



**MAHARSHI DAYANAND UNIVERSITY,  
ROHTAK- 124 001, INDIA**

(NAAC Accredited 'A' Grade State University established under  
Haryana Act No. XXV of 1975)

**EXAMINATION SCHEME & SYLLABI  
M.Sc. FOOD TECHNOLOGY  
(2 Year Program)**

**Choice Based Credit System (CBCS)**

(w.e.f. Academic Session 2016-17)

**DEPARTMENT OF FOOD TECHNOLOGY**

Web site: <http://www.mdurohtak.ac.in>

**Credit Matrix for M.Sc. Food Technology Program (w.e.f. session 2016-17)**

SEMESTER	CORE PAPERS (INCLUDING PRACTICALS)	DISCIPLINE SPECIFIC ELECTIVES (INCLUDING PRACTICALS)	FOUNDATION COURSE	OPEN ELECTIVE (INTERDISCIPLINARY)	DISSERTATION	INDUSTRIAL TRAINING	TOTAL
I	28	-	-	-	-	-	28
II	20	04	02	03	-	-	29
III	16	08	-	03	-	02	29
IV	08	-	-		20	-	28
TOTAL	72	12	02	06	20	02	114

**REQUIRED CREDITS FOR THE COURSE**

CORE PAPERS=72

DISCIPLINE SPECIFIC ELECTIVES=12

OPEN ELECTIVE (INTERDISCIPLINARY)=06

FOUNDATION COURSE=02

DISSERTATION=20

INDUSTRIAL TRAINING=02

**TOTAL=114**

## SCHEME OF EXAMINATION

### M.SC. FOOD TECHNOLOGY (CHOICE BASED CREDIT SYSTEM)

(W.E.F. ACADEMIC SESSION 2016-17)

SEMESTER –I						
Paper No.	Nomenclature of Paper	Credits	Hrs.	Max. Marks	Internal Assessment	Total Marks
CORE PAPERS						
16FT21C1	Food Chemistry	4	4	80	20	100
16FT21C2	Principles of Food Engineering	4	4	80	20	100
16FT21C3	Basic Principles of Food Processing and Preservation	4	4	80	20	100
16FT21C4	Food Microbiology	4	4	80	20	100
16FT21C5	Food Analysis &Instrumentation	4	4	80	20	100
LAB COURSES						
16FT21C6	Lab course-I (16FT21C1, 16FT21C2 & 16FT21C5)	4	8	-	-	100
16FT21C7	Lab Course-II (16FT21C3 & 16FT21C4)	4	8	-	-	100
TOTAL CREDITS = 28						700

**Total Credits=28**

**Total Marks=700**

SEMESTER –II						
Paper No.	Nomenclature of Paper	Credits	Hrs.	Max. Marks	Internal Assessment	Total Marks
CORE PAPERS						
17FT22C1	Technology of Cereals & Bakery Products	4	4	80	20	100
17FT22C2	Technology of Fruits and Vegetables	4	4	80	20	100
17FT22C3	Unit Operations in Food Engineering	4	4	80	20	100
DISCIPLINE SPECIFIC (ELECTIVE)-I (Any One)						
17FT22D1	Post Harvest Technology of Plantation Crops	4	4	80	20	100
17FT22D2	Technology of Legumes and Oilseeds	4	4	80	20	100
17FT22D3	Technology of Meat, Poultry and Fish Products	4	4	80	20	100
OPEN ELECTIVE PAPER						
	To be opted by the students from the pool of open electives	3	3			
FOUNDATION COURSE						
	To be opted by the students from the pool of Foundation Electives	2	2			
LAB COURSES						
17FT22C4	Lab Course-III (17FT22C1, 17FT22C2 )	4	8	100	-	100
17FT22C5	Lab Course-IV (17FT22C3 & 17FT22DI-1/2/3 )	4	8	100	-	100

TOTAL CREDITS= 29

### SEMESTER –III

Paper No.	Nomenclature of Paper	Credits	Hrs.	Max. Marks	Internal Assessment	Total Marks
CORE PAPER						
17FT23C1	Technology of Milk and Milk products	4	4	80	20	100
17FT23C2	Food Packaging	4	4	80	20	100
DISCIPLINE SPECIFIC (ELECTIVE)-II (Any One)						
17FT23D1	Nutraceuticals and Functional Foods	4	4	80	20	100
17FT23D2	Food Additives	4	4	80	20	100
17FT23D3	Flavor Chemistry and Technology	4	4	80	20	100
DISCIPLINE SPECIFIC (ELECTIVE)-III (Any One)						
17FT23D4	Sensory Analysis of Foods	4	4	80	20	100
17FT23D5	Food Biotechnology	4	4	80	20	100
17FT23D6	Enzymes and Fermentation Technology	4	4	80	20	100
OPEN ELECTIVE PAPER						
	To be opted by the students from the common pool	3	3			
17FT23IT	Industrial Training*	2	-	50	-	50
LAB COURSES						
17FT23C3	Lab Course-V (17FT23C1 & 17FT23C2	4	8	100	-	100
17FT23C4	Lab Course-VI (17FT2D-II 1/2/3 & 17FT23D-III 4/5/6)	4	8	100	-	100
Total credits = 29						

### SEMESTER –IV

Paper No.	Nomenclature of Paper			Max. Marks	Internal Assessment	Total Marks
		Credits	Hrs.			
CORE PAPERS						
18FT24C1	Advances in Food Processing and Preservation	4	4	80	20	100
18FT24C2	Food Safety and Quality Assurance	4	4	80	20	100
18FT24C3	Dissertation/Project Work	20	40	-	-	300
Total credits = 28						500

\* The students will have to undergo in plant training during the summer break after 2<sup>nd</sup> semester. However, the viva-voce of the industrial training report will be conducted in the 3<sup>rd</sup> semester and hence the credits will be given to the students in the 3<sup>rd</sup> semester.

## ***Instructions for the students***

### ***Course Types:***

**Core paper (C):** There are Core Courses in every semester. These courses are to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.

**Discipline Specific Elective (D):** Discipline specific elective is a course which can be chosen from a pool of papers floated by the department. It will be supportive and discipline related & mandatory as per course curriculum.

**Foundation Course (F):** The foundation course is based upon the content that leads to Knowledge enhancement and is to be opted by the student from a pool of foundation course floated by the university. It is mandatory as per course curriculum.

**Interdisciplinary Course/Open Elective (O):** Open elective course may be from an unrelated discipline. It is interdisciplinary/open elective & mandatory as per course curriculum and is to be opted by the students from a pool of open elective papers floated by various departments.

### **NOTE**

1. For all lecture courses, one credit per lecture/week/semester will generally be adopted.
2. Each theory course will be of 4 hours and practical will be of 8 hours duration per week.
3. Each theory paper examination will be of 3 hours duration and practical examination will be of 4 hours duration.
4. The dissertation is to be innovative work based on small piece of research work allotted in 3<sup>rd</sup> semester. The allotment/distribution of students is to be done at department level. Scheme of chapters of dissertation may be as follows-

Acknowledgement

Certificate by Supervisor

- (i) Introduction with objectives
- (ii) Review of literature in brief
- (iii) Materials & methods
- (iv) Results
- (v) Discussion
- (vi) Summary

Last date of submission will be 30<sup>th</sup> June without late fee. The evaluation of dissertation will be done by external examiner from a panel approved by PGBOS and an internal examiner. The written part of dissertation report shall account for 250 of marks and the viva-voce will be conducted by a duly constituted board of examiners for the remaining 50 marks.

