.; Nelson, David L.; Cox, Michael M.).
7. U, Satyanarayana and U, Chakrapani. Biochemistry with clinical concepts and case studies.

**Learning outcomes:**

1. The student will be able to relate the metabolic pathways of macronutrients to function in the body.
2. The student will gain an understanding of macro- and micronutrient sources and functions in the human body



# FOOD MICROBIOLOGY

COURSE CODE FT-104

CREDIT (3+1)

## Objectives:

1. To acquaint the students with different groups of microorganisms associated with food, their activities, destruction and detection in food.
2. To familiarize the students with industrial standards concerning safe food production and the existent national and international systems that ensure food quality

## UNIT- I

Introduction; Historical development, Discovery of microbial world, Biogenesis, abiogenesis controversy, germ theory of disease, immunization, chemotherapy, discovery of viruses, applied microbiology, Microbiology in 20<sup>th</sup> century. General characteristics of bacteria, yeast, mold, viruses and algae. Brief account of bacterial, yeast and mold reproduction.

## UNIT II

Microbial growth and reproduction; Definition of growth, growth curve, growth rate, generation time, measurement of growth, effect of environmental factors such as temperature, moisture, salt, pH, oxidation reduction potential and radiation on growth. Control of microorganisms by physical, chemical and biological agents, thermal death time, Z, F and D values.

## UNIT III

Sources and prevention of contamination. General principles of food preservation. Microbiology of air, water, milk products; cereals and cereal products; meat and meat products, fish and fish products; poultry and eggs; spices and condiments; canned foods.

## UNIT-IV

Food borne illnesses: Food borne infections, Food borne intoxications, mycotoxins (sources and prevention); Food sanitation and public health; Control of Food Borne Pathogen by natural Antimicrobials

## UNIT IV

Microbial techniques; Isolation and preservation of microbial cultures (Brief introduction). Methods of genetic improvement (Recombinant DNA Technology). Bacterial toxins and mycotoxins with special preference to *Staphylococcus*, *Clostridium*, *Aspergillus*. Food poisoning and safety measures.

## UNIT-V

Food fermentation, Microbial cultures in food fermentation and their maintenance; Bioreactors types and designs. Traditional fermented foods of India and other Asian

countries - fermented foods based on milk, meat, and vegetables; fermented beverages.  
Probiotics and Prebiotics

### **Practical:**

1. Instruments of microbiology laboratory and their functions.
2. Preparation of nutrient medium slant, broths.
3. Demonstration of serial dilution method and techniques of isolation and enumeration of microorganisms.
4. To study the effect of temperature, pH and aeration on growth of microorganisms.
5. To demonstrate acid fast staining.
6. To stain the given bacteria by Gram's staining method.
7. To measure the size of given microorganisms by ocular micrometre.
8. To determine the number of microorganisms by Haemocytometer.
9. To determine the motility of bacteria by hanging drop method.
10. Biochemical tests for the micro-organisms.

### **Books Recommended**

1. Dubey, R.C., and Maheshwari, D. K. (2001). *A text book of microbiology*, S. Chand and Co., New Delhi.
2. Pelczar, M. J., Chan, E. G. S. and Krieg, N.R. (2002). , *Microbiology 5<sup>th</sup> edition*, Tata McGraw Hill and Co, New Delhi.
3. Purohit, S. S. (2001). *Microbiology*, Fundamentals and applications.
4. Sharma, P.D. (2000). *Microbiology*, A text book for university students.
5. Frazier, W. C. & Westhoff, D. C. (1996). *Food Microbiology*, Tata McGraw Hill and Co.
6. James, M.J. (1997). *Modern Food Microbiology*, 4<sup>th</sup> Edition, CBS Publishers, New Delhi
7. Barnart, G.J. (1997). *Basic Food Microbiology*, CBS Publishers, New Delhi.
8. Stainer, R.Y. (1996). *General Microbiology*, 5<sup>th</sup> edition, Mac Millan Publishers, New Delhi.
9. *Food Microbiology: An introduction* by TJ Montville et al. ASM press (2012).
10. *Food Microbiology: Fundamentals and Frontiers* by MP Doyle and RL Buchanan. ASM press (2007).
11. *Food Microbiology* by MR Adams et al. RSC (2016).
12. *Food Microbiology* by WM Foster. CBS Publishers (2016).

### **Learning Outcomes:**

1. The student will be able to apply microbiological aspects involved in different settings of food industry
2. Students will be familiar with different types of industrially important microorganisms.

## **FOOD CHEMISTRY**

**COURSE CODE FT-105**

**CREDIT (3+1)**

### **Objectives:**

1. To provide an understanding of structure, reactions and functional properties of different food components.
2. Students will learn the fundamentals of chemical processes and their significance with respect to food processing.

### **UNIT-I**

Introduction; Definition of food chemistry, historic development of food chemistry. Effect of biochemical reactions on quality and safety of food. Role of food chemistry in society. Water; structure of water, water solute interactions, water activity, moisture sorption isotherms. Water in foods: Function; Types; Structure; Association and dissociation of water; Phase diagram; Relevance to deteriorative processes in foods

### **UNIT-II**

Carbohydrates- Monosaccharides, monosaccharide isomerization and reactions, Oligo saccharides- lactose, maltose, sucrose; Polysaccharides, their solubility, gel formation and hydrolysis. Starch- structure, retro-gradation and gelatinization. Structure and functional properties of Gums, pectin, pentosans, cellulose dietary fibre and  $\beta$ -glucan. Starch digestibility and Glycaemic Index; Modified starches; Forms and derivatives of cellulose (MCC, CMC, MC and HPMC)

### **UNIT-III**

Fats- Classification and structure of fats and fatty acids, rancidity of fats, refining, hydrogenation and inter-esterification of fats. Safety of hydrogenated fats, consumption trends and nutritional aspects of fats. Frying and fat changes. Functionality of triglycerides in foods; Mechanism of lipid oxidation; Pro-oxidants; Measurement of lipid oxidation; Role of fats in body; Health problems associated with fats; Trans fats; Bioactivity of fatty acids; Recommendations for fat intake; Fat replacement strategies

### **UNIT-IV**

Protein- structure, denaturation, functional properties, viscosity, dough formation, Protein quality/Biological value of proteins; Chemical and biological methods for evaluation of protein quality; Functional properties; Major source of food proteins; Methods of protein characterization and analysis; Processing induced physicochemical changes in proteins; Chemical and enzymatic modification of proteins. Enzymes- types and chemical nature, factors influencing enzyme action, enzyme inactivation, coenzymes. Enzyme specificity,

Kinetics and inhibition. Uses of enzymes in food processing. Browning and its control. Plant pigments, structure and their role in foods.

## UNIT-V

Minerals: General functions of minerals; Specific functions and requirements of Ca, P, Mg, Fe, Cu, Pb, Zn, Se and As Pigments: Myoglobin; Chlorophyll; Anthocyanins; Carotenoids; Betalains Browning reactions: Enzymatic and Non-enzymatic browning of foods Antioxidants: Natural antioxidants; Mechanisms of action; Techniques of evaluation of antioxidant activity. Flavour: Nature of flavour components, Applications, Importance of aroma compound. Vitamins: Sources, requirements and functions of different vitamins

### Practical:

1. Determination of moisture on dry matter basis.
2. Determination of moisture sorption isotherms.
3. Determination of protein by Kjeldhal and Lowry method.
4. Estimation of sugars by Lane and Eyon method.
5. Quantitative determination of starch in cereal grains.
6. Quantitative determination of amylase and amylopectin.
7. Saponification value, iodine value, free fatty acids, acid value, peroxide value and
8. Rancidity tests for fats and oils.
9. Estimation of non-enzymatic browning.
10. Estimation of crude fat content by Soxhlet method.
11. Estimation of beta carotene in fruits and vegetables.
12. Determination of total ash, acid soluble and insoluble ash
13. Estimation of total crude fibre and total dietary fibre.

### Books recommended:

1. Fennema, O. R., Damodaran, S. (2008). *Food Chemistry*, 4<sup>th</sup> Edn. CRC Press USA.
2. Meyer, L. H. (2006). *Food Chemistry*, CBS Publishers & Distributors, New Delhi.
3. Nielson, S.S. (2002). *Introduction to the Chemical Analysis of Foods*, CBS Publishers & Distributors, New Delhi.
4. Baianu, I.C. (1997). *Physical Chemistry of Food Processes*, Vol I & II, CBS Publishers & Distributors, New Delhi.
5. DeMan (2007). *Principles of Food Chemistry*, 3<sup>rd</sup> edition. CBS Publishers & Distributors, New Delhi.
6. Food Chemistry by HK Chopra and PS Penesor. Narosa Publishing (2010).
7. Food Science by NN Potter. CBS Publishers (2007).
8. Chemistry and Technology of Oils and Fats by MM Chakraborty. Prentice Hall (2003).
9. Essentials of Food Science (4th edition) by V Vaclavik and CW Elizabeth. Springer (2014).

10. Plant Food Flavors by S Mehthani and PK Ingle. National Institute Science Communication (1999).

11. Flavor, Fragrance and Odor Analysis by R Marsili. CRC Press (2011).

**Learning Outcome:**

1. The student will be able to understand basics of changes in food matrix
2. The student will be able to understand chemistry of food preservation/shelf-life.

**APPLIED MATHEMATICS**

**COURSE CODE FT-101**

**CREDIT (3+0)**

**Objectives:**

1. The course objective is to develop the basic mathematical skills of engineering that are imperative for effective understanding of engineering subjects.
2. The topics introduced will serve as basic tool for specialized studies in different fields

**UNIT-I**

Matrix, types of matrix, properties of matrix addition and multiplication, transpose of a matrix, symmetric and skew symmetric matrix, orthogonal matrix, inverse of a square matrix. Elementary matrices, rank of a matrix, characteristic equation, Eigen values and Eigen vectors, Cayley Hamilton's theorem.

