

# **M.Sc. FOOD TECHNOLOGY**

## **COURSE STRUCTURE**

(According to NEP Guidelines; with effect from the Academic Year 2022-2023)

### **ANNEXURE – I**

### **ANNEXURE – II**



**CARMEL COLLEGE OF ARTS, SCIENCE AND COMMERCE FOR WOMEN**  
**NUVEM – GOA**  
**POSTGRADUATE SELF-FINANCED PROGRAMME (CO-ED)**  
**AFFILIATED TO GOA UNIVERSITY**

## **COURSE DETAILS OF M.Sc. (FOOD TECHNOLOGY)**

*(with effect from the Academic Year 2022-2023)*

*Food scientists and technologists are versatile, interdisciplinary, and collaborative practitioners in a profession at the crossroads of scientific and technological developments. As the food system has drastically changed, from one centred around family food production on individual farms and home food preservation to the modern system of today, most people are not connected to their food nor are they familiar with agricultural production and food manufacturing designed for better food safety and quality. The Post Graduate (Degree) Department of Food Technology, set up in 2017, endeavours to develop professionals skilled at advancing the science of food. The objectives of M.Sc. (Food Technology) are:*

- ✓ Provide students with theoretical knowledge and practical abilities required to work in the food industry, research centres, and food-related national and international organizations*
- ✓ Contribute to a healthier population by imparting education and understanding of nutritional science*
- ✓ Develop confident and competent individuals, able to adapt to the changing fabric of society through their professional expertise and personal traits*

The Programme equips students for higher research leading to a Ph.D. Degree or to setting up an enterprise of their own, or for employment in Research Institutes, in teaching, and in Industry.

### **Prerequisites:**

B. Sc. in Food Technology/ Food, Nutrition, and Dietetics/ Microbiology/ Biotechnology/ Zoology/ Chemistry/ Botany/ Life Sciences/ Bio-sciences or Allied Subjects

## **ANNEXURE I**

### **COURSE STRUCTURE OF M.Sc. (FOOD TECHNOLOGY)**

(According to NEP Guidelines; with effect from the Academic Year 2022-2023)

#### **M.Sc. (Food Technology) Part I**

<b>SEMESTER I</b>				
<b>CODE</b>	<b>TITLE OF PAPER</b>	<b>THEORY/ PRACTICAL</b>	<b>NO. OF CREDITS</b>	<b>CONTACT HOURS</b>
<b>Discipline Specific Core Courses (16 credits)</b>				
FTC-501	Food Chemistry and Nutritional Biochemistry	Theory	3	45
FTC-502	Food Microbiology and Preservation	Theory	3	45
FTC-503	Lab in Food Chemistry and Microbiology	Practical	2	60
FTC-504	Food Processing and Packaging	Theory	3	45
FTC-505	Food Quality, Safety Standards, and Laws	Theory	3	45
FTC-506	Lab in Food Processing and Quality Management	Practical	2	60
<b>Discipline Specific Elective Courses (4 credits)</b>				
FTC-507	Industrial Food Waste Management	Theory	2	30
FTC-508	Lab in Industrial Food Waste Management	Practical	2	60
FTC-509	Food Additives, Adulteration, and Toxicology	Theory	2	30
FTC-510	Lab in Food Additives, Adulteration, and Toxicology	Practical	2	60
<b>SEMESTER II</b>				
<b>Discipline Specific Core Courses (16 credits)</b>				
FTC-511	Food Biotechnology	Theory	3	45
FTC-512	Lab in Food Biotechnology	Practical	2	60
FTC-513	Normal and Clinical Nutrition	Theory	3	45
FTC-514	Lab in Normal and Clinical Nutrition	Practical	2	60
FTC-515	Bakery, Confectionery, and Convenience Food Technology	Theory	3	45
FTC-516	Lab in Bakery, Confectionery, and Convenience Food Technology	Practical	1	30
FTC-517	Food Engineering	Theory	2	30
<b>Discipline Specific Elective Courses (4 credits)</b>				
FTC-518	Spice and Plantation Crop Technology	Theory	2	30
FTC-519	Lab in Spice and Plantation Crop Technology	Practical	2	60
FTC-520	Nutraceuticals and Health Foods	Theory	2	30
FTC-521	Lab in Nutraceuticals and Health Foods	Practical	2	60

*A student will have to opt for the combination of Theory and its related Practical Paper in the choices provided*

## M.Sc. (Food Technology) Part II

SEMESTER III				
CODE	TITLE OF PAPER	THEORY/ PRACTICAL	NO. OF CREDITS	CONTACT HOURS
<b>Generic Elective Courses (12 credits)</b>				
FTC-601	Cereal, Legume, and Oilseed Processing Technology	Theory	3	45
FTC-602	Lab in Cereal, Legume, and Oilseed Processing Technology	Practical	1	30
FTC-603	Meat, Poultry, Freshwater, and Marine Food Technology	Theory	3	45
FTC-604	Lab in Meat, Poultry, Freshwater, and Marine Food Technology	Practical	1	30
FTC-605	Dairy Technology	Theory	3	45
FTC-606	Lab in Dairy Technology	Practical	1	30
FTC-607	Beverage Technology	Theory	3	45
FTC-608	Lab in Beverage Technology	Practical	1	30
FTC-609	Pre- and Post-Harvest Technology of Horticulture Produce	Theory	3	45
FTC-610	Lab in Pre- and Post-Harvest Technology of Horticulture Produce	Practical	1	30
FTC-611	Snack Food Technology	Theory	3	45
FTC-612	Lab in Snack Food Technology	Practical	1	30
FTC-613	Entrepreneurship and Business Management	Theory	2	30
FTC-614	Food Plant Layout and Design	Theory	2	30
<b>Research Specific Elective Courses (8 credits)</b>				
FTC-615	Research Methodology	Theory	2	30
FTC-616	Academic Writing	Theory	2	30
FTC-617	Fundamentals of Statistics	Theory	2	30
FTC-618	Creative and Social Media Writing	Theory	2	30
FTC-619	Food Product Development and International Trade	Theory	2	30
FTC-620	Food Sensory Science and Flavour Technology	Theory	2	30
FTC-621	Instrumentation and Process Control	Theory	2	30
FTC-622	Business Communication	Theory	2	30
<b>SEMESTER IV</b>				
FTC-623	Dissertation	Dissertation	16	240
<b>Research Specific Elective Courses (4 credits)</b>				
FTC-624	Advanced Statistics	Theory	2	30
FTC-625	Epidemiology and Health Economics	Theory	2	30
FTC-626	Internship	Practical	2	60
FTC-627	Study Tour	Practical	2	60



## ANNEXURE II: SYLLABUS

<b>COURSE CODE</b>	FTC-501
<b>COURSE TITLE</b>	FOOD CHEMISTRY AND NUTRITIONAL BIOCHEMISTRY
<b>NUMBER OF CREDITS</b>	3

<b>PRE-REQUISITES</b>	The student should be knowledgeable about chemistry and the different types of food
<b>COURSE OBJECTIVES</b>	1. To acquaint students with the chemical constituents of food, their interactions during processing, and evaluation of varied characteristics of food 2. To familiarize students with the classification of foods and nutrients, and their metabolism in the human body