5. The workload for dissertation work will be calculated as 1h/student/week.

**M.SC Food Technology (CBCS)**  
**Course Curriculum 2016-17**

## **16FT21C1**

### **Food Chemistry**

**There will be nine questions in all. The first question comprising of short answer type questions covering the entire syllabus will be compulsory. The remaining eight questions will comprise of a set of two questions from each unit and the candidate will be required to attempt four questions selecting one from each unit. All questions carry equal marks.**

**MM: 80**  
**Time: 3h**

#### **Unit I**

Food chemistry- definition, scope and importance; water in food, water activity and shelf life of food; chemistry and stability of water and fat soluble vitamins; minerals and their bioavailability, Food enrichment and fortification.

#### **Unit II**

Carbohydrates-classification, physical and chemical properties of sugars, functional properties and uses of pectic substances, gums and dietary fiber in food; browning reaction in food: enzymatic and non-enzymatic browning, their occurrence and applications in food; starches: functionality of starch in foods, gelatinization and retro-gradation of starches, modified starches, resistant starches.

#### **Unit III**

Lipids classification, properties- lipolysis, auto-oxidation, rancidity and flavour reversion, thermal decomposition and effect of ionizing radiations; modification of fats and oils (hydrogenation and interesterification), fat mimetics.

#### **Unit IV**

Proteins : Classification and structures of protein and amino acids; physical, chemical and functional properties of proteins, functional properties of food proteins, modification of food protein in processing and storage and its implications, texturized, denaturation of protein, gel formation, functionality of egg proteins and wheat proteins in foods

#### **Recommended Books:**

1. Meyer, L.H.(1998) Food Chemistry, Van Nostrand, Reinhold Company Publication, New york, London.
2. Alias C. and Lindeu G (1991) Food Biochemistry, Ellis Horwood, New York
3. Pomeranz, Y and Meloan, R. (1995) Food Analysis: Theory and Practice, Westport, An AVI Publication, New York, Sydney, Toronto.
4. Fennema, R.O (1997) Food Chemistry, Second Edition, Food Science & Technology series, Marcel Dekker, INC., New York
5. John M. deMan (2007). Principals of Food Chemistry, Springer India pvt Ltd, New Delhi.
6. Tom Coultate (2016) Food The chemistry of its components, Published by Royal Society of Chemistry, Cambridge, UK

**16FT21C2**  
**Principles of Food Engineering**

**There will be nine questions in all. The first question comprising of short answer type questions covering the entire syllabus will be compulsory. The remaining eight questions will comprise of a set of two questions from each unit and the candidate will be required to attempt four questions selecting one from each unit. All questions carry equal marks.**

**MM: 80**  
**Time: 3h**

**Unit I**

Introduction to food engineering; material and energy balances: basic principles, process flow diagrams, total mass balance, component mass balance, material balance problems involved in dilution, concentration and dehydration; heat balance calculations.

**Unit II**

Fluid flow principles: fluid statics and fluid dynamics, mass and energy balances in fluid flow; Newtonian and Non-Newtonian fluids, streamline and turbulent flow; fluid flow applications- measurement of pressure and velocity.

Liquid transport system- pipelines and pumps for food processing plants-positive displacement pumps, air-lift pumps, propeller pumps, centrifugal pumps and jet pumps.

**Unit III**

Heat transfer in food processing: modes of heat transfer- conductive, convective and radiative heat transfer; thermal properties of foods, conductive heat transfer in a rectangular slab, tubular pipe and multilayered systems, estimation of convective heat transfer coefficient, forced convection and free convection, estimation of overall heat transfer coefficient; heat exchangers: plate, tubular, scraped surface and steam infusion heat exchangers.

Thermal process calculations: commercially sterile concept, concept of D, F and Z values, reference F value; effect of temperature on thermal inactivation of micro-organisms, thermal process calculation for canned foods; calculation of processing time in continuous flow systems.

**Unit IV**

Psychrometrics: Properties of dry air: composition of air, specific heat of dry air, enthalpy of dry air and dry bulb temperature.

Properties of water-vapor: specific volume of water vapor, specific heat of water vapor, enthalpy of water vapor.



Properties of air-vapor mixtures: Gibbs-Dalton law, dew-point temp, humidity ratio (or moisture content), relative humidity, wet bulb temperature.

Psychrometric chart: use of psychrometric chart to evaluate complex air conditioning processes.

**Recommended Books:**

1. Singh, R.P and Heldman, D.R.(1984). *Introduction to Food Engg.*, Academic Press, INC, London.
2. Earle, R.L. (1983) *Unit Operations in Food processing*, 2nd Edition Pergamon Press Oxford,U.K.
3. Toledo, R.T.(1997). *Fundamentals of Food Process Engineering*, CBS Publishers, New Delhi.
4. Batty, J.C. and Folkman, S.L. 1983. *Food Engineering Fundamentals*. John wiley and Sons, New York.

**16FT21C3**  
**Basic Principles of Food Processing & Preservation**

**There will be nine questions in all. The first question comprising of short answer type questions covering the entire syllabus will be compulsory. The remaining eight questions will comprise of a set of two questions from each unit and the candidate will be required to attempt four questions selecting one from each unit. All questions carry equal marks.**

**MM: 80**  
**Time: 3h**

**Unit I**

Scope and importance of food processing; historical developments in food processing; food spoilage: microbial, physical, chemical & miscellaneous.

Heat preservation and processing: heat resistance of microorganisms, thermal death curve, types of heat treatments and effects on foods, canning of foods, cans and container types, spoilage of canned foods, heat penetration, brief concept of different heat processing methods: blanching, roasting, frying, baking etc.

**Unit II**

Refrigeration storage: requirements of refrigeration storage, changes of foods during refrigeration storage, refrigeration load, chilling and refrigeration, cold storage.

Freezing and frozen storage: freezing curves, slow and quick freezing, factors determining freezing rate, freezing methods, changes in food during freezing, frozen food storage, freeze drying in food processing

**Unit III**

Dehydration: drying, dehydration and concentration, drying curves, drying methods and type of dryers; food concentration, methods of concentration of fruit juices, liquid food concentrates, changes in food during dehydration and concentration.

Water activity: role of water activity in food preservation, intermediate moisture foods (IMF), principles, characteristics, advantages and problems of IM foods.

**Unit IV**

Food frying: general principles, frying process; shallow frying and deep frying, frying oils, factors affecting oil uptake during frying.

Emulsification in food processing: principles, examples of emulsification in food; milk, ice-cream mix, coffee/tea whiteners, salad dressings, meat sausages, margarine and spreads.

Chemical preservation: types, uses and effects of class I and class II preservatives in foods.

House hold preservation methods: pickling, salt curing, oiling and smoking, sugar addition.

**Recommended Books:**

1. Norman, N.P and Joseph, H.H.(1997). Food Science, Fifth edition, CBS Publication, New Delhi
2. Frazier, W.C and Westhoff, D.C (1996). Food Microbiology, 4<sup>th</sup> edition, Tata Mc Graw Hill Publication, New Delhi.
3. Kalia M. and Sangita, S. (1996). Food Preservation and Processing, First edition, Kalyani Publishers, New Delhi.
4. Sivasankar, B. (2002): Food Processing and Preservation, Prentice Hall of India Pvt.Ltd., New Delhi.
5. Desrosier & Desrosier, Technology of Food Preservation.
6. Fellows, Food process technology: Principles and Technology, CRC publications.
7. Khetarpaul N. (2005). Food Processing and Preservation, Dya Publishing House , New Delhi.

**16FT21C4**  
**Food Microbiology**

**There will be nine questions in all. The first question comprising of short answer type questions covering the entire syllabus will be compulsory. The remaining eight questions will comprise of a set of two questions from each unit and the candidate will be required to attempt four questions selecting one from each unit. All questions carry equal marks.**

**MM: 80**  
**Time: 3h**

**Unit I**

Microbiology: Introduction, historical developments in food microbiology; prokaryotes and eukaryotes; classification of microorganisms- a brief account; sources of microorganisms in foods; microbial growth, growth curve; factors affecting growth-intrinsic and extrinsic factors controlling growth of microorganisms, microbiological criteria of foods and their significance.