**UNIT-II**

Limits, properties of limits, techniques for evaluating limits, continuity of a function, differentiation of some elementary function by first principle, the product and quotient rules and higher order derivatives. Increasing and decreasing functions and the derivative tests. Maxima and minima of a function. Rolle's Theorem and mean value theorem.

**UNIT-III**

Differential calculus: Taylors and Maclaurins expansions, curvature, asymptotes, tracing of curves, partial differentiation, homogeneous functions and Euler's theorem, composite functions, total derivatives, derivative of an implicit function. Integration, Integration of some elementary functions. Definite integral, properties of definite integral, area of region between two curves. Beta and Gamma functions.

**UNIT-IV**

Measures of central tendency, measures of dispersion, co-efficient of dispersion, skewness, measures of skewness, moments. Correlation, coefficient of correlation, limits of correlation, coefficient of correlation, Limits of correlation coefficient, computation of correlation coefficient, Regression, Linear regression, Lines of regression, properties of regression coefficient.

**UNIT-V**

Theory of probability, Mathematical definition of probability, Statistical definition of probability, independent events, Addition and Multiplication theorem on probability. Conditional probability and Baye's Theorem. Random variable, Probability mass function and Probability density function. Distribution function. Binomial distribution, Poisson distribution and Normal distribution.

**Books Recommended:**

1. A text book of Engineering Mathematics by N.P Bali and Manish Goyal. Laxmi Publication (P) LTD. 2007.
2. Applied Mathematics by J David Logan John Wiley and Sons. 2013
3. Principles and Techniques of Applied Mathematics by Bernard Friedman. 1990
4. Partial Differential Equations of Applied Mathematics by Erich Zauderer, John Wiley and Sons. 2011.
5. Foundations of Applied Mathematics by Michael D Greenberg, Courier Corportaion. 2013.

**Learning outcomes:**

1. The students will be able solve mathematical problems using analytical methods.
2. Students will be able to recognize the relationship between different areas of mathematics and connection between mathematics and other disciplines.

## COMPUTER APPLICATIONS

COURSE CODE FT-152

CREDITS (1+2)

### Objectives:

1. Aim is to provide students with an opportunity to develop understanding of the basic operations of computer system.
2. To make students familiar with computer application software and their use in research work.

### UNIT-I

Introduction to computers, A Simple Computer Model, Hardware and Software essentials of a computer, Need of computer in present world, Characteristics of Computers, Evolution of Computers, and Basic Operations of a computer System. Input / Output Units: Defining input and output units, types and description of Input –Output devices, printing devices. Storage: Primary memory, Memory Cell, Memory organization, ROM, RAM and its types, Secondary storage devices and its types.

### UNIT-II

Processor: Description of Processor, its components, ALU, CU, Processor Registers, Basic Architectures, Processor generations. Number System (Binary, octal, hexadecimal) and there conversion.

### UNIT-III

System Software and utilities, Application Software, Licensed and open source softwares, Need of Operating Systems, Types of Operating Systems, World Wide Web, How internet works, Benefits and drawbacks of using internet, LAN, WAN, MAN.

### UNIT-IV

Introduction of different programming languages. DOS commands & MS Office. Internal and External commands in detail, Microsoft office (MS Word, MS Excel, MS PowerPoint).

### UNIT-V

Importance of Computerization and IT in Food Industries, Computers, operating environments and information systems for various types of food industries, Principles of communication; Role of computer in optimization; Introduction to operation research, A computer oriented algorithmic approach; Queing Systems and waiting models, PERT, CPS and CPM, Food process Modelling and Simulation; Introduction to SCADA and INTELUTION, CAD and CAM in Food Industry, Instrumentation, process control, inventory control: Automation, robotics, expert systems, and artificial intelligence.

### Practical:

1. Practical Use of word processing software for creating reports statistical analysis.
2. Introduction to computer using PC tutor Operating system practice using DOS commands Problem solving using spread sheets.
3. Stastical Quality control, sensory evaluation of food
4. Chemical Kinetics in food processing
5. Use of word processing software for creating reports and presentations

6. Familiarization with the application of software in food industries, Milk Plant, dairy units, fruit and vegetable processing unit
7. Familiarization with software related to food industry, ergonomics application in the same, visit to industry and knowledge of computer
8. Identify the different parts of a computer system, Know how each and every parts of a computer system works, Learn how different parts of the computers work together to produce a good output.
9. Create a document using a suitable word processing package, with at least three paragraphs and perform editing operations.
10. Document creation, Text manipulation with Scientific Notations.
11. Create a formal letter using a suitable word processing package, to place a purchase order for procurement of books. Use mail merge feature
12. Table creation, Table formatting and Conversion. Use tables for list of books.
13. Create a Spreadsheet and enter the marks of a student, calculate total and print grade, if the student has passed in all subjects.
14. Using simple mathematical formulas in excel.
15. Applications of MS Excel to solve the problems of food technology

#### **Books Recommended:**

1. Introduction to computers by Peter Norton, Tata McGraw Hill.
2. Computer Fundamentals by V. Rajaraman, Pearson Education.
3. Unix concepts and applications, Sumitabha Das, Tata McGraw Hill.
4. Computer Applications in Food Technology Elsevier Science & Technology Books. R. Paul Singh.
5. Computer concepts for Agri Business AVI Pub. Corp, West Port, USA. M.V. Verton.
6. Computer Fluid Dynamics Applications in Food Processing Springer Briefs in Food, Health, and Nutrition. Anandharamakrishnan.

#### **Learning outcomes:**

1. Students can work effectively with a range of current standard, office productivity software's.
2. Students can solve a range of problems using different type of software's.
3. They can maintain quality assurance through critically evaluating procedures and results.



# **CEREALS, PULSES AND OILSEEDS PROCESSING TECHNOLOGY**

**COURSE CODE FT-201**

**CREDIT HOURS (3+1)**

## **Objective:**

1. To illustrate the recent developments in the cereals science and technology.
2. To explain modern processing techniques of cereals in food industries.
3. To impart knowledge regarding various processed product lines in food industries.

### **UNIT-I**

Food grain production and consumption trends, Coarse grain processing. Wheat kernel structure, wheat grading, roller flour milling, influence of wheat type and grain quality on flour yield, grain hardness and its relevance to end product quality, advances in wheat cleaning, conditioning and milling, wheat flour component interactions (protein-starch, protein-lipid and starch-lipid) and their influence on end product quality, advances in isolation, biochemical characterization, micro-structural and functionality of wheat gluten proteins.

### **UNIT-II**

Advances in role of wheat proteins in dough and gluten visco-elasticity, micro-structure of dough, conversion of dough foam structure to bread sponge structure during bread baking, concept of gas retention in wheat dough during fermentation and baking, advances in bread making processes, effect of wheat components and ingredients on the growth of yeast during fermentation operation, bread staling and its prevention, production of variety biscuits, breads and pasta products.

### **UNIT-III**

Paddy varieties, their composition and quality characteristics, advances in methods of paddy parboiling, advantages and limitation of parboiling, paddy de-husking processes, Rice ageing, accelerated ageing, modern rice milling, factors affecting head rice yields and losses at different stages of milling, rice mill machinery, Rice based products and their quality, colour sorters, Methods of rice bran oil extraction and refining.

### **UNIT-IV**

Dry and wet milling of maize, modern methods of maize processing, gluten and starch separation, maize starch conversion into value added products, acid hydrolysis, enzyme hydrolysis, processing for dextrose, malto-dextrin and other products, Barley varieties, composition and quality characteristics, malting process and industrial applications of barley malt and malt products.

### **UNIT- V**

Legumes: Structure, Composition, Nutritional Value, Post-Harvest Technology – storage, transportation, handling, prevention of spoilage and post-harvest losses, fumigation, etc. Processing Methods – sprouting, fermentation. Effect of Processing on Composition and Nutritive Value, Fortification and Value-Addition of Products, cooking quality, milling and processing of pulses, fermented and traditional products from pulses.

## UNIT-VI

Oilseeds: Structure, Composition, Nutritional Value, Toxic Constituents, Pre-treatments, decortication, mechanical expelling, solvent extraction, refining, by-product utilization of oil milling industry, de-oiled cakes: composition and utilization, processing of DOCs into protein products. Millets: structure, composition, post-harvest processing, chemical, technological and milling aspects of millets.

### Books recommended:

1. Kulp K. & Ponte J. G. (2014). *Handbook of Cereal Science & Technology*, 2<sup>nd</sup> edition: CRC press.
2. Kent NL. 1983. *Technology of Cereals*. Fourth Edition. Pergamon Press.
3. Matz SA. 1969. *Cereal Science*. AVI Publ.
4. Pomeranz Y. 1987. *Modern Cereal Science & Technology*. VCH Publ.
5. Wrigley C.W. & Batey I. L. (2010). *Cereal grains, assessing and managing quality*, CRC press.
6. Dendy D. A. V. & Dobsasoczyk B. J. (2001). *Cereal and Cereal Products, Chemistry and Technology: An ASPEN publication*.
7. Owens G. (2000). *Cereal Processing Technology*: CRC Press.
8. Faridi H. & Faubin J. M. (1997). *Dough Rheology & Baked product Texture*: CBS Publishers.
9. A Chakraverty: *Post-harvest Technology of Cereal, pulses and oilseeds*

### Practical:

1. Determination of physical characteristics of cereals.
2. Milling of wheat into flours.
3. Determination of wet and dry gluten.
4. Preparation of bread, biscuits, cookies and cakes.
5. Parboiling of rice.
6. Determination of crude fibre in wheat flour.
7. Visit to local roller flour mill.
8. Visit to local bakery.
9. Visit to local rice hulling unit.
10. Determination of ash and sugars in flour and bakery products.
11. Cooking quality of rice.