<b>CONTENT</b>		
<b>1</b>	<b>FOOD AND ITS CONSTITUENTS</b>	<b>10 hours</b>
1.1	Food and Nutrients - <i>Definition, Classification, and Functions</i>	
1.2	Role of Water in Food and Human Health – <i>Interaction with food components and food stability</i>	
1.3	Pigments, Phytonutrients, Antioxidants, Flavour Components – <i>Definition, Classification, and Functions</i>	
1.4	Anti-nutritional Factors in Foods	
1.5	Digestion, Absorption, and Transport of Foods and Nutrients	
<b>2</b>	<b>CARBOHYDRATES</b>	<b>10 hours</b>
2.1	Definition, Structure, Properties, Functions, Classification, Dietary Sources, Chemical Reactions, Deficiencies and Excess, Recommended Dietary Allowances	
2.2	Reducing and Non-Reducing Sugars; Browning Reactions in Foods – <i>formation and control</i>	
2.3	Starch, Resistant Starches and Dietary Fibre – <i>Definition, Sources, Granule Structure, Properties, Functions, and Native and Modified Starches</i>	
2.4	Metabolic Pathways - <i>Glycolysis, Gluconeogenesis, Glycogenesis, Glycogenolysis, Citric Acid Cycle</i>	
<b>3</b>	<b>PROTEINS</b>	<b>10 hours</b>
3.1	Definition, Structure, Properties, Functions, Classification, Dietary Sources, Chemical Reactions, Deficiencies and Excess, Recommended Dietary Allowances	
3.2	Metabolic Pathways - <i>Transamination, Deamination, Decarboxylation, Urea Cycle</i>	
3.3	Stress and Anti-freeze Proteins; Protein Isolates and Concentrates	
3.4	Denaturation of Proteins	
3.5	Evaluation of Protein Quality	
<b>4</b>	<b>LIPIDS</b>	<b>10 hours</b>
4.1	Definition, Structure, Properties, Functions, Classification, Dietary Sources, Chemical Reactions, Deficiencies and Excess, Recommended Dietary Allowances	
4.2	Metabolic Pathways - <i>Fatty Acid Oxidation, Biosynthesis of Fatty Acids</i>	
4.3	Synthesis and Functions of Cholesterol; Ketogenesis	

4.4	Rancidity and Hydrogenation of Fats	
4.5	Emulsions	
4.6	Synthetic Fats	

<b>5</b>	<b>VITAMINS AND MINERALS</b>	<b>5 hours</b>
5.1	Classification, Functions, Dietary Sources, Deficiencies and Excess, Recommended Dietary Allowances	

<b>PEDAGOGY</b>	Lectures/ Assignments/ Seminars
<b>REFERENCE BOOKS</b>	Agarwal A and Udipi SA. 2014. <i>Textbook of Human Nutrition</i> . Jaypee Brothers Medical Publishers (P) Ltd.
	Bamji MS, Krishnaswamy K, and Brahman GNV. 2009. <i>Textbook of Human Nutrition</i> . Third Edition. Oxford and IBH Publishing Co. Pvt. Ltd.
	Belitz H.-D, Grosch W, and Schieberle P. 2009. <i>Food Chemistry</i> . Fourth Edition. Springer.
	Civille GV and Carr BT. 2016. <i>Sensory Evaluation Techniques</i> . Fifth Edition. CRC Press.
	Damodaran S and Parkin K. 2017. <i>Fennema's Food Chemistry</i> . Fifth Edition. CRC Press.
	Lawless HT and Heymann H. 2010. <i>Sensory Evaluation of Food</i> . Second Edition. Springer
	Meyer LH. 2004. <i>Food Chemistry</i> . CBS Publishers and Distributors
	Nelson DL and Cox MM. 2017. <i>Lehninger Principles of Biochemistry</i> . Seventh Edition. WH Freeman.
	Potter NN, and Hotchkiss JH. 2007. <i>Food Science</i> . 5 <sup>th</sup> Edition. CBS Publishers and Distributors.
	Rodwell VW, Bender DA, Botham KM, Kennelly PJ, Weil PA. 2015. <i>Harper's Illustrated Biochemistry</i> . 30 <sup>th</sup> Edition. McGraw Hill Education.
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Recognise the role of various types of chemical bonding on physicochemical properties of food</li> <li>2. Predict the outcome of interaction between different biomolecules</li> <li>3. Sketch the basic skeleton of biochemical pathways (glycolysis, gluconeogenesis, tricarboxylic acid cycle, etc.)</li> <li>4. Illustrate and explain the digestion, absorption and transport of dietary biomolecules</li> <li>5. Propose or hypothesise mechanisms for the distribution of nutrients on consumption of complex food items</li> <li>6. Debate the fortification of foods on the basis of their composition and functional properties</li> </ol>

<b>COURSE CODE</b>	FTC-502
<b>COURSE TITLE</b>	FOOD MICROBIOLOGY AND PRESERVATION
<b>NUMBER OF CREDITS</b>	3

<b>PRE-REQUISITES</b>	The student should be aware of the different types of microorganisms and their impact on health; they should be knowledgeable about chemistry and different types of food
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>To acquaint the students with different groups of microorganisms associated with food, their activities, destruction and detection in food</li> <li>To acquaint students with the industrial techniques used to preserve and process foods, extend their shelf-life and improve their palatability characteristics</li> </ol>

<b>CONTENT</b>		
<b>1</b>	<b>INTRODUCTION TO FOOD MICROBIOLOGY</b>	<b>10 hours</b>
1.1	Microorganisms in Food	
1.2	Morphological and Ultrastructure of Microbial Cell - <i>Physiology of microbes (Gram positive and Gram-negative bacterial membrane, spore, pili, flagella), Prokaryotic cellular reserve materials, Pathogenic and beneficial microorganisms</i>	
1.3	Microbial Growth – <i>Kinetic and growth requirements, Intrinsic and Extrinsic factors influencing microbial growth and survival; Computer modelling of microbial growth</i>	
1.4	Microbes as Food - <i>Single cell protein, algae as food, mycoprotein from fungi for use as food and feed, mushroom cultivation</i>	
<b>2</b>	<b>PRINCIPLES OF FOOD MICROBIOLOGICAL ANALYSIS</b>	<b>10 hours</b>
2.1	Bacteria, Fungi, Virus, Protozoa, and Algae – <i>general characteristics, identification, morphological characteristics, importance in food microbiology</i>	
2.2	Culture Media - <i>components of media, natural and synthetic media, various media used for bacterial analysis, sterilization of media</i>	
2.3	General Microbiological Techniques - <i>bacterial isolation, purification and characterization, enumeration and preservation of bacteria (methods in brief)</i>	
2.4	Methods of Disinfection, Sanitation and Asepsis	
<b>3</b>	<b>MICROBES IN FOOD FERMENTATION AND SPOILAGE</b>	<b>10 hours</b>
3.1	Microbial Cultures in Food Fermentation and their Maintenance; Bioreactors – <i>types and designs</i>	
3.2	Traditional Fermented Foods of India and Other Asian Countries - <i>fermented foods based on milk, meat, and vegetables; fermented beverages</i>	
3.3	Prebiotics, Probiotics, Synbiotics, and Postbiotics	
3.4	Microbial Spoilage of Meat, Eggs, Milk, Seafood and their Products	
3.5	Microbial Spoilage of Vegetables, Fruits, Cereals and their Products	
<b>4</b>	<b>PRINCIPLES OF FOOD PRESERVATION</b>	<b>5 hours</b>
4.1	Microbial Control by Water and Temperature – <i>Water Activity, Thermal Death Time, Psychrometric Charts</i>	
4.2	Microbial Control Using Natural and Synthetic Preservatives - <i>types, permissible limits, safety aspects</i>	