**Unit II**

Effect of food preservatives, heating process, irradiation, low temperature storage, chemical preservatives and high-pressure processing on the microbiology of foods; control of water activity and microbial growth, applications of hurdle technology for controlling microbial growth.

**Unit III**

Foods microbiology and public health: food poisoning, types of food poisonings, important features etc; bacterial agents of food borne illness, food poisoning by clostridium, salmonella, E. coli, bacillus, staphylococcus etc.; non-bacterial agents of food borne illness: poisonous algae, and fungi - a brief account, the HACCP system and food safety used in controlling microbiological hazards.

**Unit IV**

Food spoilage and microbes of milk, meats, fish and various plant products, spoilage of canned foods; Indicator microorganisms, methods of isolation and detection of microorganisms or their products in food; conventional methods; rapid methods (newer techniques) - immunological methods; fluorescent, antibody, radio immunoassay, principles of ELISA, PCR (Polymerized chain reactions).

**Recommended Books:**

1. James M. Jay (2000). Modern Food Microbiology, 5<sup>th</sup> Edition, CBS Publishers.
2. Banwart, G.J. (1997). Basic Food Microbiology, CBS Publishers.
3. Adam M.R. & Moss, M.O. (1995). Food Microbiology, New Age International Pvt. Ltd Publishers.
4. Bibek Ray (1996). Fundamental Food Microbiology, CRC Press.
5. Stanier, R.Y. (1996). General Microbiology, Vth Edition, MacMillan

**16FT21C5**  
**Food Analysis and Instrumentation**

**There will be nine questions in all. The first question comprising of short answer type questions covering the entire syllabus will be compulsory. The remaining eight questions will comprise of a set of two questions from each unit and the candidate will be required to attempt four questions selecting one from each unit. All questions carry equal marks.**

**MM: 80**  
**Time: 3h**

**Unit I**

Introduction to food analysis, types of samples and sampling techniques, storage and preservation of samples, expression of results.

**Unit II**

Proximate analysis of foods: Principles of moisture, fat, protein, carbohydrates, crude fiber and vitamins in foods.

**Unit III**

Instrumentation in food analysis: principles, types and applications of colorimetry and spectroscopy, photometry, electrophoresis; chromatography and atomic absorption spectrophotometry.

**Unit IV**

Instrumentation in food analysis: color measurement in foods; X-ray analysis of foods and its applications; mass spectroscopy; nuclear magnetic resonance (NMR); differential scanning calorimetry (DSC).

Refractometry and ultrasonics in food analysis; texture analysis in foods, sensory versus instrumental analysis of texture, rapid methods of microbial analysis; immunoassays methods

**Recommended Books:**

1. Ronald S. Kirk, Ronald, Sawyer, (1991). *Pearson's Composition & Analysis of foods*, 9th Edition Longman scientific & Technical , U.K.
2. Pomeranz , Y. & Mrloan (1978) . *Food Analysis: Theory and Practice*, Westport, connectiant : AVI .
3. Amerine, M.A. Pangborn, R.M., and Rosseler, E.B. 1965. Principles of Sensory Evaluation of Food. Academic Press, New York.

**17FT22C1**

## **Technology of Cereals & Bakery Products**

**There will be nine questions in all. The first question comprising of short answer type questions covering the entire syllabus will be compulsory. The remaining eight questions will comprise of a set of two questions from each unit and the candidate will be required to attempt four questions selecting one from each unit. All questions carry equal marks.**

**MM: 80  
Time: 3h**

### **Unit I**

Structure and chemical composition of wheat grain; criteria of wheat quality – physical and chemical factors; Wheat milling – general principles and operations, cleaning, conditioning and roller milling systems; flour extraction rates and various flour grades and types; criteria of flour quality, dough rheology and its measurement.

### **Unit II**

Structure and composition of corn grain, different types of corn; wet and dry milling of corn, products of wet and dry milling of corn, corn starch and corn sweeteners (high fructose corn syrups) and their uses.

### **Unit III**

Structure and chemical composition of rice grain; milling of rice – types of rice mill; huller mill, sheller-cum-cone polisher mill; modern rice milling unit operation-dehusking, paddy separation, polishing and grading; factors affecting rice yield during milling; rice bran as rice milling byproducts.

Rice parboiling technology, different parboiling methods, CFTRI process of parboiling, changes during parboiling, advantages and disadvantages of parboiling.

Dimensional and cooking quality characteristics of rice and factors affecting cooking behaviour of rice grains; rice convenience foods: precooked rice, canned rice, expanded rice, rice-based infant food formulae.

## Unit IV

Barley malting process: steeping, germination and drying; significance of malting; different types of malts and their food applications, barley beta glucans and their food functionality

### Recommended Books

1. Samuel, A.M.(1996) “ *The Chemistry and Technology of Cereals as Food and Feed* “, CBS Publisher & Distribution, New Delhi.
2. Pomeranz, Y.(1998) “ *Wheat : Chemistry and Technology*”, Vol 1,3” Am. Assoc. Cereal Chemists. St. Paul, MN, USA.
3. Honeney, R.C.(1986) “ *Principles of Cereal Science and Technology*”, Am. Assoc. Cereal Chemists, St. Paul, MN, USA.
4. Pomeranz, Y. (1976) “ *Advances in Cereal Science and Technology*”, Am. Assoc. Cereal Chemists St.Paul, MN, USA.
5. Juliano, B.O.(1985). “ *Rice Chemistry and Technology*”, Am. Assoc. Cereal Chemists, St. Paul, MN,USA.
6. Chakraverty, A. 1988. *Postharvest Technology of Cereals, Pulses and oilseeds*. Oxford and IBH, New Delhi.
7. Kent, N.L. 1983. *Technology of Cereals*. 3rd Edn. Pergamon Press, Oxford, UK.



**17FT22C2**  
**Technology of Fruits and Vegetables**

**There will be nine questions in all. The first question comprising of short answer type questions covering the entire syllabus will be compulsory. The remaining eight questions will comprise of a set of two questions from each unit and the candidate will be required to attempt four questions selecting one from each unit. All questions carry equal marks.**

**MM: 80**  
**Time: 3h**

**Unit I**

Classification and composition of fruits and vegetables and their nutritional significance; climacteric and non-climacteric fruits; post harvest treatments, edible coatings.

Physical and chemical indices of fruit maturity, crop maturity and ripening, bio-chemical changes during maturation, ripening, processing and storage.

Pre-processing operations: washing, blanching, peeling, sorting and grading of fruits and vegetables; minimal processing of fruits and vegetables; quality factors for processing, export standards, fruit product order (FPO).

**Unit II**

Technology of jam, jellies, marmalades, specifications, role of pectin and theories of gel formation.

Technology for juice pressing, juice extraction and clarification, methods of bottling, enzymatic clarification and debittering of juices, physiological and enzymological aspects of fruit juice production, fruit juice concentrates and powders- preparation and specifications, packaging.

Fruit juice beverages, squash, cordial, crush, RTS, nectar, syrups, blending of juices.

**Unit III**

Technology of tomato products: sauce, puree, ketchup and tomato paste

Fruit preserves and candied fruits, dehydrated fruits & vegetables, spoilage of processed products.

Canning of fruits and vegetables, preparation of syrups and brines, spoilage of canned fruits and vegetables

**Unit IV**

Stages of new product development, by products from fruit and vegetable wastes, utilization and disposal of fruit industry wastes.

Production of mushroom and its processed products;

Cashew and coconut: chemical composition, processing technology and their processed products.