### Learning outcomes:

On successful completion of the subject, the students will be able to:

1. Comprehend the recent advancement in the major cereal grains quality and processing aspects.
2. Understand the mechanism underlying the interaction of various flour components and their role in end use quality.
3. Grasp the basic and advanced milling methods for wheat, rice, maize.

4. Know about by-product utilization of various grains.

## HORTICULTURAL CROPS PROCESSING TECHNOLOGY

COURSE CODE FT 202

CREDITS (3+1)

### Objectives:

1. To acquaint students with the principles and methods of processing of fruits and vegetables.
2. To familiarize students with processing techniques of horticultural produce

### UNIT-I

Maturity indices of fruits and vegetables, Determination of quality parameters, Harvesting tools of different horticultural produce, Losses in post-harvest operations, unit operations in food processing, sorting, grading, Principles and guidelines for the location of processing units. Climacteric and non-climacteric fruits. Principles and methods of preservation by heat pasteurization, canning, bottling. Different types of cans, syrups, brines. Quality requirements of raw material for processing. Primary Processing Techniques – *grading, sorting, cleaning, washing, peeling, slicing, and blanching.*

### UNIT-II

Vegetables: Classification, Types, Composition, and Nutritive Value of Vegetables, Harvesting Indices, Storage of Fresh Produce, transportation, Packaging, and Marketing of Fresh Produce, Spoilage and Quality Control Measures

### UNIT-III

Fruits: Classification, Types (simple and aggregate), Composition, and Nutritive Value, Fruits harvesting indices, storage of Fresh Produce – principles, methods, and techniques, chilling injury, Transportation, Packaging, and Marketing of Fresh Produce, Spoilage and Quality Control Measures.

### UNIT-IV

Processing for Pulps, Purees, and Concentrates Processing for Pickles, Gravies, Powders, Sauces, and Soups Processing for Jams, Jellies, Marmalades, and Confectioneries. Dehydrated Fruits and Vegetables products. Fruit juices and beverages their standards, Juice extraction, clarification techniques.

### UNIT-V

**Plantation Crops:** Definition and role of plantation crops in national economy and export potential. **Spices:** Definition, classification and functions. Quality specifications for spices, Chemical composition, processing, uses and special attributes of different spices like saffron, chillies, cumin, coriander, turmeric, fennel, fenugreek, pepper, cinnamon, cloves, ginger, mint and cardamom. Oleoresins and essential oils. **Tea:** Composition and processing of tea. Tea products such as tea concentrate, decaffeinated tea and flavoured tea. *Kashmiri kehwa*. **Coffee:** Chemical composition, processing, roasting and brewing of coffee. Coffee products such as decaffeinated coffee and instant coffee. **Cocoa:** Chemical composition, processing of cocoa and cocoa beverages. Cardamom composition and processing.

**Practical:**

1. Vegetable and Fruit Maturity Index Determination and Calculation
2. Quality Standard Measurements of Vegetable and Fruit Products
3. Blanching of fruits and vegetables and its determination
4. Determination of browning in fruit-based products
5. Determination of Ascorbic acid in fruit/fruit based products
6. Preparation of fermented products from vegetables
7. Preparation of osmo-dehydrated fruits products
8. Preparation of Dehydrated Vegetables
9. Preparation of Banana and Potato Wafers
10. Preparation of Dried Figs and Raisins
11. Preparation of jam and jellies
12. Preparation of pickles

**Books recommended:**

1. Kadar AA.1992. *Post-harvest Technology of Horticultural Crops*. Second Edition. University of California.
2. Lal G, Siddapa GS and Tandon GL.1986. *Preservation of Fruits and Vegetables*. ICAR.
3. Thompson AK. 1995. *Post-Harvest Technology of Fruits and Vegetables*. Blackwell Sci.
4. Nondestructive Evaluation of Food Quality: Theory and Practice (2010) Jha, Shyam N. (Ed.) Springer.
5. Verma LR. & Joshi VK. 2000. *Post-Harvest Technology of Fruits and Vegetables*. Indus Publ.
6. D.K. Salunkhe and S.S. Kadam, 2013. *A handbook of Fruit Science and Technology*. CRC Press

**Learning outcomes:**

1. Comprehend the recent advancement in the major fruits and vegetable processing.
2. Understand the mechanism underlying the interaction of various constituents of horticultural produce and their role in end use quality.
3. Grasp the basic and advanced processing techniques in plantation crops.
4. Know about by-product utilization of various horticultural produce.

## **FOOD ANALYTICAL TECHNIQUES**

**COURSE CODE FT-203**

**CREDITS (2+2)**

### **Objectives:**

1. To develop an understanding about the advanced analytical and instrumental techniques.
2. To illustrate the principle and mechanism of analytical instruments.
3. To describe bio-chemical analysis of food components.

### **Unit -I**

Introduction to Rheology of Foods: Definition of texture, rheology and psychophysics – their structural basis; physical considerations in study of foods; salient definitions- stress tensor and different kinds of stresses.

### **Unit -II**

Examining food microstructures: history of food microstructure studies, light microscopy, transmission electron microscopy, scanning electron microscopy, other instrumentation and techniques, image analysis: image acquisition, image processing, and measurement analysis. Food structure: traditional food structure and texture improvement, approaches to food structure, extrusion and spinning, structured fat products, structure and stability, gels, gelation mechanisms, mixed gels, the microstructure of gels, structure-property relations in gels.

### **Unit-III**

The nature of electronic excitation-Use of UV spectra-Instrumentation-Effects of solvent-Effect of conjugation-Presentation of UV spectra FTIR Spectroscopy-electromagnetic radiation - origin of molecular vibrations - principles of vibrational spectroscopy - normal mode of molecular vibrations – infrared activity. Fourier transform infrared spectroscopy - working principles – sample preparation and measurement - applications. Fluorescence Spectroscopy- Fundamentals of fluorescence spectroscopy – selection of filters – selection of fluorophores, optical detectors. Fluorescence quenching and fluorescence resonance energy transfer. Confocal imaging and detection - laser scanning confocal microscopy – principles and applications.

### **Unit-IV**

Classification of chromatographic techniques, adsorption and partition, theory of chromatographic separation, distribution coefficient, retention, adsorption, efficiency and resolution, Types of chromatographic techniques: paper, TLC and HPTLC. Types of chromatographic techniques: HPLC, column, ion exchange, size exclusion and droplet counter current -instrumentation: columns, pumps, detectors, techniques and applications. Instrumentation, types of columns, retention time, volume, capacity ratio, partition coefficient, theoretical plate & number, separation efficiency, resolution and applications.

### **UNIT-V**

Electrophoresis: Different kinds of electrophoresis, western blotting, gel documentation, DNA analysis: DNA purification, PCR-based analysis, DNA fingerprinting. Microscopic

techniques: Light microscopy, Scanning electron microscopy, Transmission electron microscopy, particle size analysis, Thermal techniques in food analysis: Differential scanning calorimetry and Thermo gravimetric analysis.

**Practical:**

1. Determination of proximate composition of food sample.
2. Estimation of total sugars in the given food samples.
3. Estimation of Ascorbic Acid content in given food samples by HPLC/ Dye method
4. To find ash content (soluble, in soluble ash )
5. Fatty acid profile by Gas Chromatography
6. **Mineral profile analysis of food samples by Atomic Absorption Spectroscopy and chemical Method.**
7. Qualitative and quantitative analysis of amino acids by paper chromatography
8. Refractive index of oil by using Abbe's Refractometer.
9. Estimate of hydrolytic and oxidative rancidity of given oil samples.
10. Determination of food adulterants in given food samples.
11. Estimation of browning in foods/ enzymatic/ non enzymatic
12. Estimation of colour of different food products using Hunter colour Lab/ Tintometer.
13. Determination of water activity of given a food product.
14. Texture profile analysis of foods samples.
15. Determination of antioxidant activity of given food sample using HPLC.
16. Extraction and estimation of plant phenolic substances by colorimetric and spectrophotometric techniques.
17. Rheology of Dough using rheometer
18. SEM/TEM of Food Samples
19. Differential Scanning calorimetry of Food Samples

**Books recommended:**

1. Pare, J. R. J. and Bélanger, J. M. R. (2015). *Instrumental Methods of Food Analysis*: Elsevier.
2. Nondestructive Evaluation of Food Quality: Theory and Practice (2010) Jha, Shyam N. (Ed.) Springer.
3. Pomeranz, Y. and Meloan, C. E. (1996). *Food Analysis: Theory and Practice* (3 ed.): CBS Publications, New Delhi.
4. Winton, A. L. (2001). *Techniques of Food Analysis*: Agrobios, Jodhpur.
5. Sharma, B. K. (1994). *Instrumental Methods of Chemical Analysis*: Krishna, Meerut.
6. Skoog, D. A., Holler, F. J. and Nieman, T. A. (1998). *Principles of Instrumental Analysis* (5 ed.): Harcourt, Singapore.
7. Gopalan, R., Subramanian, P. S. and Rangarajan, K. (2008). *Elements of Analytical Chemistry*: Sultan Chand & Sons

**Learning outcomes:**

After the completion of the course, the students will be able to:

1. Thorough knowledge about the applications of various analytical and instrumental techniques.
2. Understand the mechanisms and principle behind various analytical techniques.