<b>5</b>	<b>METHODS OF FOOD PRESERVATION</b>	<b>10 hours</b>
5.1	Microbial Control by Thermal Processing - <i>Irradiation, Blanching, Pasteurization, Sterilization, Canning, Extrusion Cooking, Baking, Roasting, Grilling, Dehydration, Concentration, Evaporation, Intermediate Moisture Foods</i>	
5.2	Microbial Control by Non-Thermal Processing - <i>Microwave Processing, Modified Atmosphere, Hurdle Technology, Irradiation, Pulsed Electric Field Electroporation, Biopreservation, High-Pressure Food Preservation, Membrane Technology, Cold Plasma Technology</i>	
5.3	Microbial Control Using Low Temperature - <i>Refrigeration, Freezing, Lyophilisation, Cryogenic Freezing, Dehydrofreezing, Freeze Concentration, Individual Quick Freezing</i>	
5.4	Microbes and Enzymes in Food Preservation	

<b>PEDAGOGY</b>	Lectures/ Assignments/ Seminars
<b>REFERENCE BOOKS</b>	Sivasankar B. 2009. <i>Food Processing and Preservation</i> . First Edition. PHI Learning.
	Banwart GJ.1989. <i>Basic Food Microbiology</i> . Second Edition. AVI Publ.
	Casida LE. 2016. <i>Industrial Microbiology</i> . Second Edition. New Age International Publishers.
	Frazier WC and Westhoff DC. 2008. <i>Food Microbiology</i> . Fourth Edition. Tata McGraw-Hill Publishing Company Limited.
	Garbutt J. 1997. <i>Essentials of Food Microbiology</i> . Second Edition. Arnold Heinemann.
	Jay JM, Loessner MJ, and Golden DA. 2005. <i>Modern Food Microbiology</i> . Seventh Edition. Springer.
	Bhat R, Alias AK, and Paliyath G. 2012. <i>Progress in Food Preservation</i> . First Edition. Wiley-Blackwell.
	Paniker CKJ. 2005. <i>Ananthanarayan and Paniker's Textbook of Microbiology</i> . Seventh Edition. Orient Blackswan.
	Ray B and Bhunia A. 2013. <i>Fundamental Food Microbiology</i> . Fifth Edition. CRC Press.
	Steinkraus KS.1996. <i>Handbook of Indigenous Fermented Foods</i> . Marcel Dekker.
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Describe the basic concepts of food microbiology and microbial technique</li> <li>2. Explain the basic concept and factors influencing food spoilage of different types of food</li> <li>3. Explain the basics of fermentation and sketch the importance of microbes</li> <li>4. Recognize the principle and understand the factors influencing food preservation</li> <li>5. Explain and debate on the different methods involved in food preservation</li> <li>6. Illustrate and discuss microbes and enzymes in food and preservation techniques</li> </ol>

<b>COURSE CODE</b>	FTC-503
<b>COURSE TITLE</b>	LAB IN FOOD CHEMISTRY AND MICROBIOLOGY
<b>NUMBER OF CREDITS</b>	2

<b>PRE-REQUISITES</b>	The student should have theoretical knowledge about the nutritional and microbiological components of food
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To enable students to analyse foods for their nutritional content</li> <li>2. To familiarize students with laboratory procedures required for determining the microbiological safety of foods</li> </ol>

<b>CONTENT</b>		
<b>1</b>	<b>FOOD CHEMISTRY AND ANALYSIS</b>	<b>30 hours</b>
1.1	Laboratory Safety Rules and Precautions	
1.2	Estimation of Reducing and Non-Reducing Sugars in Honey/Fruit Juices	
1.3	Estimation of Proteins in food using the Biuret Method	
1.4	Saponification, Iodine, and Acid Value of Edible Oils – <i>fresh and stale foods</i>	
1.5	Estimation of Lactose in Milk	
1.6	Estimation of Ascorbic Acid in Foods	
1.7	Estimation of Beta-Carotene in Foods	
1.8	Estimation of Calcium, Phosphorous and Iron content of Foods	
1.9	Estimation of Browning Intensity	
1.10	Estimation of Anti-Nutritional Factors in Foods	

<b>2</b>	<b>FOOD MICROBIOLOGY</b>	<b>30 hours</b>
2.1	Familiarization with Instruments used in Microbiological Lab, their principles and working	
2.2	Gram Staining of Bacteria	
2.3	Determination of Bacterial Viable Count in Food	
2.4	Plate Culture and Microscopic Examination of <i>Saccharomyces cerevisiae</i>	
2.5	Isolation of Food (Bread, Fruit) Pathogenic Fungi, Microscopic Examination and Identification	
2.6	Detection and Enumeration of Pathogenic and Indicator Organisms in Food	
2.7	Evaluation of Microbiological Quality of Water and MPN of Coliforms	
2.8	Enumeration of Microbes from Fermented Foods	
2.9	Detection of Physiological Groups in Food: Osmophiles/ Halophiles	
2.10	Evaluation of Microbiological Quality of Water and Commonly Consumed Street Foods	
2.11	Detection of Microbial enzymatic hydrolysis (starch, protein, fats)	

<b>PEDAGOGY</b>	Experiments in the Laboratory
<b>REFERENCE BOOKS</b>	Garg N, Garg KL, and Mukerji KG. 2010. <i>Laboratory Manual of Food Microbiology</i> . I.K. International Publishing House Pvt. Ltd.
	Sehgal S. 2016. <i>A Laboratory Manual of Food Analysis</i> . I.K. International Publishing House Pvt. Ltd.

<b>COURSE OUTCOMES</b>	<b>On completion of the course, the student will be able to:</b> <ol style="list-style-type: none"> <li>1. Recognize and exemplify good laboratory practices with knowledge of different glassware/ instrument/ equipment used in microbiology laboratory</li> <li>2. Evaluate the quality of water and food items</li> <li>3. Illustrate microbial enumeration, characterization and culturing techniques.</li> <li>4. Estimate different biomolecules by qualitative and quantitative tests</li> <li>5. Determine and justify the presence of different macro- and micro-nutrients in food</li> <li>6. Determine and estimate anti-nutritional factors in food</li> </ol>
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<b>COURSE CODE</b>	FTC-504
<b>COURSE TITLE</b>	FOOD PROCESSING AND PACKAGING
<b>NUMBER OF CREDITS</b>	3

<b>PRE-REQUISITES</b>	The student should be knowledgeable about chemistry and the different types of food
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To acquaint students with the industrial techniques used to process foods, extend their shelf-life and improve their palatability characteristics</li> <li>2. To familiarize students with advances in food processing techniques</li> <li>3. To acquaint students with the principles, methods, and materials used for safe packaging of foods</li> </ol>