### **Recommended Books:**

1. R.P.Srivastava and Sanjeev Kumar (2001) : Fruit and Vegetable Preservation – Principles and Practices, Third edition, International Book distributing Co. Lucknow(India)
2. A.K.Thompson (2003): Fruit and Vegetables – Harvesting, handling and storage. 2<sup>nd</sup> edition Blackwell Publishing.
3. Er. B. Pantastico: Post harvest Physiology, handling and utilization of tropical and subtropical fruits and vegetables. AVI Publishing Company, Inc.
4. W.V Cruess (1997): Commerical Fruit and Vegetable Products. Allied Scientific Publishers. Bikaner (India)
5. Girdharilal (1996) Preservation of Fruits and Vegetables. ICAR, New Delhi
6. Dauthy, M.E. 1997. Fruit and Vegetable Processing. International Book Distributin Co. Lucknow, India.
7. Hamson, L.P. 1975. Commercial Processing of Vegetables. Noyes Data Corporation, New Jersey.
8. Dauthy, M.E. 1997. Fruit and Vegetable Processing. International Book Distributing Co. Lucknow, India.

**17FT22C3**  
**Unit Operations in Food Engineering**

**There will be nine questions in all. The first question comprising of short answer type questions covering the entire syllabus will be compulsory. The remaining eight questions will comprise of a set of two questions from each unit and the candidate will be required to attempt four questions selecting one from each unit. All questions carry equal marks.**

**MM: 80**  
**Time: 3h**

**Unit I**

Preliminary unit operations – material handling, cleaning, sorting and grading.

Material handling–theory, classification of various material handling equipments, conveyors and elevators

Cleaning – types of contaminants found on raw foods, aims of cleaning, methods of cleaning- dry, wet and combination methods; dry cleaning methods - screening, aspiration, magnetic cleaning and abrasive cleaning; wet cleaning methods- soaking, spray washing, flotation washing and ultrasonic washing.

Sorting and grading – advantages of sorting and grading, grading factors, methods of sorting and grading.

**Unit II**

Conversion unit operations – size reduction, mixing and filtration.

Size reduction- benefits of size reduction, nature of forces used in size reduction, criteria of size reduction, equipment selection (hardness of feed, mechanical structure of feed, moisture content and temperature sensitivity of feed); mode of operation of size reduction equipment – open circuit and closed circuit grinding, free crushing, choke feeding and wet milling; size reduction of solid foods, fibrous foods and liquid foods; effects of size reduction on solid and liquid foods.

Mixing – mixing terminology (agitating, kneading, blending, and homogenizing), mixing equipments – mixers for liquids of low or moderate viscosity (Paddle agitators, turbine agitators and propeller agitators), mixers for high viscosity pastes (Pan mixer, horizontal mixer and dough mixer), mixers for dry solids (tumbler mixer & vertical screw mixer); effects of mixing on foods.

Filtration – filtration terminology (feed slurry, filtrate, filter medium, filter cake and filter), filtration methods/equipments – pressure filtration, vacuum filtration, & centrifugal filtration.

**Unit III**

Preservation unit operations (high temperature operations)- pasteurization, evaporation and dehydration.

Pasteurization– basic concept, effects of pasteurization on foods.

Evaporation – main functions of evaporation, factors affecting the rate of heat transfer, factors influencing the economics of evaporation, evaporation equipments –horizontal tube evaporators, vertical tube evaporator and plate evaporator; single and multiple effect evaporators.

Dehydration – objectives of dehydration, dehydration terminology, basic dehydration theory; drying curves, dehydration systems – tray drier, tunnel drier, drying time calculations.

#### **Unit IV**

Preservation unit operation (low temperature operations) - refrigeration, freezing and freeze drying.

Refrigeration – introduction, components of refrigeration systems – compressor, condenser and expansion valve; mechanical refrigeration system.

Freezing – technological principles of freezing operations, freezing systems- direct contact and indirect contact system; influence of freezing rate on food system; freezing time calculations.

Freeze drying – conventional drying vs freeze drying; equipments used and effects of freeze drying on food quality.

#### **Recommended Books:**

1. Earle, R.L. (1983) Unit Operations in Food Processing, 2<sup>nd</sup> Edition, Pergamon Press, Oxford, U.K.
2. Singh, R. P. and Heldman, D. R. (1984). Introduction to Food Engg., Academic Press, INC, London.
3. Harper, J.C. (1976) Elements of Food Engg., AVI Publ. Co., Westport, Connecticut.
4. Toledo, R.T. (1980). Fundamentals of Food Process Engg., AVI. Publ. Co., Westport, Connecticut.
5. Brennan, J.G., Buffers, J.R., Cowell N.D., Lilly, A.E.V. (1976). Food Engg. Operations, 2<sup>nd</sup> Ed., Elsevier, New York.
6. Lewis, M.J. (1987). Physical Properties of Foods & Foods Processing Systems, Ellis Horwood, England.

**17FT22D-II**  
**Post Harvest Technology of Plantation Crops**

**There will be nine questions in all. The first question comprising of short answer type questions covering the entire syllabus will be compulsory. The remaining eight questions will comprise of a set of two questions from each unit and the candidate will be required to attempt four questions selecting one from each unit. All questions carry equal marks.**

**MM: 80**  
**Time: 3h**

**UNIT -I**

Coffee: Production, processing of coffee, drying, fermentation, roasting and brewing of coffee; decaffeinated coffee, coffee brew concentrate; types, standards and specifications of coffee products; chicory: technology of chicory powder and use in coffee products

**UNIT -II**

Tea: Production, composition and manufacturing; types of tea; tea products such as soluble tea, tea concentrate, instant tea, decaffeinated and flavored tea; quality evaluation and grading of tea.

**UNIT -III**

Cocoa: processing and analysis of cocoa beans; changes taking place during fermentation of cocoa bean; processing of cocoa products: cocoa powder, cocoa liquor manufacture, cocoa butter; chocolates: types and technology of chocolate manufacturing

**UNIT -IV**

Spices, condiments, seasonings and culinary herbs; classification and beneficial properties of spices; processing and manufacturing of major Indian spice: pepper, cardamom, ginger, chili and turmeric, clove, garlic, Cumin, coriander, cinnamon, mint and vanilla.  
Oleoresins and essential oils: method of manufacture; chemistry of the volatiles; enzymatic synthesis of flavor identical; adulteration problem in spices, packaging of spices

**Recommended Books**

1. Kenneth T. Farrell (1985). Spices, condiments and seasonings. The AVI Pub. Company.
2. Banerjee B. 2002. *Tea Production and Processing*. Oxford Univ. Press.
3. Kenji Hirasa and Mitsuo Takemasa(1998). Spice Science and Technology, Marcell Dekker, Inc.
4. Minifie BW. 1999. *Chocolate, Cocoa and Confectionery Technology*. 3<sup>rd</sup> ed. Aspen Publ.
5. NIIR. 2004. *Handbook on Spices*. National Institute of Industrial Research Board, Asia Pacific Business Press Inc.
6. Sivetz M & Foote HE. 1963. *Coffee Processing Technology*. AVI Publ.

**17FT22D-I2**  
**Technology of Legumes and Oilseeds**

**There will be nine questions in all. The first question comprising of short answer type questions covering the entire syllabus will be compulsory. The remaining eight questions will comprise of a set of two questions from each unit and the candidate will be required to attempt four questions selecting one from each unit. All questions carry equal marks.**

**MM: 80**  
**Time: 3h**

**Unit I**

Status, production and major growing areas of legumes and oilseeds in India and world; structure and chemical composition of pulses and oilseeds; nutritional and antinutritional factors.

Milling scenario of pulses in India, milling techniques: dry milling and wet milling; processing of legumes: soaking, germination, decortication, cooking, fermentation; puffing, roasting and parching; utilization of pulses; protein isolates and concentrates; role of legumes in human nutrition.