3. Acquaint with the spectroscopic and microscopic techniques

## **MEAT, FISH AND POULTRY PROCESSING**

**COURSE CODE FT-204**

**CREDITS**

**(2+1)**

### **Objectives:**

1. To describe the muscle composition, structure and properties of meat muscle.
2. To explain the structural changes that take place post-mortem during conversion of muscle to meat.
3. To illustrate the manufacture and handling of meat products and to assess the factors that affects the safety and quality of meat products.
4. To describe the manufacture and handling of egg and poultry products and to assess the factors that affects the safety and quality of poultry products.
5. To illustrate the manufacture and handling of fish and fish products and to assess the factors those affect the safety and quality of fish and fish products.

### **UNIT I**

Status and scope of meat and poultry industry in India; Muscle- structure, chemical composition and physico-chemical properties of meat muscle, nutritive value, conversion of muscle into meat; Slaughtering of animals and poultry, post-mortem inspection and grading of meat; Factors affecting post-mortem changes, properties and shelf life of meat; Meat tenderization - natural and artificial methods.

### **UNIT II**

Processing and preservation of meat - mechanical deboning, aging or chilling, freezing, pickling, curing, cooking and smoking of meat; Thermal processing- canning of meat, retort pouch, dehydration and irradiation; Meat Products - uncooked comminuted and restructured meat products, sausages, meat emulsions, dried meats, intermediate moisture meats and meat extracts, ready to eat (RTE) meat products. Meat plant sanitation and waste disposal.

### **UNIT III**

Poultry products: types, chemical and nutritive value of poultry meat; Poultry handling and dressing: inspection of birds, poultry slaughter and dressing, factors affecting quality of poultry; Egg: structure, composition and nutritive value of eggs, changes in egg due to aging; Quality evaluation of eggs, candling, albumen index, haugh unit, yolk index; Egg preservation: grading of eggs, whole egg preservation, pasteurization, dehydration, freezing; Egg products: egg powder, value added egg products (Meringues and Foams etc.), packaging of egg and egg products.

### **UNIT IV**

Fish products - production of fish meal, fish protein concentrate, fish liver oil, fish paste and fish sauce and other important by products; Quality control of processed fish; Fish

processing; By-product utilisation: By-products and wastes from meat and poultry industry; HACCP in meat industry.

**Practicals:**

1. Fish, Meat cutting and handling.
2. Dressing of poultry.
3. Evaluation of the quality of meat, poultry and fish,
4. Canning, freezing, dehydration cured product of fish and meat.
5. Meat based soup and its quality control.
6. Measures of egg quality, egg powder etc.
7. Analysis of fish and fish products.
8. Preparation of fish oil and meal.
9. Fish protein concentrate uses.
10. Visit to meat, fish and poultry processing industries.

**Books recommended:**

1. Mead G. (2004) *Poultry Meat Processing and Quality*, Woodhead Publishers.
2. Panda P. C. (1992) *Text Book on Egg and Poultry Technology*, Vikas Publishers.
3. Hui Y. H. (2012) *Handbook of meat & meat processing, 2<sup>nd</sup> Edition*, CRS Press.
4. Gracey JF. 1999. Thornton's Meat hygiene. 11<sup>th</sup> Ed. WB Saunders.
5. Stadelman W & Cotterill OJ. 2002. Eggs Science and Technology. 4<sup>th</sup> Ed. CBS.
6. Mountney GJ. Poultry Products Technology. 2<sup>nd</sup> Ed. AVI Publ.
7. Elton D. Aberle, John C. Forrest, David E. Gerrard, Edward W. Mills (2012). Principles of Meat Science, 5<sup>th</sup> Ed. Kendall Hunt Publishing Company.
8. Sharma, B.D. Outlines of Meat Science and Technology, (2011). Jaypee Brothers Medical Publishers.

**Learning outcomes:**

After the completion of the course, the students will be able to:

1. Understand the muscle composition, structure and properties of muscle meat.
2. Understand the process of manufacturing of various value added meat, poultry and products.
3. Understand the process of manufacturing of various value added fish products.
4. Learn about the various food standards in relation to meat, fish, poultry and egg.



# BAKERY AND CONFECTIONARY PRODUCTS

COURSE CODE FT 251

CREDITS (1+1)

## Objectives:

1. To make aware a student with knowledge and understanding of the raw material used for preparation of various bakery and confectionary products.
2. To make aware a student with knowledge and understanding in the basic operation and working of various equipment's involved in bakery and confectionary technology.
3. To make aware a student with knowledge and understanding in the basic steps and operation in preparation of bread, biscuits, cakes and other bakery products.
4. To make aware a student with knowledge of layout and setting up of bakery plant.

## UNIT-I

Status of bakery and confectionery industries in India; Raw materials for bakery and confectionery products- essential and optional ingredients; Functionality of bakery ingredients; FSSAI specification of raw materials; Bakery equipment: divider, rounder, proofer, moulder; equipment used in baking, different types of oven, slicer.

## UNIT-II

Principles of Baking. Raw Material and their Role – *flour, leavening agents, sugars, fats, additives, spice*. Types of Bakery Products and Technology for their Manufacture – *dough and batters; cakes, pies, pastries, bread, biscuits*. Icings and Fillings. Quality Parameters of Bakery Products - *chemistry of dough and batters; rheological testing and interpretation of data; sensory evaluation*. Staling and Nutrient Losses in Bakery Products. Sanitation and Hygiene in a Bakery Unit.

## UNIT-II

Principles of Confectionery Manufacture. Raw Material and their Role – *interfering agents, inversion of sugars, etc*. Types of Confectionery Products and Technology for their Manufacture. Quality Parameters of Confectionery Products. Nutrient and other Losses in Confectionery Products. Sanitation and Hygiene in a Confectionery Unit. Equipment used in the Confectionery Industry. Manufacture of Indian Confectioneries

## UNIT-IV

Convenience food technology. Sugar – raw material, types, and manufacture. Chocolate – raw material, types, and manufacture. Chewing Gum - raw material, types, and manufacture. Lozenges - raw material, types, and manufacture. Pan Coating – hard and soft panning; problems in coating; glazing, polishing, and tableting. Nutritional Value. Quality Parameters

## UNIT-V

Food safety rules and regulations for bakery and confectionery products; Layout, setting up of units and hygienic conditions required in bakery plant; Operation and maintenance of bakery equipment.

**Practical:**

1. Quality analysis of raw materials used in bakery and confectionary industry according to PFA standards.
2. Tests for the Rheological Properties of Dough
3. Preparation of Advanced Bakery Products – *sourdoughs, pastries, croissants, doughnuts*
4. Preparation of Filled and Iced Cakes
5. Preparation of Chocolate
6. Preparation of Coated Confectionery
7. Quality Evaluation of the Bakery Products, Filled and Iced Cakes, Chocolate, and Coated Confectionery
8. Study and analysis of the production charts used for different products by bakery industry.
9. Visits to bakery and confectionary industry. Local market survey for bakery and confectionary products

**Books recommended:**

1. Khatkar B. S. (2011) Baking Science and Technology, Arihant Publication.
2. Amendola J. & Rees N. (2003) Understanding Baking: The Art and Science of Baking, Wiley.
3. Dubey S. C. (2002) Basic Baking, The Society of Indian Bakers.
4. Manley D. (2000) Technology of Biscuits, Crackers & Cookies. 2<sup>nd</sup> Edition, CRC Press.
5. NPCS Board of Food Technologists (2014) Confectionery Products Handbook (Chocolate, Toffees, Chewing Gum & Sugar Free Confectionery), Asia Pacific Business Press Inc.
6. Edwards W.P. (2007) The Science of bakery products, RSC Publications.
7. Mohos F. (2010) Confectionery & chocolate engineering, principles & applications, Wiley Blackwell Publishing Ltd.

**Learning outcomes:** After the completion of the course, the students will be able to:

1. Understand various raw materials used for preparation of various bakery and confectionary products.
2. Have knowledge on basic operation and working of various equipment involved in bakery and confectionary technology.
3. Understand the various processes used for the manufacturing of bakery products like bread, biscuits, cakes, muffins and their quality determination.
4. Acquire knowledge of the various processes used for the manufacturing of confectionary products like chocolate, candies, toffees, gums and their quality determination.
5. Acquire knowledge on food safety rules and regulations for bakery and confectionary products.

# FOOD PRODUCT DEVELOPMENT

COURSE CODE FT-252

CREDITS (2+0)

## Objectives:

1. To acquaint students with techniques of Product Development and International Trade for the food sector.
2. To equip students with knowledge of intellectual property rights (IPR), related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy

## UNIT-I

Innovations in product development. Definition and Need for Product Development. Factors affecting Food Product Development – *corporate factors, market factors, technological pressures, government issues and legislations*. Classes and Characteristics of New Food Products. Line Extensions and Repositioning of Existing Products. Reformulations. New Packaging. Ethics in Food Product Development

## UNIT-II

Food product development process. Stages/ Phases of New Product Development – *idea generation, screening, feasibility studies, consumer research, financial review, product design and formulation*. Process Development – *recipe development and scale-up, consumer trials, market testing*. Quality Assessment of New Developed Products – *sensory evaluation, shelf life testing*. Packaging and Labelling Protocols. Costing/ Pricing and Economic Evaluation of the Product. Product Launch. Product Life Cycle

## UNIT-III

Specialty food products. *Specialty Product Development with reference to Health and Nutritional Needs for the following*: Therapeutic and Medical Foods. Infant Foods Geriatric Foods. Functional Foods and Nutraceuticals. Herbal Foods. Sports Drinks. Prebiotics and Probiotics

## UNIT-IV

International trade. Salient Features of International Marketing. International Marketing Environment. Export Regulation – direct, indirect licensing and joint ventures. Product Promotion and Pricing, Distribution Channels. World Trade Organization (WTO)

## UNIT-V

Intellectual properties (IIP's). Historical Perspectives and Need for the Introduction of Intellectual Property Right regime. TRIPs and Provisions in TRIPS Agreement. Intellectual Property Rights (IPR) - benefits of securing IPRs. Indian legislations for the protection of various types of intellectual properties. Fundamentals of Patents, Copyrights, Geographical Indications, Trade Secrets and Traditional Knowledge, Trademarks, Material Transfer Agreements, Research Collaboration Agreements, License Agreements etc.