<b>CONTENT</b>		
<b>1</b>	<b>INTRODUCTION TO FOOD PROCESSING</b>	<b>10 hours</b>
1.1	Definition and Difference between Food Processing and Food Preservation; Functions, Benefits and Drawbacks of Food Processing; Effect of Processing on Flavour Components	
1.2	Primary Processing Techniques – <i>dicing, slicing, mincing, macerating, liquefaction, emulsification</i>	
1.3	Methods of Cooking – <i>Dry Heat, Moist Heat, Combination, Microwave</i>	
1.4	Novel Food Processing Products – <i>mushrooms, algae, leaf protein concentrates, protein from petroleum yeast, food analogues, edible insects</i>	
1.5	Performance Parameters for Food Processing – <i>hygiene, energy efficiency, minimization of waste, labour</i>	
1.6	Overview of the Types of Food Processing Industries	

<b>2</b>	<b>PROCESSING EQUIPMENT</b>	<b>5 hours</b>
2.1	Mechanical, Transport, and Storage Equipment – <i>types, use, and factors affecting selection and purchase</i>	
2.2	Size Reduction, Homogenization, Mixing, and Foaming Equipment	
2.3	Separation Equipment – <i>grading and sorting equipment</i>	
2.4	Thermal Processing and Refrigeration Equipment	
2.5	Evaporation and Dehydration Equipment	

<b>3</b>	<b>FRUIT AND VEGETABLE PROCESSING</b>	<b>5 hours</b>
3.1	Beverages and Purees - <i>Role of Enzymes; Processing Techniques; Equipment and Methods; Processed Products</i>	
3.2	Jams, Jellies, Marmalades, and Crystallized Products – <i>Ingredients and their role</i>	
3.3	Pickles, Sauces, and Preserves - <i>Ingredients and their role</i>	

<b>4</b>	<b>INTRODUCTION TO FOOD PACKAGING</b>	<b>5 hours</b>
4.1	Functions and Objectives of Packaging	
4.2	Forms of Packaging – <i>rigid, semi-rigid, flexible</i>	
4.3	Packaging Closures and Sealing Systems	

<b>5</b>	<b>MATERIALS USED FOR FOOD PACKAGING</b>	<b>10 hours</b>
5.1	Paper and Paper-based Packaging Materials – <i>types, properties, advantages and disadvantages</i>	
5.2	Metal Packaging Materials - <i>types, properties, advantages and disadvantages</i>	
5.3	Glass Packaging Materials - <i>types, properties, advantages and disadvantages</i>	
5.4	Plastics and Composites - <i>types, properties, advantages and disadvantages</i>	
5.5	Edible and Biodegradable Food Packaging Materials - <i>types, properties, advantages and disadvantages</i>	
5.6	Selection and Design of Packaging Material for Dehydrated Foods, Frozen Foods, Dairy Products, Fresh Fruits & Vegetables, Meats, and Sea foods	

<b>6</b>	<b>PACKAGING MATERIAL PROPERTIES</b>	<b>10 hours</b>
6.1	Barrier properties – <i>permeability, transmission rates, migration, diffusion and solubility</i>	
6.2	Mechanical Properties – <i>tensile strength, bursting strength, tearing resistance, puncture resistance, impact strength, tear strength, stiffness, crease or flex resistance</i>	
6.3	Optical Properties	
6.4	Labels, and Food and Packaging Material Interactions	
6.5	Methods of Testing and Evaluation	
6.6	Aseptic Packaging of Foods - <i>definition, function and methods</i>	
6.7	Active and Intelligent Packaging - <i>definition, function and design</i>	

<b>PEDAGOGY</b>	Lectures/ Assignments/ Seminars
<b>REFERENCE BOOKS</b>	Novel Food Processing Technologies by Barbosa-Canovas, Tapia & Cano CRC Press, 2004.
	Food Processing: Principles and Applications by Ramaswamy H. & Marcotte M. Taylor & Francis.
	Fellows PJ. 2016. <i>Food Processing Technology Principles and Practice</i> . Fourth Edition. Woodhead Publishing.
	Ramaswamy HS and Marcotte M. 2005. <i>Food Processing: Principles and Applications</i> . Taylor & Francis.
	Sivasankar B. 2009. <i>Food Processing and Preservation</i> . First Edition. PHI Learning
	Robertson GL. 2016. <i>Food Packaging Principles and Practice</i> . Third Edition. CRC Press.
	Natarajan S, Govindarajan M, and Kumar B. 2014. <i>Fundamentals of Packaging Technology</i> . Second Edition. PHI.
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Define and distinguish between food processing and preservation</li> <li>2. Discuss the principle, working, and application of equipment implemented in food processing</li> <li>3. Elaborate on processing technology of fruit and vegetable products</li> <li>4. Exemplify the functions and objectives of packaging and forms of packaging material</li> <li>5. Outline the characteristics of various packaging materials and select appropriate packaging systems for food products</li> <li>6. Explain the role and importance of aseptic packaging, and novel techniques like active and intelligent packaging</li> </ol>

<b>COURSE CODE</b>	FTC-505
<b>COURSE TITLE</b>	FOOD QUALITY, SAFETY STANDARDS, AND LAWS
<b>NUMBER OF CREDITS</b>	3

<b>PRE-REQUISITES</b>	The student should be aware of the different types of microorganisms and their impact on health
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To familiarize students with the industrial standards concerning safe food production</li> <li>2. To acquaint students with the existent national and international systems that ensure food quality</li> <li>3. To familiarize students with national and international laws governing food production, import and export</li> </ol>

<b>CONTENT</b>		
<b>1</b>	<b>FOOD SAFETY AND QUALITY</b>	<b>10 hours</b>
1.1	Biochemical Changes caused by Microorganisms – <i>putrefaction, lipolysis, antagonism and synergism in microorganisms</i>	
1.2	Food Hygiene – <i>Food-borne Infections &amp; Intoxications, Microbial Toxins, Indicator Organisms</i>	
1.3	Industrial Plant Sanitation and Hygiene – <i>Concept of food safety and quality; Quality attributes</i>	
1.4	Quality Control & Assurance – <i>Objectives; Functions; TQM, GMP, GHP, GLP, GAP, HACCP; Indian and International Quality Systems and Standards (AGMARK, BIS, FPO, ISO, BRC, Codex Alimentarius, and related standards.); CEDAC; Food Adulteration</i>	

<b>2</b>	<b>QUALITY ANALYSIS</b>	<b>5 hours</b>
2.1	Food Sampling Techniques; Rapid Detection Methods of Microorganisms	
2.2	Sensory Evaluation of foods – <i>Organoleptic Analysis, Methods and Tests of Sensory Evaluation, Organizing Sensory Evaluation Programmes, Computer-Aided Sensory Evaluations</i>	
2.3	Separation techniques – <i>Ultrafiltration, Ultracentrifugation, Sedimentation, Solid Phase Extraction, Supercritical Fluid Extraction, Chromatography, Electrophoresis</i>	
2.4	Analytical Techniques – <i>Spectroscopy, Microscopy, Immunoassays, Isotopic techniques, Nanotechnology, Thermal and Sub-thermal methods</i>	