**Unit II**

Processing and utilization of soyabean for value added products; soy based fermented products; innovative products from pulses and oilseeds; future developments in products and processes; products from legumes and uses: starch, flour, protein concentrates and isolates

**Unit III**

Sources of edible oils (groundnut, mustard, soyabean, sunflower, safflower, coconut, sesame and oil from other sources); physio-chemical properties; processing of oilseeds: rendering, pressing, solvent extraction, refining, hydrogenation; factors affecting extraction; packing and storage of fats and oils, changes during storage.

**Unit IV**

Oil specialty products: margarine, mayonnaise, salad dressing, fat substitutes etc; chemical adjuncts: lecithins and GMS; Nutritional food mixes from oilseeds: processing of oilseeds for food use, protein rich foods, protein enriched cereal food.

**Recommended Books:**

1. Hamilton, R.J. and Bharti, A. Ed. 1980. Fats and Oils: Chemistry and Technology. Applied Science, London.
2. Salunkhe, O.K. Chavan, J.K, Adsule, R.N. and Kadam, S.S. 1992. World Oilseeds: chemistry, Technology and Utilization. VNR, New York.
3. Wolf, I.A. Ed. 1983. Handbook of Processing and Utilization in Agriculture. (2 vol. set). CRC Press, Florida.
4. Mathews, R.H. Ed. 1989. Legumes: Chemistry, Technology and Human Nutrition. Marcel Dekker, New York.
5. Salunkhe, D.K., Kadam, S.S. Ed. 1989. Handbook of World Food Legumes: Chemistry, Processing and Utilization, (3 vol. set). CRC Press, Florida.

**17FT22D-I3**  
**Technology of Meat, Poultry and Fish Products**

**There will be nine questions in all. The first question comprising of short answer type questions covering the entire syllabus will be compulsory. The remaining eight questions will comprise of a set of two questions from each unit and the candidate will be required to attempt four questions selecting one from each unit. All questions carry equal marks.**

**MM: 80**

**Time: 3h**

**Unit I**

Status and scope of meat industry in India; Structure and physico-chemical properties of muscle

meat: composition and nutritive value, conversion of muscle into meat, post mortem changes in meat, rigor mortis, cold shortening, pre-rigor processing; stunning and slaughtering methods.

Aging of meat, meat tenderization- natural and artificial methods; cooking methods for meat: roasting, frying and braising; storage and preservation of meat: chilling, freezing, curing, smoking, dehydration, freeze-drying, irradiation, canning.

**Unit II**

Cooking, palatability and eating quality of meat, microbial spoilage of meat; restructured meat products (sausages), meat analogs; meat industry by products: importance and applications; intermediate moisture and dried meat products; meat plant hygiene and good manufacturing practices; packaging of meat products.

**Unit III**

Egg: Structure, composition and nutritive value of eggs, Storage and shelf life problems

Quality evaluation of eggs: international and external quality evaluation, candling, albumen index, Haugh unit, yolk index etc.

Egg preservation: grading of eggs, whole egg preservation, pasteurization, dehydration, freezing, egg products: egg powder, value added egg products (e.g., Meringues and Foams etc.), packaging of egg and egg products

Poultry products: types, chemical and nutritive value of poultry meat, slaughtering and evaluation of poultry carcasses; poultry cut-up parts and meat/bone ratio; preservation, grading and packaging of poultry meat.

**Unit IV**

Fish processing: factors affecting quality of fresh fish, fish dressing, chilling, freezing, glazing, salting and canning of fish; manufacturing of fish paste, fish oil, fish protein concentrate and fish meal; by-products of fish industry and their utilization.

**Recommended Books:**

1. Joshi, B. P. (1994). Meat Hygiene for Developing Country, Shree Almora Book Depot, India.
2. William J. & Owen J., (1977). Egg Science & Technology, AVI Publishing Company, INC. Westport, Connecticut.
3. Lawrie, R.A. (1998). Meat Science. Woodhead Publishers.
4. Mead, G. (2004). Poultry Meat Processing and Quality. Woodhead Publishers.
5. Panda, P.C. (1992). Text Book on Egg and Poultry Technology, Vikas Publishers
6. William J. & Owen J. (1977). Egg Science & Technology, AVI Publishing Company INC. Westport, Connecticut.



**17FT23C1**  
**Technology of Milk and Milk products**

**There will be nine questions in all. The first question comprising of short answer type questions covering the entire syllabus will be compulsory. The remaining eight questions will comprise of a set of two questions from each unit and the candidate will be required to attempt four questions selecting one from each unit. All questions carry equal marks.**

**MM: 80**  
**Time: 3h**

**Unit I**

Dairy industry in India: scope, strengths and opportunities for dairy industry

Milk: definition, composition and nutritive value; factors affecting composition of milk

Physico-chemical properties of milk : chemical properties of milk lipids, milk fat structure, fat destabilization; functional properties of milk lipids, milk proteins, their types, precipitation (casein micellar structure and its aggregation); milk enzymes, milk coagulation; lactose; vitamins and minerals in milk.

Technology of fluid milk: filtration/clarification, standardization, pasteurization (LTLT, HTST), sterilization, homogenization, UHT processing, aseptic packaging, storage and distribution

**Unit II**

Technology of recombined and reconstituted milk: composition, process of manufacture, defects

Technology of condensed and evaporated milk: composition, process of manufacture, defects (their causes and prevention).

Technology of milk powders (WMP, SMP): composition, process of manufacture, defects (their causes and prevention), instantization of milk powder.

Technology of Cheese: classification, composition, Nutritive value, process of manufacture of cheddar, mozzarella, cottage and processed cheese, defects (their causes and prevention).

**Unit III**

Technology of yogurt, Acidophilus milk, bulgaricus milk, kumiss and kefir.

Technology of frozen milk products: composition, process of manufacture, defects (their causes and prevention).

Technology of indigenous milk products: dahi, butter, ghee, channa, paneer, khoa etc.

Newer concepts in dairy products: cream powder, sterilized cream, butter spread, butter powder, cheese spread, whey protein concentrates, Lactose

## **Unit IV**

Membrane processing of milk: types of membranes, applications of reverse osmosis, ultrafiltration and microfiltration in dairy industry

Utilization of milk industry by-products: Importance / Need and food applications

Milk and milk product standards and legislations in India: Grading of milk and criterion of grading, milk adulteration problem, synthetic milk

Dairy plant sanitation: hygiene in dairy Industry, different types of cleansing and sanitizing agents, their applications, cleaning systems

### **Recommended Books:**

1. Sukumar, De (1994). Outlines of Dairy Technology. Oxford University Press.
2. Smith G. (2003). Dairy processing improving quality. Woodhead Publishers.
3. Andrews, A.T. (1994). Biochemistry of Milk Products. Woodhead Publishers.
4. Technology of Dairy Products by Early, R.
5. Aneja RP, Mathur BN, Chandan RC & Banerjee AK. 2002. *Technology of Indian Milk Products*. Dairy India Publ.
6. Rathore NS *et al.* 2008. Fundamentals of Dairy Technology - Theory & Practices. Himanshu Publ.
7. Walstra P. (Ed.). 2006. Dairy Science and Technology. 2nd Ed. Taylor & Francis.

## **17FT23C2**

### **Food packaging**

**There will be nine questions in all. The first question comprising of short answer type questions covering the entire syllabus will be compulsory. The remaining eight questions will comprise of a set of two questions from each unit and the candidate will be required to attempt four questions selecting one from each unit. All questions carry equal marks.**

**MM: 80**

**Time: 3h**

#### **Unit I**

Introduction to Food Packaging: definition, factors involved in the evolution and selection of a food package, functions of food packaging (containment, protection, convenience and communication).