**Books recommended:**

1. Erbisch FH and Maredia K. 1998. *Intellectual Property Rights in Agricultural Biotechnology*. CABI, Wallingford.
2. Ganguli, Prabudha. 2001. *Intellectual Property Rights: Unleashing Knowledge Economy*. McGraw-Hill, New Delhi India, Ministry of Agriculture. 2004. *State of Indian Farmer. Vol. 5. Technology Generation and IPR Issues*. Academic Foundation, New Delhi. *Intellectual Property Rights: Key to New Wealth Generation*. 2001. NRDC and Aesthetic Technologies, New Delhi.
3. Rothschild, Max & Newman, Scott (Ed.). 2003. *Intellectual Property Rights in Animal Breeding and Genetics*. CABI, Wallingford.
4. Saha R. (Ed.). 2006. *Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies*. Daya, Delhi.

**Learning outcomes:**

1. The student will be able to understand Product Development and International Trade for the food sector.
2. The student will gain the ability to understand Intellectual property rights and their value in economy

# HEAT AND MASS TRANSFER

COURSE CODE FT-253

CREDITS (3+0)

## Objectives:

1. To understand the fundamentals of heat and mass transfer mechanisms and their application in process industries.
2. To acquaint the students with the basic principles of various mechanical operations, construction and working of the equipment.

### UNIT-I

Basic heat transfer process, thermal conductivity, and convective film coefficient, Stefan Boltzman's constant and equivalent radiation-coefficient. Overall heat transfer co-efficient, physical properties related to heat transfer. One dimensional steady state conduction, theory of heat conduction, Fourier's law. Linear heat flow through slab, cylinder and sphere.

### UNIT-II

Concept of electrical analogy and its application for thermal circuits, heat transfer through composite walls and insulated pipes, equations of temperature distribution with different boundary conditions. Steady state heat conduction with heat dissipation to environment. Introduction to extended surfaces (FINS) of uniform area of cross section. Effectiveness and efficiency of FINS. Unsteady state heat conduction, Convection forced and free convection, dimensional analysis and convection heat transfer.

### UNIT-III

Concept of Nusselt number, Prandlt number, Reynolds number, Grashof number, some important empirical relations used for determination of heat transfer coefficient. Radiation: heat radiation, emissivity, transmissivity, radiation through black and grey surfaces, determination of shape factors, introduction to condensing and boiling heat transfer, film and drop wise condensation, non-condensable gases, boiling heat transfer. Heat exchangers: general discussion, fouling factors, jacketed kettles, LMTD, parallel and counter flow heat exchangers, shell and tube, plate heat exchangers. Application of different type of heat exchangers in dairy and food industry

### UNIT-IV

Mass & Energy Balance-Units & dimensions, Mass balance, Concept of limiting & excess reactant, Tie element, Recycle & By-pass. Energy balance-concepts. Principle of Mass Transfer, Fick's Law, Flux equation, Molecular Diffusion in gases & liquids. Extraction-Liquid-liquid extraction, selectivity & choice of solvent, liquid-liquid extraction equipment, Leaching-Introduction, leaching equipment, Principles of continuous-counter current leaching.

### UNIT-V

Absorption- packing's & packed tower, principle of absorption, desorption or stripping. Distillation – Vapour liquid equilibrium, relative volatility, flash & batch distillation, steam

distillation, vacuum distillation, azeotropic mixtures, and distillation tower, humidification & dehumidification, humidity chart, wet and dry bulb temperature & cooling tower.

**Books Recommended:**

1. Geankoplis C. J. Transport processes and separation process principles, 4<sup>th</sup> Edition. Prentice Hall of India.
2. McCabe. Warren L., Smith. Julian C., Peter Harriott, Unit Operations of Chemical Engineering, 7<sup>th</sup> Edition. McGraw-Hill, Inc., New Delhi.
3. Treyball R.E, Mass Transfer Operation, 3<sup>rd</sup> Edition-McGraw Hill Publication.
4. Singh, R.P., &Healdman. Introduction to Food Engineering, 3<sup>rd</sup> Edition, Academic Press, London, UK.
5. Humelblau D.M.& Riggs, J. B., Basic principles and Calculation in Chemical Engineering, 7<sup>th</sup> Edition.Prentice-Hall of India Pvt. Ltd.
6. Introduction to Food Engineering. R.Paul Singh, Dennis R Healdman
7. Heat and Mass Transfer. Er. K. Y Rajput.
8. Handbook of Food Engineering Practice. Kennet. J . Valentas and R.Paul Singh

**Learning outcomes:**

1. The students will be able to understand the basic laws of heat transfer.
2. They can analyse the problems involving steady state conduction in simple geometries.
3. The can analyse heat exchangers performance

## PROCESSING OF MILK AND MILK PRODUCTS

COURSE CODE FT-301

CREDITS (3+1)

### Objective:

1. To illustrate the technologies of processing of milk and milk products.
2. To describe the different physico-thermal properties and their applications.
3. To elucidate the thermal processing of milk and quality changes therein.
4. To explain the hygiene and sanitation practices in milk plant.

### UNIT-I

Dairy Industry in India: present status and scope; Milk: definition, composition and nutritive value; grading of milk; factors affecting composition of milk; physico-chemical properties of milk; FSSAI standards and legislations for market milk. Liquid milk processing: filtration/clarification; bactofugation; standardization; homogenization; pasteurization (LTLT, HTST); sterilization; UHT processing; aseptic packaging; storage and distribution. Technology of special milks: Technology of sterilized/ flavored milk, acidophilus milk, bulgarian milk, kumis, kefir; reconstituted & recombined milk, toned, double toned milk.

### UNIT-II

Technology of fat rich dairy products: Cream: definition and legal standards, consumer cream products, standardization & production of cream, processing of cream (neutralization & pasteurization), butter: definition, butter-making process, overrun, yield, theories of churning, quality of butter, fat losses in cream & butter, defects in cream & butter. Ice-cream: definition, classification and composition of ice-cream, technological aspects of ice cream preparation, packaging, hardening, storage and shipping of ice cream.

### UNIT-III

Technology of condensed and dried milk: Definition and legal standards for evaporated and condensed milks, methods of manufacture and physico-chemical properties of evaporated and condensed milk, concept of heat stability & its control, defects in condensed and evaporated milks, Quality of raw milk for dried milks, definition and legal standards for dried milks, milk drying system (film, roller, drum, spray, foam spray drying), method of manufacture of dried milks (WMP & SMP), defects in dried milk, Technology of yoghurt and cheese: Yoghurt - Definition and technology of yoghurt manufacturing, technology of different varieties of cheese manufacturing (cheddar & mozzarella), changes during ripening of cheese, yield of cheese; manufacture of processed cheese, defects in cheese, accelerated ripening of cheese.

### UNIT-IV

Technology of indigenous dairy products: Introduction to traditional dairy products, *khoa*, *channa*, *paneer*, *dahi*, *shrikhand*, *ghee*, *khoa* and *channa* based sweets, miscellaneous traditional dairy foods, Dairy industry by-products and sanitation: By-products: introduction, definition, composition, Importance and food applications, whey protein concentrates & isolates, Dairy plant sanitation: hygiene in dairy industry, different types of cleansing/sanitizing agents and their applications, cleaning systems in dairy industry.

### Practical:

1. Sampling equipment and sampling of milk.

2. Platform tests (Acidity, COB and Alcohol test).
3. Determination of milk fat percentage by Gerber's method.
4. Determination of specific gravity by lactometer.
5. Visit to milk processing plants.
6. Microbial examination of milk samples.
7. Methylene blue reduction test of milk.
8. Analysis of milk: total solids, fat, SNF, protein, lactose, acidity, ash, total bacterial count,
9. Analysis of adulteration of milk (sugar, carbohydrate, urea, neutralizer, water)
10. Turbidity test for sterilized milk, preparation of sterilized flavoured milk
11. Preparation of ghee from cream/ butter
12. Preparation of ice-cream, overrun of ice cream (by weight/by volume)
13. Preparation of cheese
14. Bulk/true density of milk powder and Solubility of milk powder
15. Preparation of yoghurt/ dahi

#### **Books recommended:**

1. Smit, Gerrit (2003). Dairy processing: improving quality, Woodhead publishing limited, England.
2. De, Sukumar (1991). Outlines of dairy technology, Oxford university press, Delhi.
3. Varnam, A.H., Sutherland, J.P. (1994). Milk and milk products, Chapman and Hall, New York, USA.
4. Walstra, P., Geurts, T.J., Noomen, A., Jellema, A., Boekel, M.A.J.S (1999). Dairy Technology: Principles of milk properties and processes, Marcel Dekker, Inc, New York.
5. Winton, A. L. and Winton, K. B. (2000). Milk and Milk Products: Agrobios, India.
6. Kutty, C. I. and Khamer, S. (2004). Milk Production and Processing: Daya, Delhi.
7. Fox, P. F. and McSweeney, P. L. H. (1998). Dairy Chemistry and Biochemistry: Kluwer Academic, New York.
8. Kurmann, J. A., Rasic, J. L. and Kroger, M. (1992). Encyclopedia of Fermented Fresh Milk Products: An International Inventory of Fermented Milk, Cream, Buttermilk, Whey and Related Products: CBS Publications, New Delhi.
9. Davis, J. G. (1994). Milk Testing: The Laboratory Control of Milk: Agro Botanical, Bikaner.

