

EXAMINATION SCHEME & SYLLABI

[Choice Based Credit System (CBCS)]

OF

M.Sc. FOOD TECHNOLOGY (2 Year Program)

(w.e.f. Academic Session 2015-16)



**DEPARTMENT OF FOOD TECHNOLOGY
MAHARSHI DAYANAND UNIVERSITY
ROHTAK-124001, INDIA**

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

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

Credit Matrix for M.Sc. Food Technology Program (w.e.f. session 2015-16)

SEMESTER	CORE PAPER	SOFT CORE ELECTIVE- (DISCIPLINE CENTRIC)	FOUNDATION COURSE	OPEN ELECTIVE (INTERDISCIPLINARY)	DISSERTATION	INDUSTRIAL TRAINING	TOTAL
I	30	-	-	-	-	-	30
II	18	06	02	02	-	-	28
III	24	06	-	-	-	04	34
IV	08	-	-	-	20	-	28
TOTAL	80	12	02	02	20	04	120

REQUIRED CREDITS FOR THE COURSE

CORE PAPER=80

SOFT CORE=12

OPEN ELECTIVE=02

FOUNDATION COURSE=02

DISSERTATION=20

INDUSTRIAL TRAINING=04

TOTAL=120

SCHEME OF EXAMINATION

M.S.C. FOOD TECHNOLOGY (CHOICE BASED CREDIT SYSTEM)

(W.E.F. ACADEMIC SESSION 2015-16)

SEMESTER –I						
Paper No.	Nomenclature of Paper			Max. Marks	Internal Assessment	Total Marks
		Credits	Hrs.			
CORE PAPER						
FT-101	Food Chemistry	4	4	80	20	100
FT-102	Principles of Food Engineering	4	4	80	20	100
FT-103	Basic Principles of Food Processing and Preservation	4	4	80	20	100
FT-104	Food Microbiology	4	4	80	20	100
FT-105	Food Analysis & Instrumentation	4	4	80	20	100
FT-106	Lab course-I	10	20	-	-	250

Total Credits=30
Total Marks=750

SEMESTER –II						
Paper No.	Nomenclature of Paper			Max. Marks	Internal Assessment	Total Marks
		Credits	Hrs.			
CORE PAPER						
FT-201	Technology of Cereals	4	4	80	20	100
FT-202	Technology of Fruits and Vegetables	4	4	80	20	100

FT-203	Unit Operations in Food Engineering	4	4	80	20	100
FT-204	Lab course-II	6	12	-	-	150
SOFT CORE (DISCIPLINE ELECTIVE PAPER)						
FT-205	Post Harvest Technology of Plantation Crops	4	4	80	20	100
FT-206	Technology of Legumes and Oilseeds	4	4	80	20	100
FT-207	Technology of Meat, Poultry and Fish Products	4	4	80	20	100
FT-208	Lab course-III (for respective elective paper)	2	4	-	-	50
OPEN ELECTIVE (INTERDISCIPLINARY) **						
FT-209	Food Adulteration	2	2	40	10	50
FOUNDATION COURSE						
FT-210	Computer Applications and Statistical Methods	2	2	40	10	50
FT-211*	Industrial Training	4	-	100	-	100

*The viva voce of the industrial training report will be conducted in the 3rd semester and hence the credits will be given to the students in the 3rd semester

** The students will have to opt any of the following open elective paper floated by various departments of faculty of life sciences:-

Sr. No.	Name of the Department	Open elective paper offered
1	Centre for Biotechnology	Principles and Applications of Biotechnology
		Principles and Applications of Agricultural Biotechnology
2	Centre for Medical Biotech	Principles of Medical Biotechnology
3	Centre for Bio-informatics	Introduction to Bioinformatics
4	Centre for Microbiology	Microbial World: Diversity & Applications
		Microbial Technology for Entrepreneurship
5	Department of Genetics	Genetics & Society
		Basics in Forensic Science
6	Department of Biochemistry	Basic Biochemistry
7	Department of Zoology	Applied Zoology
8	Department of Botany	Plant Resource Utilization
9	Department of Environmental Sciences	Environment Issues & Disaster Management

Total Credits=28

Total Marks=700

SEMESTER –III						
Paper No.	Nomenclature of Paper			Max. Marks	Internal Assessment	Total Marks
		Credits	Hrs.			
CORE PAPER						
FT-301	Technology of Milk and Milk products	4	4	80	20	100
FT-302	Food Packaging	4	4	80	20	100
FT-303	Food Safety and Quality control	4	4	80	20	100
FT-304	Technology of Bakery and Confectionary Products	4	4	80	20	100
FT-305	Lab course-IV	8	16	-	-	200
SOFT CORE (DISCIPLINE ELECTIVE PAPER)						
FT-306	Enzymes and Fermentation Technology	4	4	80	20	100
FT-307	Food Biotechnology	4	4	80	20	100
FT-308	Food additives	4	4	80	20	100
FT-309	Lab course-V (for respective elective paper)	2	4	-	-	50