Paper and paper based packaging materials: types of paper (Kraft, bleached, greaseproof, glassine), paper products (paper bags, cartons, drums and molded paper containers), functional properties of paper; testing of paper packaging materials.

Safety considerations in food packaging – types of food safety problems associated with package, package labeling and food safety.

#### **Unit II**

Plastic packaging materials: classification of polymers, functional and mechanical properties of thermoplastic polymers; processing and converting of thermoplastic polymers (extrusion, blow molding, injection molding, compression molding, lamination and heat sealing); testing of plastic packages.

Packaging requirements of selected foods- cereal and snack food, beverages, milk and dairy products, poultry & eggs, red meat, frozen foods, horticultural products and microwavable foods.

#### **Unit III**

Metal packaging materials: container making processes (end manufacture, three-piece can manufacture and protective and decorative coatings); functional properties of metal containers; Tin plate containers- quality control tests.

Glass packaging materials: composition and manufacture of glass containers; glass container nomenclature; glass containers-closure functions, closure terminology and construction; properties of glass containers – mechanical, thermal and optical properties; testing of glass containers.

#### **Unit IV**

Aseptic packaging of foods: sterilization of packaging material food contact surfaces & aseptic packaging systems; active food packaging – definition, scope, physical and chemical principles involved.

Edible films and coatings– use of edible active layers to control water vapor transfer, gas exchange, modification of surface conditions with edible active layers.

Oxygen absorbents – classification and main types of oxygen absorbents, factors influencing the choice of oxygen absorbents, factors influencing the choice of oxygen absorbents, application of oxygen absorbents for shelf-life extension of food and advantages and disadvantages of oxygen absorbents.

Ethanol vapor: ethanol vapour generator, uses of ethanol for shelf-life extension of food, effect of ethanol vapour on food spoilage/food poisoning bacteria, and advantages and disadvantages of ethanol/vapour generators.

### **Recommended Books:**

1. Robertson, G.L.(2006). Food Packaging: Principles and Practice (2nd ed.), Taylor & Francis
2. Sacharow, S. and Griffin, R.C. (1980) Principles of Foods Packaging, 2<sup>nd</sup> Ed., Avi,Publication Co. Westport, Connecticut, USA.
3. Athalye, A.S. (1992), Plastics in Packaging, Tata McGraw –Hill Publishing Co., New Delhi.
4. Rooney, M.L. (1995). Active Food Packaging, Blackie Academic & Professional, Glasgow,UK.
5. Bakker, M. (1986) The Wiley Encyclopaedia of Packaging Technology, John Willey & Sons. Inc; New York.
6. Food Packaging Technology Handbook. NIIR Board, National Institute of Industrial Research, 2003
7. Ahvenainen, R. (Ed.) Novel Food Packaging Techniques, CRC Press, 2003
8. Han, J.H. (Ed.) Innovations in Food Packaging, Elsevier Academic Press, 2005
9. Coles, R., McDowell, D. and Kirwan, M.J. (Eds.) Food Packaging Technology, CRC Press, 2003

**17FT23D-III**  
**Nutraceuticals and Functional Foods**

**There will be nine questions in all. The first question comprising of short answer type questions covering the entire syllabus will be compulsory. The remaining eight questions will comprise of a set of two questions from each unit and the candidate will be required to attempt four questions selecting one from each unit. All questions carry equal marks.**

**MM: 80**  
**Time: 3h**

**Unit I**

Concept on Nutraceuticals: nutraceutical and functional foods, nutraceutical as new dietary ingredients, biological significance of nutraceuticals, nutraceuticals and dietary supplement, world market for nutraceuticals, regulatory issues

Nutrigenomics: nutrigenomics an introduction and its relation to nutraceuticals.

**Unit II**

The role of nutraceuticals/functional foods in disease prevention: angiogenesis and cardiovascular diseases, cancer, diabetes, cholesterol management, obesity and inflammation dosage levels,

**Unit III**

Health benefits of nutraceuticals, natural pigments (chlorophyll, chlorophyllin, carotenoids) anthocyanins, glucosinolates, isoflavonoids, phytoestrogens, omega-3 and omega-6 fatty acids, antioxidants, phytosterols; dosage for effective control of disease or health benefit with adequate safety

**Unit IV**

Definition, development of functional foods, isolation, storage, processing and stability of phytochemicals/bioactive compounds.

Prebiotics and probiotics: usefulness of probiotics and prebiotics in gastro intestinal health and other benefits, beneficial microbes; prebiotic ingredients in foods; types of prebiotics and their effects on gut microbes, resistant starch, fructo-oligosaccharides as probiotic food components

**Recommended Books:**

1. Brigelius-Flohé, J & Joost HG. (2006). Nutritional Genomics: Impact on Health and Disease. Wiley VCH.

2. Cupp J & Tracy TS. (2003). Dietary Supplements: Toxicology and Clinical Pharmacology. Humana Press.
3. Gibson GR & William CM. (2000). Functional Foods - Concept to Products.
4. Goldberg I. (1994). Functional Foods: Designer Foods, Pharma Foods.
5. Losso JN. (2007). Anti-angiogenic Functional and Medicinal Foods. CRC Press
6. Neeser JR & German BJ. (2004). Bioprocesses and Biotechnology for Nutraceuticals. Chapman & Hall.
7. Robert EC. (2006). Handbook of Nutraceuticals and Functional Foods. 2<sup>nd</sup> Ed. Wildman.
8. Shi J. (2006). Functional Food Ingredients and Nutraceuticals: Processing Technologies. CRC Press.
9. Webb GP. (2006). Dietary Supplements and Functional Foods. Blackwell Publ.

**17FT23D-II2**  
**Food additives**

**There will be nine questions in all. The first question comprising of short answer type questions covering the entire syllabus will be compulsory. The remaining eight questions will comprise of a set of two questions from each unit and the candidate will be required to attempt four questions selecting one from each unit. All questions carry equal marks.**

**MM: 80**  
**Time: 3h**

**Unit I**

Food additives- definitions, classification and functions, need for food additives, food preservatives, classifications, antimicrobial agents (types, mode of action and their application), safety concerns, regulatory issues in India, international legal issues

Nutrient supplements & thickeners, polysaccharides, bulking agents, antifoaming agents, synergists, antagonists.

**Unit II**

Antioxidants (synthetic and natural, mechanism of oxidation inhibition), chelating agents: types, uses and mode of action

Coloring agents: color retention agents, applications and levels of use, natural colorants, sources of natural color (plant, microbial, animal and insects), misbranded colors, color extraction techniques, color stabilization

**Unit III**

Flavoring agents: flavors (natural and synthetic flavors), flavor enhancers, flavor stabilization, flavor encapsulation

Flour improvers: leavening agents, humectants and sequesterants, hydrocolloids, acidulants, pH control agents buffering salts, anticaking agents, etc.

**Unit IV**

Sweeteners: natural and artificial sweeteners, nutritive and non-nutritive sweeteners, properties and uses of saccharin, acesulfame-K, aspartame, corn sweeteners, invert sugar sucrose and sugar alcohols (polyols) as sweeteners in food products

Emulsifiers: Types, selection of emulsifiers, emulsion stability, functions and mechanism of action.

Additives, food uses and functions in formulations; permitted dosages

**Recommended Books:**

1. Branen AL, Davidson PM & Salminen S. (2001). Food Additives. 2nd Ed. Marcel Dekker.
2. Gerorge AB. (1996). Encyclopedia of Food and Color Additives. Vol. III. CRC Press.
3. Gerorge AB. (2004). Fenaroli's Handbook of Flavor Ingredients. 5th Ed. CRC Press.
4. Madhavi DL, Deshpande SS & Salunkhe DK. (1996). Food Antioxidants: Technological, Toxicological and Health Perspective. Marcel Dekker.
5. Morton ID & Macleod AJ .(1990). Food Flavours. Part A, B & C. Elsevier.
6. Nakai S & Modler 6. HW. (2000). Food Proteins: Processing Applications. Wiley VCH.
7. Stephen AM. (2006). Food Polysaccharides and Their Applications. Marcel Dekker.