#### **Learning outcomes:**

After the completion of the course, the students will be able to:

1. Understand the processes related to storage, processing and distribution of milk and milk Products.
2. Perceive the different properties of milk and milk products.
3. Apprehend the thermal processing of milk.
4. Grasp the technology of fat rich dairy products.
5. Comprehend the technology of condensed milk, dried milk, cheese, yoghurt and indigenous products will be understood.



6. Have knowledge regarding hygiene and sanitation practices in the milk and milk products industry.

## **FOOD RHEOLOGY**

**COURSE CODE FT-302**

**CREDITS (2+0)**

### **Objectives:**

1. To provide necessary background and hands-on experience on rheological principles and measurement methods as needed in the food and related industries.

#### **UNIT-I**

Introduction, need for rheological data in the food (and other) industry. Theoretical Background: Classification of materials – Deformation, Stress, strain, tensors, Elastic (Hookean) solid. Viscous liquid. Rheological models for fluids, apparent viscosity, Time-dependent materials, yield stress, Steady shear flow, viscometric functions.

#### **UNIT-II**

Rheological and textural properties of selected food products: Measurement modes and techniques; Effect of processing and additives (stabilizers and emulsifiers) on food product rheology; Relationship between instrumental and sensory data. Large Deformations and failure in foods: Definitions of fracture, rupture and other related phenomena; Texture Profile Analysis; Instrumental measurements – Empirical and Fundamental methods; Rheometers and Texture Analyzers; Measurement of Extensional viscosity; Acoustic measurements on crunchy foods.

#### **UNIT-III**

Measurement of rheological parameters, Falling ball viscometers, Rotational viscometers, Brookfield viscometer, Rheometer: Geometries, shear rate approximations. Tube (capillary) viscometry: Gravity operated glass capillaries; Pipe viscometer: Rabino witch-Mooney equation (end correction, slip correction). Mixer viscometry: Principles and applications (suspensions, emulsions), elastic behavior of viscoelastic fluids, Rheological (mechanical) Models: The Maxwell Fluid, Stress relaxation, Shear creep and creep recovery. Dynamic Measurements: Small Amplitude Oscillatory Shear, Deborah Number, Normal stresses and normal stress differences, Extensional Viscosity: Squeezing Flow.

#### **UNIT-IV**

Measurement of Rheological Parameters - Yield stress. Extrapolation method, Tests using the controlled stress rheometer, The Yield Stress Brookfield Rheometer, Mathematical treatment of test results.

### **Books recommended:**

1. Bourne, M. Food Viscosity and Texture, 2nd Edition, Academic Press, New York, 2002.
2. Macosko, Ch.W. Rheology: Principles, Measurements, and Applications (Advances in Interfacial Engineering), Wiley-VCH, 1994.
3. Morrison, Faith. Understanding Rheology, Oxford University Press, 2001.
4. Phan-Thien, N. Understanding Viscoelasticity. Basics of Rheology. Springer, 2002.

### **Learning outcomes**

1. Students' preparation for the basic operations in food physical properties (rheology).
2. Includes acquisition and application of food science and technology knowledge on the food's physical and structural properties, namely in food quality control, product

development, food plant layout development and correlations between rheological and sensory food properties.

## **FOOD PACKAGING, STORAGE AND LOGISTICS**

**COURSE CODE FT-303**

**CREDIT (3+0)**

### **Objective:**

1. To explain the various recent techniques of food packaging, applications, principles and requirements of these techniques.
2. Awareness of students about the recycling of packaging materials, biodegradable packaging materials and safety and legislative aspects.

### **UNIT-I**

Packaging techniques, oxygen, ethylene and other scavengers: Oxygen scavenging technology, selection of right type of oxygen scavengers, ethylene scavenging technology, carbon dioxide and other scavengers, antimicrobial food packaging, antimicrobial packaging system, effectiveness of antimicrobial packaging.

### **UNIT-II**

Advantages of non-migratory bioactive polymers, Inherently bioactive synthetic polymers: types and application, Polymers with immobilized bioactive compounds, defining and classifying time temperature indicators (TTIs), requirements for TTIs, development of TTIs, maximizing the effectiveness of TTIs to monitor shelf-life during distribution, use of freshness indicator in packaging: Compounds indicating the quality of packaged food products, pathogen indicators, moisture regulation: Silica gel, clay, molecular sieve, humectants, irreversible adsorption.

### **UNIT-III**

Developments in modified atmosphere packaging (MAP): Novel MAP applications for fresh-prepared produce, novel MAP gases, testing novel MAP applications, Applying high O<sub>2</sub> MAP. Combining MAP with other preservation techniques, packaging-flavour interactions: Factors affecting flavour absorption, role of the food matrix, role of differing packaging materials.

### **UNIT-IV**

Modern packaging systems: Green plastics for food packaging, problem of plastic packaging waste, range of biopolymers, developing novel biodegradable materials, Integrating intelligent packaging: role of packaging in the supply chain, creating integrated packaging, storage and distribution: alarm systems and time temperature indicators, traceability: radio frequency identification, recycling packaging materials: recyclability of packaging plastics, improving the recyclability of plastics packaging, Testing the safety and quality of recycled material, using recycled plastics in packaging, methods for testing consumer responses to new packaging concepts.

### **Books recommended:**

1. Jung, H. H. (2014). *Innovations in Food Packaging*: Oxford, London.
2. Ahvenainen. R. (2003). *Novel Food Packaging Techniques*:CRC Publications.

3. Robertson, G. L. (2010). *Food Packaging and Shelf Life*: CRC Publications, New York.
4. Robertson, G. L. (2006). *Food Packaging: Principles and Practice* (2 ed.): CRC Publications, Boca Raton.

**Learning Outcomes:**

On successful completion of the subject, the students will be able to:

1. Comprehend advance knowledge on the properties and production of various packaging materials and effect of various indicators used in supply chain management to indicate the food quality
2. Understand various types of scavengers and emitters for improving the food shelf life.
3. Learn about consumer response about new packaging systems and safety and legislative requirements
4. Acquaint about food-package interaction between package-flavour, gas storage systems for food storage, recycling and use of green plastics for reducing the pollution and their effect on food quality.

# FOOD SAFETY AND QUALITY

**COURSE CODE FT-304**

**CREDITS (3+0)**

## **Objectives:**

1. To illustrate the importance of food safety, food quality, food laws and regulations in Food industry.
2. To describe the food quality management systems.
3. To explain the national and international food laws and regulations.
4. To exemplify different food adulterants.

### **UNIT -I**

Importance of food safety and regulations; Sampling and specifications of raw materials; Application of food standards and their specification for foods, food products, additives, preservatives, colouring agents, emulsifying and stabilizing agents and antioxidants; Definition of food quality and safety, Wet chemistry Methods/ techniques for the assessment of quality and safety of different foods; Non-destructive and rapid techniques for assessing food quality and safety including spectroscopy, sensors and colour/imaging techniques. Grading and marketing of standards and specifications of finished products; various methods/ techniques for the assessment of quality of different foods; Grading and marketing of standards and specifications of finished products; Various National and International standards; Agencies involved in enforcement of food laws and regulations; Food and nutritional labelling. Food adulteration: Types of adulterants, Common adulterants for foods like milk and milk products, honey, wheat flours, edible oils, cereals, condiments (whole and ground) pulses, coffee, tea, confectionery, baking powder, non-alcoholic beverages, vinegar, besan and curry powder

### **UNIT-II**

Concepts of quality management: Objectives, importance and functions of quality control; Quality management systems in India; Quality assurance, Total Quality Management; GMP/GHP; GLP, GAP, HACCP; Sanitary and hygienic practices. NABL accreditation and NABL accredited Laboratories in India Euro GAP

### **UNIT -III**

Regulatory Approaches to Food safety-present scenario, food safety and standards Act, 2006, Food Licensing & Registration System (FLRS). The Food Safety and Standards Regulations 2011: Licensing and Registration of Food businesses, Sampling procedures and plans. Food product standards and Food Additives, Prohibition and Restriction on sales, contaminants, toxins and residues, Laboratory and analysis, sampling.

### **UNIT-IV**

Food categorization System, Product/ Ingredient Approval, Export & Import Laws and Regulations, FTDR Act, 1992 and Foreign Trade Policy, Food Import Clearance System (FICS). Introduction to OIE and IPPC , other International Food Standards ( e.g. European

Commission , USFDA etc) WTO: Introduction to WTO agreement: SPS and Agreement, Export and Import Laws and regulation.

## UNIT-V

Codex Alimentations Commission (CAC), CAC Implications on trade in light of SPS and TBT, Other International Standards Bodies. Food Commodity Geographical identification bar coding, Certification of organic labelling procedures, bar coding, food label design.

### Books recommended:

1. Resources at FSSAI Website.
2. Early R. 1995. Guide to Quality Management Systems for Food Industries. Blackie Academia.
3. Export and Import Policy of GOI.
4. Jha S N (2015). Rapid Detection of Food Adulterants and Contaminants: Theory and Practice. Elsevier, USA (ISBN 9780124200845)
5. Jha S. N. (editor) (2010). Non-destructive Evaluation of Food Quality: Theory and Practice. Springer – Verlag GmbH Berlin Heidelberg, Germany, ISBN 978-3-642-15795-0, doi 10.1007/978-3-642-15796-7
6. Lawless, H. T. and Heymann, H. (2013). *Sensory Evaluation of Food: Principles and Practices*: Springer, New Delhi.
7. Schmidt, R. H. and Rodrick, G. E. (2003). *Food Safety Handbook*: John Wiley, New Jersey.
8. Rees, N. and Watson, D. (2000). *International Standards for Food Safety*: Aspen, America.
9. Ho, S. K. M. (1999). *Operations and Quality Management*: ITP, London.