<b>3</b>	<b>INDIAN FOOD REGULATORY REGIME</b>	<b>10 hours</b>
3.1	Erstwhile Prevention of Food Adulteration Act and Essential Commodities Act	
3.2	FDA - <i>Structure and Function, Administrative Set-up, Roles and Responsibilities of Staff</i>	
3.3	FSSAI – <i>Genesis and Evolution, Structure and Function, Administrative Set-up at the State Level, Roles and Responsibilities of Staff, Initiatives, Systems, and Processes</i>	
3.4	Licensing and Registration of Food Units – <i>Central and State Licensing Authorities</i>	
3.5	Codex India	

<b>4</b>	<b>INTERNATIONAL FOOD LAWS, ORGANIZATIONS AND AFFILIATIONS</b>	<b>10 hours</b>
4.1	Food and Agricultural Organization (FAO) & World Health Organization (WHO) – <i>Role and Functions</i>	
4.2	World Animal Health Organization	
4.3	World Trade Organization (WTO)	

4.4	European Committee for Standardization, European Union on Food Safety, EFSA, Euro-Asian Council for Standardization	
4.5	COPANT and ASEAN	
4.6	ISO – special emphasis on ISO 9001:2000/2008; ISO 22000:2005; ISO 45001; ISO 14001	
4.7	Rapid Alert System	

<b>5</b>	<b>EXPORT AND IMPORT LAWS AND REGULATIONS</b>	
5.1	Food Packaging and Labelling Requirements – <i>nutrition labelling, health claims, nutrition claims, specialized food regulation – Genetically Modified Foods (GMF), dietary supplements</i>	<b>10 hours</b>
5.2	Foreign Trade Policy	
5.3	Export (Quality Control and Inspection) Act, 1963	
5.4	Plant and Animal Quarantine	
5.5	Customs Act and Import Control Regulations	
5.6	National Agencies for Implementation of International Food Laws and Standards	

<b>PEDAGOGY</b>	Lectures/ Assignments/ Seminars
<b>REFERENCE BOOKS</b>	Adams MR, Moss MO, and McClure P. 2016. <i>Food Microbiology</i> . Fourth Edition. Royal Society of Chemistry.
	Early R. 2012. <i>Guide to Quality Management Systems for the Food Industry</i> . Blackie Academic & Professional
	Heinz HJ. 1991. <i>Principles and Practices for the Safe Processing of Foods</i> . First Edition. Butterworth-Heinemann.
	Raj D, Sharma R, and Joshi VK. 2011. <i>Quality Control for Value Addition in Food Processing</i> . New India Publishing Agency.
	Bizmanualz. 2008. <i>ISO 22000 Standard Procedures for Food Safety Management Systems</i> .
	Gupta V. 2017. <i>The Food Safety and Standards Act, 2006</i> . Ninth Edition. Commercial Law Publishers (India) Pvt. Ltd.
	Prabhakar K. 2016. <i>A Practical Guide to Food Laws and Regulations</i> . Bloomsberry India Professional.
	Rees N and Watson D. 2000. <i>International Standards for Food Safety</i> . Aspen Publication.
	Singhal KL and Singhal D. 2012. <i>Implementing ISO 9001:2008 Quality Management System: A Reference Guide</i> . Second Edition. PHI Learning.
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Understand relevance of hygiene, plant sanitation, adulteration, various hazards, and safety measures</li> <li>2. Elaborate on Indian and International Quality Systems and standards</li> <li>3. Determine quality of food by theoretical application of sensory, separation and analytical techniques</li> <li>4. Discuss Indian food regulations and their criterion for implementation</li> <li>5. Recall the role of the international regulatory agencies, organisations, and affiliations</li> <li>6. Recollect common export and import laws and regulations</li> </ol>

<b>COURSE CODE</b>	FTC-506
<b>COURSE TITLE</b>	LAB IN FOOD PROCESSING AND QUALITY MANAGEMENT
<b>NUMBER OF CREDITS</b>	2

<b>PRE-REQUISITES</b>	The student should have theoretical knowledge regarding food preparation and quality
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>To provide students with the basic practical skills required to prepare foods, and evaluate raw and processed foods</li> <li>To enable students to evaluate food establishments for their consumer acceptability and sanitation attributes</li> </ol>

<b>CONTENT</b>		
<b>1</b>	<b>FOOD PROCESSING</b>	<b>30 hours</b>
1.1	Stages of Preparation and Observation of Sugar Syrup	
1.2	Preparation of Bakery Products – <i>Cakes, Cookies, Breads, Pies, Pastries</i>	
1.3	Extrusion Cooking – <i>Preparation of Pastas</i>	
1.4	Dehydration & Evaporation – <i>Preparation of Condensed Milk &amp; Salted Dry Fish</i>	
1.5	Fruit & Vegetable Processing; Use of Chemical Additives for Preservation; Thermal Processing of Foods – <i>Preparation of Jams, Jellies, Squashes, Pickles, Chutneys, Sauces</i>	
1.6	Emulsions and Emulsifying Agents – <i>Preparation of Mayonnaise &amp; Vinaigrettes</i>	
1.7	Fermented Foods – <i>Preparation of idlis and curds/ yoghurt</i>	
1.8	Frozen Foods – <i>Preparation of Ice Cream &amp; Fruit/ Vegetable Pulp</i>	

<b>2</b>	<b>QUALITY MANAGEMENT</b>	<b>30 hours</b>
2.1	Evaluation of Quality Attributes of Raw and Processed Foods	
2.2	Evaluation of Sensory Characteristics of Bakery Products	
2.3	Evaluation of Sensory Characteristics of Thermally Processed Foods	
2.4	Detection of Adulterants in Foods	
2.5	Detection of Heavy Metals, Insecticides & Pesticides in Foods	
2.6	Determination of Nutrient Levels in Foods and Comparisons to Standards	
2.7	Determination of Hygiene of a Food Service Organization	
2.8	Preparation of a HACCP chart for a Food Industry	

<b>PEDAGOGY</b>	Experiments in the Laboratory
<b>REFERENCE BOOKS</b>	Mahindru SN. 2010. <i>Encyclopaedia of Food Analysis</i> .
	Vaclavik VA, Devine MM, and Pimentel MH. 2010. <i>Dimensions of Food</i> . Seventh Edition. CRC Press.
	Weaver CM and Daniel JR. 2003. <i>The Food Chemistry Laboratory: A Manual for Experimental Foods, Dietetics, and Food Scientists</i> . Second Edition. CRC Press.
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>Understand the scientific principles underlying production of various food products like bakery, extruded, fermented, thermally processed, emulsified, and frozen foods</li> <li>Analyse and compare the quality attributes of different food products</li> </ol>



	<ol style="list-style-type: none"> <li>3. Possess knowledge to detect presence of adulterants, heavy metals, insecticides, and pesticides in food samples</li> <li>4. Determine the nutrient levels in foods and compare it to standards</li> <li>5. Construct and deduce the hygiene analysis report of a food service organization</li> <li>6. Develop a HACCP chart for a particular component of the food industry</li> </ol>
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## DISCIPLINE SPECIFIC ELECTIVE COURSES (4 CREDITS)