**17FT23D-II3**  
**Flavor Chemistry and Technology**

**There will be nine questions in all. The first question comprising of short answer type questions covering the entire syllabus will be compulsory. The remaining eight questions will comprise of a set of two questions from each unit and the candidate will be required to attempt four questions selecting one from each unit. All questions carry equal marks.**

**MM: 80**  
**Time: 3h**

**Unit 1**

Definition and description of flavor, trigeminal nerve, taste and oral receptors, molecules of taste and sensation, compounds providing sensory effects and taste active compounds, flavor profile and its principal chemical flavour components classes, flavor composites and flavour emulsions

**Unit 2**

Natural and synthetic flavoring substances and their chemical characteristics. Flavor components/constituents of fruit and vegetables, coffee, tea, spices, cheese and meat.

**Unit 3**

Extraction techniques/methods of flavouring compounds from different sources, their utilization and applications, spice oils and oleoresins, analysis of flavors components (subjective and objective).

**Unit 4**

Production of flavouring compounds during food processing (Lipid oxidation, maillard reaction, food fermentations etc.), biological routes for the production of flavour: enzymatic and microbial production of flavouring compounds

**Recommended books**

1. David J. Rowe 2005. Chemistry and Technology of flavours and fragrances. Blackwell publishing Ltd (CRC press)
2. Carolyn Fisher and Thomas R Scott (1997). Food flavours Biology and Chemistry, published by The Royal Society of Chemistry, U.K.
3. Burdock GA. 2004. Fenaroli's Handbook of Flavor Ingredients. 5th Ed. CRC Press.
4. Deibler D & Delwiche J. 2004. Handbook of Flavor, Characterization: Sensory Analysis, Chemistry and Physiology. Marcel Dekker.
5. Heath HB. 1986. Flavor Chemistry and Technology. CBS Publ. New Delhi.
6. Taylor A. 2002. Food Flavor Technology. Sheffield Academic Press.

**17FT23D-III4**  
**Sensory Analysis of Foods**

**There will be nine questions in all. The first question comprising of short answer type questions covering the entire syllabus will be compulsory. The remaining eight questions will comprise of a set of two questions from each unit and the candidate will be required to attempt four questions selecting one from each unit. All questions carry equal marks.**

**MM: 80**  
**Time: 3h**

**UNIT I**

Definition of sensory analysis, importance of sensory evaluation of foods, basic food tastes and sensations, senses of taste, smell and sensation, general testing conditions i.e. testing area, testing setup, testing schedule; preparation of samples: coding and order of presentation, other sensory quality parameters-size and shape, texture, colour and temperature sensation

**UNIT II**

Selection and training of sensory panellists, types of panels- trained, semi trained and consumer panels, factors influencing sensory measurements

**UNIT III**

Sensory testing of foods: threshold tests, difference tests, ranking tests, hedonic tests, acceptance and preference tests, scoring test, sensitivity tests

**UNIT IV**

Methods of sensory evaluation of different food products: milk and milk products, fruit and vegetables, cereal products, confectioneries and chocolates, coffee and tea, spices

**Suggested Readings**

1. Amerine MA, Pangborn RM & Rossles EB. 1965. *Principles of Sensory Evaluation of Food*. Academic Press
2. Jellinek G. 1985. *Sensory Evaluation of Food - Theory and Practice*. Ellis Horwood.
3. Lawless HT & Klein BP. 1991. *Sensory Science Theory and Applications in Foods*. Marcel Dekker.
4. Maslowitz H. 2000. *Applied Sensory Analysis of Foods*. Vols. I, II. CRC Press
5. Piggot JR. 1984. *Sensory Evaluation of Foods*. Elbview Applied Science Publ.
6. Potter NN & Hotchleiss JH. 1997. *Food Science*. 5<sup>th</sup> ed. CBS
7. Rai SC & Bhatia VK. 1988. *Sensory Evaluation of Agricultural Products*. Indian Agricultural Statistics Research Institute (ICAR).
8. Stone H & Sidel JL. 1985. *Sensory Evaluation Practices*. Academic Press
9. Watts CM, Ylimaki CL, Jaffery LE & Elias LG. 1989. *Basic Sensory Methods for Food Evaluation*. Int. Dev. Res. Centre, Canada.

**17FT23D-III5**  
**Food Biotechnology**

**There will be nine questions in all. The first question comprising of short answer type questions covering the entire syllabus will be compulsory. The remaining eight questions will comprise of a set of two questions from each unit and the candidate will be required to attempt four questions selecting one from each unit. All questions carry equal marks.**

**MM: 80**  
**Time: 3h**

**Unit I**

Introduction to food biotechnology; Application of biotechnology in food, basic principles of genetic engineering; improvement of the food crops by genetic engineering; Recombinant DNA Technology genetically modified plants and animals for enhanced food production

**Unit II**

Natural antimicrobials for food preservation: phytoalexins, essential oils and their components; bacteriocins: nisin, pediocins etc; applications of bacteriocins in food systems as biopreservatives

Biotechnology and Food ingredients: fat substitutes, biocolors and sweeteners.

**Unit III**

Protein engineering in food technology: methods, applications of protein engineering to produce glucose isomerase, Lactobacillus beta-galactosidase.

Nutrogenomics - concept, working, significance and relevance. Biosensors and novel tools and their application in food science.

**Unit IV**

Development and formulation of novel products such as probiotic foods, transgenic plant foods: golden rice, Bt brinjal, maize, tomato, potato, soyabean etc.

Ethical issues concerning GM foods; testing for GMOs; current guidelines for the production, release and movement of GMOs; labeling and traceability; trade related aspects; biosafety; risk assessment and risk management, effect of biotech foods on the food business of developing and developed countries

**Recommended Books:**

1. Lee, B.H. (1996). Fundamentals of Food Biotechnology, VCH Publishers.
2. Tombs, M.P. (1991). Biotechnology in Food Industry, Open University Press, Milton Keynes.
3. Knorr, D. (1987). Food Biotechnology, Marcel Dekker, INC, New York.

4. Schwartzberg, A & Rao (1990). *Biotechnology & Food Process Engineering*, Marcel Dekker , INC , New York.
5. Goldberg, I & Williams, R. (1991). *Biotechnology and food Ingredients*, Van Nostrand Reinhold, New York.
6. King , R . D. and Cheetham , P.S.J. (1986)). *Food Biotechnology*, Elsevier Applied Science, London.

**17FT23D-III6**  
**Enzymes and Fermentation Technology**

**There will be nine questions in all. The first question comprising of short answer type questions covering the entire syllabus will be compulsory. The remaining eight questions will comprise of a set of two questions from each unit and the candidate will be required to attempt four questions selecting one from each unit. All questions carry equal marks.**

**MM: 80**  
**Time: 3h**

**Unit I**

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

**Unit II**

Role of enzymes in dairy processing (cheese making and whey processing), role of enzymes in meat processing (tenderization) and egg processing, enzymes for the fruit juice clarification and debittering, role of enzymes in brewing, baking (fungal -amylase for bread making; maltogenic -amylases for anti-staling; xylanases and pentosanases as dough conditioners; lipases or dough conditioners

**Unit III**

Introduction to fermentation, batch and continuous, solid state/submerged fermentations, fermenter types and design, downstream processing in fermentation: objectives, various product recovery and purification methods.