### Learning outcomes:

After the completion of the course, the students will be able to:

1. Understand various areas of Food Safety & Quality Assurance.
2. Grasp knowledge of the quality assessments of food products.
3. Comprehend food quality managements systems.
4. Apprehend the Indian and International food laws.
5. Conceive the concept of adulteration in food products.

# FOOD PLANT LAYOUT AND MAINTENANCE

**COURSE CODE FT-354**

**CREDITS (2+0)**

## **Objectives:**

1. To make them familiar with the overall integration of man, materials, machinery, supporting activities and any other considerations.
2. To acquaint the students with the simplification of production processes in terms of equipment utilization.

### **UNIT-I**

Plant Location and Layout-Concept and factors governing plant location. Location economics- comparison of rural vs urban plant sites, plant site selection guide. Classes of layout problems, objectives, principles and types of layouts – process layout, product layout, combination layout, fixed position layout; methods and tools of plant and factory layouts; plant layout procedures. Layouts of different types of food and fermentation industries – canning, dairy, bread, biscuit, beer, tomato processing, rice mill and wheat mill.

### **UNIT-II**

Network Analysis of Processes-Basic terms, objectives and advantages of network analysis, various network techniques, PERT and CPM techniques, smoothing.

### **UNIT-III**

Factory Building and Cost Analysis- Considerations in building design, types of factory buildings, building construction materials for floors, walls, roofs, etc. Fixed cost, variable cost, depreciation, methods of economic analysis, profitability analysis of a plant.

### **UNIT-IV**

Plant Maintenance-Objectives and importance of maintenance, types of maintenance – corrective or breakdown maintenance, scheduled maintenance, preventive maintenance and predictive maintenance, hygiene maintenance in food plant, hygiene of factory workers, record maintenance.

## **Books Recommended:**

1. Douglas ,J.M. , “Conceptual Designs of Chemical Processes”,. McGraw Hill, 1989.
2. Peters ,M.s and Timmerhaus ,K.D, “Plant Designs and Economics for Chemical Engineers” 4th Edition McGraw Hill,1 991.
3. S. N. Jha (2006). Dairy and Food Processing Plant Maintenance: Theory and Practice (ISBN No. 81-8189—088-4). Publisher: International Book Distributing Company (Publication division), Lucknow
4. Biegler L.,grossmann I.E.and Westeberg A.W. “Systematic Methods of Chemical Engineering and Process Designs ,” prentice Hall ,1997.

## **Learning outcomes:**

1. They can provide the guidelines to food industries for better working environment, safety of employees with reduced hazards.
2. They can also provide guidance to food industries for minimizing the waste and higher productivity.

## STATISTICAL METHODS

COURSE CODE FT-306  
(2+1)

CREDITS

### Objectives:

1. To impart basic understanding of sampling and different sampling techniques.
2. To provide basic understanding about different statistical methods.
3. To exemplify the statistical basis of chart, control chart for variables and attributes.

### UNIT I

Statistical terms and notations, frequency distribution, frequency curve, measures of central tendency and dispersion, Binomial and poisson distribution; Introduction to sampling. Sampling: Characteristics, Advantages and disadvantages; Need of sampling; Sampling errors; Sample size; Sampling techniques (simple, complex random, probability and non-probability, systematic and stratified), PCA

### UNIT II

Statistical Methods: normal distribution, test of significance, null hypothesis, types of error, level of significance and degree of freedom, steps involved in testing of hypothesis, z-test, t-test for testing sample mean and difference between two means, paired t- test, chi-square test, F-test, analysis of variance, correlation and regression analysis.

### UNIT III

Statistical quality control: Introduction, advantages and limitations; Techniques of statistical quality control, control charts for variations,  $\bar{x}$  and R chart, control chart for attribution, c chart, p chart, np chart; consumer risk, producer risk; Acceptance quality level (AQL); Lot tolerance percentage quality level (LTPD), process average fraction defective. Operative characteristic curve, simple and double sampling plans for pre-packaged foods.

### UNIT IV

How to use excel; Computer aided statistical tools designs: SPSS, RSM, PCA and MATLAB, Measurement of Skewness etc.

### Practical:

1. Formation of frequency distribution and graphical representation.
2. ANOVA
3. Measures of central tendency.
4. Measures of dispersion.
5. Applications of 'Z' test for one and two sample problems
6. Applications of 't' test for one and two sample problems.
7. Applications of Chi-square test.
8. Rank correlation coefficient.

### Books recommended:

1. Rangana (1995) *Food Quality Assurance*.
2. Hubbard M. R. (2005) *Statistical quality control for food industry*, Springer Publishers.
3. Gupta S. P. (2006) *Statistical Methods*.
4. Gupta S. C. & Kapoor V. K. *Statistical Methods*.
5. Gupta S. C. & Kapoor V. K. *Fundamentals of Applied Statistics*.

6. Sharma J. K. (2005) *Business Statistics*.

**Learning outcomes:**

After the completion of the course, the students will be able to:

1. Understand concept of sampling, sampling distribution and its application.
2. Acquire basic concept and ideas of Statistical quality control and different Statistical methods.
3. Understand basics of control chart for variables and for attributes with its application, concept of Process Capability Analysis (PCA).
4. Solve the problems regarding measures of central tendency and measures of dispersion and problems related to chi square test, analysis of variance, regression analysis.



## INDUSTRIAL MICROBIOLOGY

**COURSE CODE FT-351**

**CREDITS (2+0)**

### **Objectives:**

1. To provide the students with broad theoretical/practical skills in industrial microbiology.
2. To make them familiar with different types of industrially important microorganisms and their applications.

### **UNIT-I**

Definition and Scope of Microbiology, Gram positive and Gram-negative bacteria. Methods for studying microorganisms, pure culture techniques, methods of sterilization – physical and chemical, media – types. Microbial growth, phases of growth, binary fission. Industrially important microorganisms.

### **UNIT-II**

Concept and scope of microbial fermentation technology, Inoculums-screening and selection fermentation medium. Fermentation processes- dual and multiple fermentation, continuous fermentation, batch fermentation. Bioreactors- types, designs and functional characteristics; Scale up of fermentation, construction of fermenters, Maintenance of aseptic conditions, Culture preservation, methods of preservation (low temperature, lyophilization, freeze drying vacuum drying etc), stock culture collection centres, criteria for selection of microorganism for fermentation, lactic acid fermentation.

### **UNIT-III**

Microorganisms as food, single cell protein, yeast, algae and fungal biomass production. Fermentation economics; Fermentation processes and products; production of organic solvents-ethyl alcohol, butyl alcohol acetone. Amino acids; Lysine, glutamic acid; Vitamins and growth factors; Vitamin B<sub>1</sub> (Riboflavin), Vitamin B<sub>12</sub>. Fermented foods- Yoghurt, ripened cheese, fermented soybean products, Alcohol production, Malt beverage, production of beer, Production of wine through microbial fermentation, Vinegar production, citric acid production through microbial process, Production of amino acids

### **UNIT-IV**

Production of enzymes-amylase, cellulase, protease, lipase, gluco-isomerase; organic acids-butyric acids, propionic acid, lactic acid. Antibiotics-pencillin, streptomycin, tetracyclines and microbial polysaccharides. Principles of immobilization techniques and their importance.

### **Books recommended:**

1. M J Pelczar, E C S Chan and N R Krieg. Microbiology. Tata McGrawHill.
2. T D Brock. Biology of Microorganisms. Prentice Hall
3. R C Dubey and D K Maheshwari. A Textbook of Microbiology. S.Chand.
4. A G Moat, J W Foster and M P Spector. Microbial Physiology. Wiley.
5. Whitaker and Stanbury. Principles of Fermentation Technology.
6. Casida. Industrial Microbiology. Tata McGraw Hill.

### **Learning outcomes:**

1. The students will be able to discuss the role of different microorganisms in food industry.
2. Students will be able to explain the production of industrial products from microorganism with fermentation.

# INTELLECTUAL PROPERTY RIGHTS

**COURSE CODE FT-352**

**CREDITS (2+0)**

## **Objectives:**

1. To acquaint the students with the fundamental aspects of intellectual property rights.
2. To disseminate knowledge on copyrights and its related rights.
3. To disseminate knowledge on patents, patent regime in India and abroad and registration aspects.

### **UNIT-I**

Introduction to Intellectual Property. Concept & Meaning of Intellectual Property. Nature and Characteristics of Intellectual Property. Origin and Development of Intellectual Property. Kinds of Intellectual Property

### **UNIT-II**

Theories of Intellectual Property. Justification and Rationale for Protecting Intellectual Property. Balancing the Protection of IPR and Public Policy Objective. Theories of IPR:- Natural Theory, Hegelian Philosophy (Personality Theory), Lockes' Theory of Property (Labour Theory), Social Contract Theory, Social Planning Theory, Incentive Theory, Reward Theory, Prospect Theory, Schumpeterian Theory, Economic Theory.

### **UNIT-III**

International Institutions and Basic International Conventions. Paris Convention for the Protection of Industrial property, 1883. The Berne Convention, 1886. TRIPS Agreement, 1994. International Institutions Concerned with Intellectual Property.

### **UNIT-IV**

Contemporary Issues in IPR. Interface between IPR and Human Rights. Interface between IPR and Competition Law. IPR and sustainable development. The Impact of Internet on IPR. E-Commerce and IPR issues. Patents- Trips Definition, kind inventions protected by patent- Patentable and Non patentable inventions. Process and product patent. Patent application process: Searching a patent, drafting a patent, Filing of a patent- Types of patent applications Patent document: Specifications and claims. Management of IP assets and IP portfolio. Commercial exploitation of IP. Assignment, licensing, and infringement. The different layers of international patent system: national, regional and international options.