<b>COURSE CODE</b>	FTC-507
<b>COURSE TITLE</b>	INDUSTRIAL FOOD WASTE MANAGEMENT
<b>NUMBER OF CREDITS</b>	2

<b>PRE-REQUISITES</b>	The student should have basic knowledge of biotechnology and microbiology
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To acquaint students with the application of biotechnology in food processing, nutrition, fermentation, and waste utilisation</li> <li>2. To familiarize students with waste generated from food industries and methods of by-product utilization</li> </ol>

<b>CONTENT</b>		
<b>1</b>	<b>INDUSTRIAL FOOD WASTE GENERATION</b>	<b>12 hours</b>
1.1	Grains, Legumes and Oilseeds	
1.2	Fruits and Vegetables	
1.3	Sugar Factories and Bakery Industries	
1.4	Breweries and Distilleries	
1.5	Dairy Industry	
1.6	Flesh Food Processing Units - <i>Meat, Poultry and Seafood</i>	

<b>2</b>	<b>FOOD WASTE EFFLUENTS</b>	<b>6 hours</b>
2.1	Characterization of food industry effluents, Environmental Consequences, Existing Disposal Methods	
2.2	Physical and chemical parameters, Oxygen demands and their interrelationships	
2.3	Waste Components and their Toxicity - <i>Residues (solids), Fats, Oils and grease, Forms of Nitrogen, Sulphur and Phosphorus, anions and cations, surfactants</i>	
2.4	Integration of New and Renewable Energy Sources for Waste Utilization	

<b>3</b>	<b>FOOD WASTE TREATMENT METHODS</b>	<b>12 hours</b>
3.1	Treatment methods for liquid waste from food industry - <i>Design and working of Activated Sludge Process, Bioremediation, Trickling Filter, Microbial Fuel Cells</i>	
3.2	Waste Water Management – <i>Quality, Treatment, Recycle, Reuse, BOD, COD, Role of Macrophytes and Microphytes</i>	
3.3	Treatment by Biological Methods - <i>SCP, Biogas, Plant-derived Fuels, Landfill Gas, Biomethanation and Biocomposting Technology for Organic Waste</i>	
3.4	Incineration, Combustion and other methods of solid waste management	
3.5	Advanced wastewater treatment systems - <i>Physical separations, Micro-strainers, Filters, Ultra filtration and reverse osmosis</i>	
3.6	Physicochemical separations - <i>Activated Carbon Adsorption, Ion Exchange Electro-Dialysis and Magnetic Separation; Chemical Oxidation and Treatment - Coagulation and Flocculation; Handling of sludge</i>	

<b>PEDAGOGY</b>	Lectures/ Assignments/ Seminars
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<b>REFERENCE BOOKS</b>	Oreopoulou V and Russ W. 2007. <i>Utilization of By-Products and Treatment of Waste in the Food Industry</i> . Springer.
	Arvanitoyannis I. 2007. <i>Waste Management for the Food Industries</i> . First Edition. Academic Press.
	Green J.H. Food Processing Waste Management, AVI Publications, Westport
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Outline and evaluate waste generated by different food industries and processing units</li> <li>2. Characterize waste and explain parameters of food waste effluents</li> <li>3. Understand environmental consequences and toxicity of waste components</li> <li>4. Recognise new and renewable energy sources for waste utilization</li> <li>5. Discuss and debate conventional and advanced waste management techniques and treatments methods</li> <li>6. Compare the methods and techniques employed in liquid and solid waste management and treatment</li> </ol>

<b>COURSE CODE</b>	FTC-508
<b>COURSE TITLE</b>	LAB IN INDUSTRIAL FOOD WASTE MANAGEMENT
<b>NUMBER OF CREDITS</b>	2

<b>PRE-REQUISITES</b>	The student should have theoretical knowledge of food processing
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To enable experimentation and observation of the outcomes of environmental waste detection techniques</li> <li>2. To provide students a practical understanding of industrial food waste management processes</li> </ol>

<b>CONTENT</b>		
<b>1</b>	<b>INDUSTRIAL WASTE WATER ANALYSIS</b>	<b>30 hours</b>
1.1	Determination of Biological Oxygen Demand (BOD) of Wastewater	
1.2	Determination of Chemical Oxygen Demand (COD) of Wastewater	
1.3	Determination of Alkalinity of Wastewater	
1.4	Determination of Dissolved Oxygen from Waste	
1.5	Qualitative and Quantitative Determination of Faecal Contamination of Water	
1.6	Determination of Statistical Process Control (SPC) of different Wastes	
1.7	Determination of TS, TSS and TDS in Water Samples	
1.8	Assessment of Bioremediation/Biodegradation Potential of Isolated Soil or Wastewater Microbes	

<b>2</b>	<b>INDUSTRIAL FOOD WASTE MANAGEMENT</b>	<b>30 hours</b>
2.1	Production of Cellulose from Crop Residue	
2.2	Extraction of banana pseudostem fibre for Juice Production	
2.3	Manufacture of Oil from Food Waste (fruit and vegetable peels, flesh food waste)	
2.4	Production of Pectin from Food Waste	
2.5	Production of Biogas from Organic Waste	
2.6	Production of Chitin from Food Waste	
2.7	Extraction of Gelatine from Food Waste	
2.8	Microbial Degradation of Waste (preparation of lab-scale compost)	

<b>PEDAGOGY</b>	Experiments in the Laboratory
<b>REFERENCES</b>	As suggested in FTC-507
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Evaluate physical, chemical and biological characteristics of waste water</li> <li>2. Analyse and evaluate waste water using different determination techniques</li> <li>3. Determine presence of faecal contaminants in water samples</li> <li>4. Demonstrate bioremediation potential of microbes in soil/water</li> <li>5. Identify and evaluate methods to obtain by-products from food waste</li> <li>6. Determine different methods to compost food waste at lab scale</li> </ol>

<b>PRE-REQUISITES</b>	The student should have knowledge of types of foods, chemistry, and microbiology
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To acquaint students with the additives relevant to the processed food industry for shelf-life extension, processing support, and sensory appeal</li> <li>2. To familiarize students with microbial, chemical and natural toxicants and allergens indigenously present and developed during food processing</li> <li>3. To orient students with the regulations and the monitoring agencies involved in controlling the safer use of additives in foods</li> </ol>

<b>CONTENT</b>		
<b>1</b>	<b>INTRODUCTION TO FOOD ADDITIVES</b>	<b>5 hours</b>
1.1	Definition, Classification, and Functions of Food Additives	
1.2	Intentional and Unintentional Food Additives – <i>effects on human health</i>	
1.3	Safety Tests for Food Additives	
1.4	Laws and Regulations – <i>JECFA, Codex Alimentarius; Toxicological Evaluation of Food Additives</i>	

<b>2</b>	<b>CATEGORIES OF FOOD ADDITIVES</b>	<b>10 hours</b>
2.1	Nutritional Additives – <i>types, functions and industrial applications</i>	
2.2	Processing Agents – <i>anti-caking, bleaching, chelating, clarifying, emulsifying, leavening agents, stabilizers and thickeners, etc.; types, functions, and industrial applications</i>	
2.3	Preservatives – <i>definition; natural and chemical preservatives; acidulants and low pH organic acids and esters; sulphur dioxide and its salts; nitrites; antibiotics; surface preservation</i>	
2.4	Antioxidants – <i>natural and chemical antioxidants; primary and secondary antioxidants; mechanism of antioxidant function; sequestrants; selection and application of antioxidants in foods; evaluation of antioxidant effectiveness</i>	
2.5	Anti-Microbial Agents	
2.6	Sensory Agents – <i>colourants, sweeteners, and flavourings – functions, types, and industrial applications</i>	