**Unit IV**

Fermentation reaction and process for the production of fermented foods like soya sauce, natto, sauerkraut, yoghurt, cheese, alcoholic beverages like beer and wine. Fermentative production of polysaccharides like dextran and xanthan.

**Recommended books**

1. Whitehurst, R.J. & Van-Oort, M., (2010), Enzymes in Food technology, Second edition Blackwell Publishing Ltd
2. Aehle, W. (2007) Enzymes in Industry: Production and application. Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim
3. Rastall, R (2007) Novel enzyme technology for food applications Woodhead Publishing Limited, Abington Hall, Abington, Cambridge CB21 6AH, England
4. Kalaichelvan, P.T., (2002), Bio process technology, MJP publishers, Chennai
5. Joshi, V.K. and Ashok Pandey, 1999, Biotechnology: Food Fermentation, Microbiology, Biochemistry and Technology , Vol. I & vol. II Educational Publisher.
6. Peppler, H.J. and D. Perlman, 2004, Microbial Technology : Fermentation Technology , 2<sup>nd</sup> Edition, Vol. II Academic Press / Elsevier.

**18FT24C1**  
**Advances in Food Processing and Preservation**

**There will be nine questions in all. The first question comprising of short answer type questions covering the entire syllabus will be compulsory. The remaining eight questions will comprise of a set of two questions from each unit and the candidate will be required to attempt four questions selecting one from each unit. All questions carry equal marks.**

**MM: 80**  
**Time: 3h**

**Unit I**

Extrusion technology: general principles, extrusion process, advantages of extrusion, extrusion equipment, single screw extruders and twin screw extruders, effect of extrusion on food properties, extrusion of starch based foods.

Hydrostatic pressure technology: general principles, effect of hydrostatic pressure on microorganisms-possible mode of action, application of hydrostatic pressure technology in food industry.

**Unit II**

Hurdle technology: principles and basic aspects of hurdle technology, different hurdles, hurdle effect, application of hurdle technology in dairy products, intermediate moisture foods, fermented products, heated foods and chilled foods.

Membrane technology: introduction of membrane, their classification and function, principles of reverse osmosis and ultrafiltration, nanofiltration and microfiltration, applications of membranes in food processing industry, modules for using membrane filters.

**Unit III**

High intensity electric field pulses (HIEFP): principles, generation of electric field pulses, applications in foods, effect on bread making and wheat dough and bread making properties, effect of HIEFP on microorganisms.

Ultrasound in food processing and preservation: Introduction, ultrasound instrumentation, ultrasound processing for enhancement of mass transfer, heat transfer and homogenization and emulsification.

**Unit IV**

Principles and uses of ohmic heating, dielectric heating and infra red heating

Microwaves processing, properties of microwaves, mechanism of heating, application of microwave in food processing and its effects on nutrients.

Super critical fluid extraction, antifreeze proteins in food preservation

Food irradiation, use of ionization radiations in food preservation, sources, units, effects, limitations, dose determination, safety and wholesomeness of irradiated foods, food irradiation techniques and recent applications of irradiation in food preservation.

**Recommended Books:**

1. Gloud, G. W. (1995). New Methods of Food Preservation, Springer Publication
2. Holdsworth, S. D. (1993). Aseptic Processing and Packaging of Food Products, Elsevier, London.
3. Church, P. N. (1993). Principles and Applications of Modified Atmosphere Packaging of Food, Blackie Academic & Professional, U.K.
4. Leistner L & Gould G.W. (2002). Hurdle Technologies: Combination Treatments for Food Stability, Safety and Quality. Springer Publications
5. Gustavo V. Barbosa-Cánovas, María S. Tapia, M. Pilar Cano (2005). Novel Food Processing Technologies , CRC press
6. Tewari, G, Juneja, V.K. (2007). Advances in thermal and non-thermal preservation, Wiley Blackwell Press
7. Da Wen Sun (2005). Emerging Technologies for Food Processing, Academic Press

**18FT24C2**  
**Food Safety and Quality Assurance**

**There will be nine questions in all. The first question comprising of short answer type questions covering the entire syllabus will be compulsory. The remaining eight questions will comprise of a set of two questions from each unit and the candidate will be required to attempt four questions selecting one from each unit. All questions carry equal marks.**

**MM: 80**  
**Time: 3h**

**Unit I**

Concept of quality: Quality attributes- physical, chemical, nutritional, microbial, and sensory; their measurement and evaluation, Introduction to food safety and food quality assurance and management concepts; objectives, importance and functions of quality control, current challenges to global food safety

**Unit II**

Various issues and concerns regarding the food safety, issues related to polluted farming, climate change affecting the food safety and quality, food borne illnesses and microbiological and chemical hazards and toxic food contaminants, Food adulteration, nature of adulterants and common food adulterants in foods

**Unit III**

Principles of food quality assurance, total quality management (TQM) – good manufacturing/management practices, good hygienic practices, good lab practices, general awareness and role of management practices in quality control

Food safety management, applications of HACCP in food safety, concept of food traceability for food safety,

**Unit IV**

Microbial quality control: determination of microorganisms in foods by cultural, microscopic, physical, chemical methods.

Statistical quality control in food industry

**Recommended Books:**

1. Early. R. (1995): Guide to Quality Management Systems for the Food Industry, Blackie, Academic and professional, London.
2. Gould, W.A and Gould, R.W. (1998). Total Quality Assurance for the Food Industries, CTI Publications Inc. Baltimore.
3. Pomeraz, Y. and MeLoari, C.E. (1996): Food Analysis: Theory and Practice, CBS publishers and Distributor, New Delhi.
4. Bryan, F.L. (1992): Hazard Analysis Critical Control Point Evaluations A Guide to Identifying Hazards and Assessing Risks Associated with Food Preparation and Storage. World Health Organization, Geneva



5. Kirk, R.S and Sawyer, R. (1991): Pearson s Composition and Analysis of Foods, Longman Scientific and Technical. 9<sup>th</sup> Edition, England.
6. Food and Agricultural Organization (1980): Manuals of Food Quality Control. 2 Additives Contaminants Techniques, Rome.
7. Furia, T.E. Ed. 1980. Regulatory Status of Direct Food Additives. CRC Press, Florida.
8. Krammer, A. and Twigg, B.A. (1970). Quality Control for the Food Industry. 3rd Edn. AVI, Westport.
9. Rekha S. Singhal , Pushpa R. Kulkarni, Dananesh V. Rege, (1997). Hand Book of Indices of food Quality and Authenticity, wood head Publishing Ltd.
10. Hubbard, Merton R. (2003). Statistical Quality Control for the Food Industry, 3rd Edition, Springer.

**Open elective course floated by Department of Food Technology to the common pool of open elective papers of the university.**

## **Food Adulteration**

### **Unit I**

Basic food groups, Function of foods and its general composition.

Food Quality & Safety, various aspects of food quality & safety, challenges of food safety.

Food adulteration and contamination, common food contaminants & adulterants

### **Unit II**

**Food Adulteration:** Nature of adulterants, methods of evaluation of food adulterants and toxic constituents in foods, common food adulterants & their detection on various foods like

- a) Milk and Milk products
- b) Oils and fats
- c) Spice and condiments
- d) Wheat and other flours
- e) Sugar and Preserve
- f) Fruit and Vegetable products
- g) Beverages Alcoholic and Non-Alcoholic

### **Unit III**

**Food Laws and Regulation:** Prevention of Food Adulteration Act 1954, Food Safety and Standards Act (2006), Food Safety and Standards Authority of India (FSSAI), BIS, FPO, APEDA.

### **Recommended Books:**

1. Gould, W.A and Gould, R.W. (1998). Total Quality Assurance for the Food Industries, CTI Publications Inc. Baltimore.
2. Furia, T.E. Ed. 1980. Regulatory Status of Direct Food Additives. CRC Press, Florida.
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