### **UNIT-V**

Copyrights-Rights and protection covered by copyright-Law of copyrights: Fundamental of copyright law, originality of material, rights of reproduction, right to perform the work publicly, copyright ownership issues, obtaining copyright registration, notice of copyright, international copyright law. Infringement of copyright under copyright act. Design: meaning and concept of novel and origin, procedure for registration. Geographical indication: meaning, difference between geographical indication and trademark. Layout design protection. Trademarks: types, logos, signatures, symbols, registration. Some practice of writing patent applications

## **Books recommended:**

1. David I. Bainbridge, Intellectual Property, Longman, 9th Edition, 2012
2. Peter Groves, Sourcebook on Intellectual Property Law, Routledge-Cavendish, 1997.
3. Intellectual property right, Deborah, E. Bouchoux, Cengage learning.

## **Learning outcomes:**

1. The students shall get an adequate knowledge on patent and copyright for their innovative research works.
2. Pave the way for the students to catch up intellectual property right as a career option

# FOOD BUSINESS MANAGEMENT

**COURSE CODE FT-302**

**CREDITS (2+0)**

## **Objectives:**

1. To provide knowledge about economics and business operations of food processing.
2. To make them familiar about the marketing needs and requirements

## **UNIT-I**

Introduction to Business Management, Theories motivation of leadership, Business environment for food industry in India and beyond, Introduction to Entrepreneurship: Entrepreneurs; entrepreneurial personality - characteristics, traits and behavioral; entrepreneurial challenges. Definitions, management principles, Maslow's Hierarchy of needs theory; Functions of management: Planning, organizing, staffing, directing, controlling, Organizational structures, principles of organization; Types of organization: Formal and informal. Introduction to economics: Definitions, nature, scope, difference between microeconomics and macroeconomics; Theory of demand and supply, elasticity of demand, price and income elasticity. Markets: Types of markets and their characteristics; National income: GDP, GNP, NNP, disposable personal income, per capita income, inflation.

## **UNIT-II**

Introduction to business models; Creating value propositions; customer focused innovation; building and analyzing business models; Business model canvas, Introduction to lean startups, Registration needs and forms of for a startup business in India, Business Pitching, Human Resource Management in startup setting. Financial management – financial statements, balance sheet and budgeting. Theory of production. Law of variable proportions and law of returns to scale; Cost: Short run and long run cost, fixed cost, variable cost, total cost, average cost, marginal cost, opportunity cost; Break even analysis; Finance management: Definition, scope, objective; Different systems of accounting: Financial accounting, cost accounting, management accounting; Human resource management: Definitions, objectives of manpower planning, process, sources of recruitment, process of selection; Corporate social responsibility: Importance, business ethics.

## **UNIT-III**

Marketing Management – definitions, Product lifecycle and positioning, planning the marketing programmes, Consumer need/market gap assessment for processed foods. Materials management – types of inventories, inventory costs, managing the inventories, economic order quantity (EOQ). Project management – Preparation of project implementation plan, project preparation evaluation measures. Production Forecasting, Planning and Control

## **UNIT-IV**

Entrepreneurial and managerial characteristics, managing an enterprise, motivation and entrepreneurship development, importance of planning, monitoring, evaluation and follow up, managing competition, SWOT analysis, generation, incubation and commercialization of ideas and innovations; Women entrepreneurship: Role and importance; Corporate entrepreneurship: Role, mobility of entrepreneur; Entrepreneurial motivation; Planning and evaluation of projects: Growth of firm, project identification and selection, factors inducing growth; Project feasibility study: Post planning of project, project planning and control.

## **UNIT-V**

Government policy on small and medium enterprises (SMEs)/SSIs; Export and import policies relevant to food processing sector; Venture capital; Contract farming and joint ventures, public-private partnerships; Overview of food industry inputs; Characteristics of Indian food processing industries and export; Social responsibility of business. World trade agreements related with food business, export trends and prospects of food products in India. Management of export import organization, registration, documentation, export import logistics, Role of APEEDA.

### **Books recommended:**

1. Reddy and Raghuram. Agriculture, Finance and Management. Oxford & IBH Pub Co, 1996
2. Kotler and Keller, Burton. Marketing Management. Pearson Education Australia, 2008
3. Duening and Ivacevinch. Management: Principles and Guidelines. Dreamtech Press, 2003.

### **Learning outcomes:**

1. Upon successful completion of the course the students will be able to manage the human resources within a food service organizations.
2. They can communicate appropriately with clients, staff and management.
3. It will also help them to adhere to the regulations, standards, and best practices of food industry.

## SCIENTIFIC WRITING

**COURSE CODE FT-401**

**CREDITS (1+1)**

**Objectives:**

1. To acquaint the students with scientific documentation, research paper writing.
2. To enhance the analytical and logical thinking of the students.

Basic concepts of research, Planning and organization of experiments for data acquisition and analysis. Type of research methods, experimental designs, equipment and principles underlying their uses. Scientific periodicals and literature related to the subject. Form and style of writing research papers, review articles, research reports and thesis. Selection of research problem and preparation and submission of research projects. Interpretation and evaluation of research data, considerations and requirements for technical writing.

**FT-402: Dissertation/Thesis**

# FUNCTIONAL FOODS AND NUTRACEUTICALS

COURSE CODE FT-451

CREDITS (2+0)

## Objectives:

1. To impart the concept of nutraceutical and functional ingredients in foods, and to determine their role in health and disease prevention.
2. To learn about various phytochemicals-their sources, functions and usefulness.
3. To understand basics of Extraction methods of Phyto-chemicals and development of functional foods.

### UNIT-I

Nutraceutical and functional foods: definition, types and scope, need, food applications and their health benefits, Nutraceutical compounds and their classification, Nutraceutical for specific situations such as cancer, heart disease, stress, osteoarthritis, hypertension etc.

### UNIT-II

Photochemical and their usefulness: Antioxidants and Flavonoids, Omega-3 Fatty Acids, Carotenoids, Dietary fibres, Phytoestrogens, glucosinolates, organ sulphur compounds etc. their effectiveness in specific disease conditions; other functional ingredients in foods such as peptides, fatty acids, Cereal products as functional foods – oats, wheat bran, rice bran etc, Functional vegetable products, oil seeds, sea foods and sea weeds, antimicrobial compounds, Coffee, tea and other beverages as functional foods/drinks and their protective effect, Effects of processing, storage and interactions of various environmental factors on the potentials of such foods, health benefits.

### UNIT-III

Extraction of Phyto-chemicals and development of functional foods: Extraction methods for maximum recovery, Stability studies, Developing functional foods, Use of bioactive compound in appropriate form with protective substances and activators, Effect of environmental conditions in food matrix on activity of bioactive compound, Effects of processing conditions and storage, Development of biomarkers to indicate efficacy of functional ingredients, delivery of immune-modulators/vaccines in functional foods.

### UNIT-IV

Prebiotics and Probiotics: Usefulness of Probiotics & Prebiotics in gastrointestinal health and other benefits, Examples of useful microbes and their benefits, Prebiotic ingredients in foods, types of prebiotics and their effects on gut microbes, Probiotic foods and their functional role, Marketing and regulatory issues for functional foods and nutraceuticals.

## Books recommended:

1. Mine, Y and Fereidoon, S. (2006). *Nutraceutical Proteins and Peptides in Health and Disease*: TF, Boca Raton.
2. Bagchi, D. (2008). *Nutraceutical and Functional Food Regulations in United States and Around the World*: Elsevier, London.
3. Shi, J. (2007). *Functional Food Ingredients and Nutraceuticals: Processing Technologies*: CRC Press, London.
4. Guo, M. (2009). *Functional Food: Principles and Technology*: WP, New Delhi.

**Learning outcomes:**

On completion of the subject, the students will be able to:

1. Acquire knowledge on various bio molecules showing health benefits.
2. Understand various physiological and biochemical aspects of life threatening and chronic diseases.
3. Apply their knowledge regarding extraction, isolation, characterization and application of nutraceuticals in food industries.
4. Identify various aspects about safety, quality and toxicology of food products including, nutraceutical and functional foods.

## **BY-PRODUCT MANAGEMENT**

**COURSE CODE FT-452**

**CREDITS (2+0)**

### **Objectives:**

1. To acquaint students with importance of food wastes for resource generation.
2. To make them familiar with various aspects of solid waste management in food industries.
3. This course will also cover different aspects regarding recovery of biological conversion products from solid waste to compost and biogas.

### **UNIT-I**

General principles of food hygiene; Personal hygiene; Hygienic food handling; Sanitation facilities and procedures in food plant operation; Method of cleaning and disinfection; Detergents and sanitizers.

### **UNIT-II**

By-product utilization: Types, availability and utilization of byproducts of cereals, legumes and oilseeds; Utilization of by-products from fruits and vegetables processing, sugar industries, brewery and distillery

### **UNIT-III**

Status and utilization of dairy by-products i.e. whey, buttermilk and ghee residue; Availability and utilization of by-products of meat, poultry and fish processing industry

### **UNIT-IV**

Waste and its consequences in pollution and global warming; Types of food processing wastes (oil, fruit juice, cereal, meat waste, dairy and food packaging) and their present disposal methods). Methods for waste treatment (physical, chemical and biological methods); Bio- methanation and bio-composting technology for organic waste; Incineration; Efficient combustion technology; Effluent treatment; Use of waste and waste water.

### **Books recommended:**

1. Waste Management for Food Industries by S Ioannis. Elsevier (2008).
2. Food Science by NN Potter. CBS Publishers (2007).
3. Essentials of Food Science by V Vaclavik and CW Elizabeth. Springer (2014).

### **Learning outcomes:**

1. The student will gain an understanding of processing techniques and disposal methods used for food waste.
2. The student will gain insights about the presence of different hazardous wastes.
3. They can acquire knowledge on waste to energy productions in perspectives of sustainable development.
4. They can acquire fair amount of knowledge for waste management in urban areas.