<b>3</b>	<b>FOOD ADULTERATION</b>	<b>5 hours</b>
3.1	Definition and Types – <i>poisonous substances, foreign matter, cheap substitutes, spoiled components; impact on human health</i>	
3.2	Commonly Adulterated Foods and their Methods of Detection	
3.3	Advanced Adulteration Detection Methods - <i>Toxicological Evaluation of Food Adulterants</i>	
3.4	Laws and Regulations – <i>Food Safety and Standards Act 2006</i>	

<b>4</b>	<b>TOXICOLOGY</b>	<b>10 hours</b>
4.1	Definition and Classification of Food Toxicants	
4.2	Principles of Toxicology – <i>processing and accumulation of toxins in the human body; elimination and detoxification mechanisms; toxicokinetics and toxicodynamics</i>	
4.3	Toxicants derived from Plants, Animals, Marine, Algal, and Microbial Sources	

4.4	Toxicants derived from Food Processing and Packaging	
4.5	Factors affecting Toxicity of Compounds; Introduction to LD <sub>50</sub> , NOAEL, LOAEL	
4.6	Manifestation of Toxic Effects - <i>food poisoning and food-borne infections and disease</i>	
4.7	Methods used in Safety Evaluation	

<b>PEDAGOGY</b>	Lectures/ Assignments/ Seminars
<b>REFERENCE BOOKS</b>	Brannen AL, Davidson PM and Salminen S. 2001. <i>Food Additives</i> . Second Edition. Marcel Dekker.
	Concon JM. 1988. <i>Food Toxicology - Principles &amp; Concepts</i> . Marcel Dekker.
	George AB. 1996. <i>Encyclopaedia of Food and Color Additives. Vol. III</i> . CRC Press.
	Hathcock JN. (Ed.). 1982. <i>Nutritional Toxicology. Vol. I</i> . Academic Press.
	Madhavi DL, Deshpande SS and Salunkhe DK. 1996. <i>Food Antioxidants: Technological, Toxicological and Health Perspective</i> . Marcel Dekker.
	Nakai S and Modler HW. 2000. <i>Food Proteins and Processing Applications</i> . Wiley VCH.
	Rehcegl M Jr. 1983. (Ed.). <i>Handbook of Naturally Occurring Food Toxicants</i> . CRC Press.
	Shabbir S. 2007. <i>Food Borne Diseases</i> . Humana Press.
	Stephen AM. (Ed.). 2006. <i>Food Polysaccharides and Their Applications</i> . Marcel Dekker.
	Steven T. 1989. <i>Food Toxicology: A Perspective on Relative Risks</i> .
	Tweedy BG. 1991. <i>Pesticide Residues and Food Safety</i> . Royal Society of Chemistry.
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Understand the laws and regulations that dictate usage of additives within approved limits</li> <li>2. Recognize the role of JECFA in safety evaluation of food additives</li> <li>3. Critique the use of additives and their concentration in commercial food products</li> <li>4. Identify commonly adulterated foods and the mode of detecting the adulterant</li> <li>5. Outline the factors influencing toxicity of a compounds; measure levels of compounds that exhibit a toxic effect</li> <li>6. Hypothesise routes of contamination of food products in the food processing industry as function of hazard analysis</li> </ol>

<b>COURSE CODE</b>	FTC-510
<b>COURSE TITLE</b>	LAB IN FOOD ADDITIVES, ADULTERATION, AND TOXICOLOGY
<b>NUMBER OF CREDITS</b>	2

<b>PRE-REQUISITES</b>	The student should have knowledge of types of foods, chemistry, and microbiology
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To familiarize students with isolation of various biopolymers from food resources</li> <li>2. To acquaint students with the practical aspects of toxin-free foods</li> </ol>

<b>CONTENT</b>		
<b>1</b>	<b>ANALYSIS OF FOOD ADDITIVES AND ADULTERANTS</b>	<b>30 hours</b>
1.1	Qualitative and Quantitative Analysis of Chemical Preservatives in Food	
1.2	Estimation of Water-soluble and Oil-soluble Colours in Foods	
1.3	Isolation of Native and Modified Proteins from Foods	
1.4	Survey of Additives used in Popular Commercial Food Products	
1.5	Measurement of Used Oil Rancidity Indices	
1.6	Detection of Pesticide Residues in Food	
1.7	Detection of Antibiotic Residues/ Hormones/ Veterinary Drugs, and Heavy Metals in Foods	
1.8	Qualitative Analysis of Adulterants in Food Samples	

<b>2</b>	<b>TOXICOLOGICAL ANALYSIS</b>	<b>30 hours</b>
2.1	Analysis of Antibiotic Sensitivity Pattern and MIC for Different Food Pathogens	
2.2	Analysis of Microbial and Plant Toxins	
2.3	Determination of LD <sub>50</sub> Value of Common Toxic Chemicals	
2.4	Detection of Chemical Toxicity using Bacterial Indicator Organisms	
2.5	Exploration of the Data in Codex General Standard for Food Additives (GSFA) Online Database	
2.6	Exploration of the resources available in <i>EFSA OpenFoodTox</i> and <i>USFDA NCTR</i>	
2.7	Mock Risk Assessment and Risk Characterization	

<b>PEDAGOGY</b>	Experiments in the Laboratory
<b>REFERENCE BOOKS</b>	Botsford, J.L. (2000) A simple, inexpensive, and rapid method to determine toxicity using a bacterial indicator organism. Proceedings of the 2000 Conference on Hazardous Waste Research, 25-35.
	Chemical hazards database (Openfoodtox)   efsa. (n.d.). Retrieved from <a href="https://www.efsa.europa.eu/en/data-report/chemical-hazards-database-openfoodtox">https://www.efsa.europa.eu/en/data-report/chemical-hazards-database-openfoodtox</a>
	GSFA online home page. (n.d.). Retrieved, from <a href="https://www.fao.org/gsfonline/index.html?lang=en">https://www.fao.org/gsfonline/index.html?lang=en</a>
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Monitor common food additives used in commercial products through market surveys</li> <li>2. Detect presence of intentional and unintentional adulterants in food products</li> </ol>

	<ol style="list-style-type: none"> <li>3. Understand the principles of techniques implemented in detection of organic contaminants and heavy metals in food</li> <li>4. Analyse sensitivity of food pathogens to various food additives</li> <li>5. Explore resources in global databases such as GFSA, NCTR, EFSA OpenFoodTox</li> <li>6. Develop a risk assessment plan, and provide suitable recommendations for minimization of hazards</li> </ol>
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**SEMESTER II****DISCIPLINE SPECIFIC COMPULSORY COURSES (16 credits)**

<b>COURSE CODE</b>	FTC-511
<b>COURSE TITLE</b>	FOOD BIOTECHNOLOGY
<b>NUMBER OF CREDITS</b>	3

<b>PRE-REQUISITES</b>	The student should have basic knowledge of biotechnology and microbiology
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To acquaint students with the application of biotechnology in food processing, nutrition, fermentation, and waste utilisation</li> <li>2. To familiarize students with waste generated from food industries and methods of by-product utilization</li> </ol>