Total credits =34

Total marks =850

SEMESTER –IV						
Paper No.	Nomenclature of Paper			Max. Marks	Internal Assessment	Total Marks
		Credits	Hrs.			
CORE PAPER						
FT-401	Advances in Food Processing and Preservation	4	4	80	20	100
SOFT CORE (DISCIPLINE ELECTIVE PAPER)						
FT-402	Food Laws, Regulations and Standards	4	4	80	20	100
FT-403	Food Toxicology and Allergens	4	4	80	20	100
FT-404	Sensory Evaluation of Foods	4	4	80	20	100
FT-405	Dissertation/Project Work	20	40	-	-	300

Total Credits=28

Total Marks=500

Grand Total Credits=120

Grand Total Marks=2800

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 6 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. After the second semester the students will be required to undertake an industrial training comprising of 4 weeks in some industry/organization/institute and shall be required to submit an industrial training report for which seminar presentation and viva-voce examination will be held in the third semester.
5. The dissertation is to be innovative work based on small piece of research work allotted in 3rd 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

Pattern of references/typing/figures will be same as in Ph.D. thesis. Last date of submission will be 30th 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.

6. The internal assessment criteria will be as given written test will be as given under

Written test = 10 marks

Assignments/presentations = 05 marks

Attendance = 05 marks

(Less than 65% =0 marks, 65-70% =2 marks, 71-75% =3 marks, 76-80% = 4 marks, above 80% = 5 marks)

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

COURSE CURRICULUM OF M.SC 1ST & 2ND SEMESTERS

W.E.F. 2015-2016

FT—101
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 at least 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 Meloon, 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

FT-102
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 at least 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.

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 at least 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, 4th 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.

FT—104
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 at least 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; Indicators 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, 5th 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

FT-105
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 at least 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.

FT- 201
Technology of Cereals

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 at least 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.

FT-202

Technology of Fruits and Vegetables 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 at least 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. 2nd 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.

FT-203

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 at least 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, 2nd 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, 2nd Ed., Elsevier, New York.
6. Lewis, M.J. (1987). Physical Properties of Foods & Foods Processing Systems, Ellis Horwood, England.

FT-205
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 at least 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 Hirasaka and Mitsuo Takemasa(1998). Spice Science and Technology, Marcell Dekker, Inc.
4. Minifie BW. 1999. *Chocolate, Cocoa and Confectionery Technology*. 3rd 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.

FT-206
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 at least 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.

FT-207

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 at least 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.

FT—209 (Open Elective)
Food Adulteration

The first question comprising of short answer type questions covering the entire syllabus will be compulsory. The remaining four questions will comprise of a set of two questions from each unit and the candidate will be required to attempt two questions selecting one from each unit.

MM: 40
Time: 2h

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 contamination & 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

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.

FT-210

Computer Applications and Statistical Methods

The first question comprising of short answer type questions covering the entire syllabus will be compulsory. The remaining four questions will comprise of a set of two questions from each unit and the candidate will be required to attempt two questions selecting one from each unit.

MM: 40

Time: 2h

Unit I

Introduction of computer: Characteristics, classification of computer; Number system: binary, octal, decimal, hexa-decimal conversion of number system. Hardware and software: Input, output, and secondary storage devices, central processing unit. Operating systems and its types and functions; Understanding computer networks: Types; topologies for LANS, transmission media; Analog and digital signals, Working with software packages: An introduction to PC-software packages; word processor- spreadsheet software-working with worksheet, formulas and functions, inserting charts; PowerPoint presentation-working with different views

Unit II

Methods of data collection, sampling and sampling methods, measurement of central tendency, mean, median, mode, standard deviation, standard error, variance.

Correlation & regression analysis, analysis of variance (ANOVA), tests of significance, t-test, z-test and f- test.

Recommended Books:

1. Introduction to Information Technology, Pearson Education, New Delhi.
2. Norton, peter, Introduction to Computers, Tata McGraw Hill, New Delhi.
3. Douglas, Comer E., Computer Networks and Internet, Pearsons Education, New Delhi.
4. Rajaraman, V., Fundamentals of Computers, Prentice Hallof India, New Delhi.
5. Office 2000: No Experience Required, BPB Publications, New Delhi.