<b>CONTENT</b>		
<b>1</b>	<b>FUNDAMENTALS OF BIOTECHNOLOGY</b>	<b>10 hours</b>
1.1	Definition, Scope, and Application of Biotechnology - <i>application in food industries, pharmaceuticals, agriculture, and waste utilisation</i>	
1.2	Fundamentals of Molecular Biology: <i>Chemistry and Biology of DNA; Types of DNA; DNA Mutations and the Role of Mutagenic Agents, Bacterial DNA replication, Bacterial transcription, Bacterial Translation, Regulation of Gene Expression in Prokaryotes</i>	
1.3	Recombinant DNA Technology: <i>DNA modifying enzymes, cloning vectors, steps involved in gene cloning</i>	
1.4	Genetic recombination mechanisms: <i>transformation, transduction, conjugation, improvement of microbial strains</i>	
1.5	Micromanipulation, Cell and Tissue Culture	
<b>2</b>	<b>GENETIC MODIFICATIONS</b>	<b>5 hours</b>
2.1	Genetically Modified Organisms (GMOs) in Industrial Fermentation Processes and Techniques for improvement in Microbial Strains	
2.2	Improvement of Crops by Genetic Engineering - <i>insect resistant and herbicide tolerant crops</i>	
2.3	Genetically Modified Plants - <i>Golden rice, Flavr savr tomato</i>	
2.4	Application of Transgenic Animals in Food and Agriculture	
2.5	Pros and Cons of Genetically Modified Foods	
<b>3</b>	<b>BIOPROCESS TECHNOLOGY</b>	<b>10 hours</b>
3.1	Principal Components of Fermentation Technology, Growth Kinetics ( <i>batch, fed-batch, continuous</i> )	
3.2	Principles of Upstream Processing, Bioprocess Measurement and Control System - <i>Computer Aided Process Control</i>	
3.3	Introduction to Downstream Processing	
3.4	Techniques Involved in Product Recovery and Purification – <i>foam separation, precipitation, filtration, centrifugation, cell disruption, liquid-liquid extraction, chromatography, membrane processes, drying, crystallization, whole broth processing.</i>	
3.5	Immobilization Biosensors – <i>types and application in the food industry</i>	

<b>4</b>	<b>INDUSTRIAL BIOTECHNOLOGY</b>	<b>10 hours</b>
4.1	Therapeutic Proteins produced by Biotechnological Processes	
4.2	Industrial Production of Enzymes ( <i>Amylases, Proteases, Lipases</i> ) and Chemicals ( <i>Alcohols, Acids and Solvents</i> )	
4.3	Use of Microorganisms in Mineral Beneficiation and Recovery; Biomass Production using Microorganisms	
4.4	Role of Plants for Production of Nutraceuticals and Bioremediation	
4.5	Manufacture of Beer, Wine, Vinegar, Cheese, and Mould-Modified Foods	
4.6	Food Ingredients: <i>xanthan gum, fat substitutes, bio-colours, organic acids and sweeteners</i>	

<b>5</b>	<b>BIOINFORMATICS &amp; BIOTECHNOLOGY FOR FOOD SECURITY</b>	<b>10 hours</b>
5.1	Bioinformatics – <i>History, Scope and Importance; Application in Food Technology; Sequence Information Sources (EMBL, GENBANK, Entrez, PDB, SWISSPROT), Pairwise Alignments, Introduction to BLAST, Multiple Sequence Alignment, Phylogenetic Analysis, Sequence Similarity Searches (BLAST, FASTA, Data Submission)</i>	
5.2	Regulatory and Social aspects of Food Biotechnology - <i>ethical issues and guidelines concerning Genetically Modified foods</i>	
5.3	Trade Related Aspects of Biotech Foods, Intellectual Property Rights (IPR) and Biopiracy	
5.4	Biotech Foods for Developing and Developed Countries	

<b>PEDAGOGY</b>	Lectures/ Assignments/ Seminars
<b>REFERENCE BOOKS</b>	Anal AK. 2017. <i>Food Processing By-Products and their Utilization (IFST Advances in Food Science)</i> . Wiley Blackwell.
	Crueger W and Crueger A. 2000. <i>Biotechnology: A textbook of Industrial Microbiology</i> . 2 <sup>nd</sup> edition. Panima Publishing Co. New Delhi.
	Doyle A and Griffiths JB. 1998. <i>Cell and Tissue Culture: Laboratory Procedures in Biotechnology</i> . John Wiley and Sons, UK.
	El-Mansi EMT, Bryce CFA, Demain AL, and Allman AR. 2012. <i>Fermentation Microbiology and Biotechnology</i> . Third Edition. CRC Press.
	Joshi VK and Singh RS. 2013. <i>Food Biotechnology: Principles and Practices</i> . I.K. International Publishing House Pvt. Ltd.
	Stanbury PF, Whitaker A and Hall SJ. 2006. <i>Principles of Fermentation Technology</i> . 2 <sup>nd</sup> edition, Elsevier Science Ltd.
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Acquire in-depth knowledge of fundamental components of biotechnology</li> <li>2. Construct a cause-effect model based on core concepts of molecular biology</li> <li>3. Explore various techniques involved in bioprocess technology, upstream and downstream processing</li> <li>4. Understand industrial biotechnological processes in production of various products</li> <li>5. Distinguish between various bioinformatic tools and their applications in biotechnology</li> <li>6. Outline ethical issues and guidelines concerning GMOs, biopiracy and trade of biotechnologically developed/ enhanced foods</li> </ol>

<b>COURSE CODE</b>	FTC-512
<b>COURSE TITLE</b>	LAB IN FOOD BIOTECHNOLOGY
<b>NUMBER OF CREDITS</b>	2

<b>PRE-REQUISITES</b>	The student should have theoretical knowledge of food science
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To enable students to experiment with and observe the outcomes of biotechnological techniques propagated in food industries</li> <li>2. To provide students a practical understanding of industrial food waste management processes</li> </ol>

<b>CONTENT</b>		
1.	Assessment of Bacterial Growth Kinetics by Batch and Fed-Batch Fermentation	<b>60 hours</b>
2.	Production and Estimation of Amylase	
3.	Mushroom Production	
4.	Micropropagation through Tissue Culture	
5.	Strain Improvement through UV Mutation for Lactose Utilization	
6.	Separation of Protoplast using Lytic Enzymes	
7.	Isolation of Bacterial Genomic DNA and Analysis by Agarose Gel Electrophoresis	
8.	Isolation of Plasmid DNA and Analysis by Agarose Gel Electrophoresis	
9.	Pesticide Degradation (DDT) by <i>Pseudomonas</i> Sp.	
10.	Exploring Bioinformatic Web Tools and Resources: EMBL, Genbank, Entrez, BLAST	

<b>PEDAGOGY</b>	Experiments in the Laboratory
<b>REFERENCES</b>	As suggested in FTC-511
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Discuss basics of fermentation and processing of bioproducts</li> <li>2. Design and execute experiments for isolation of DNA from microbial sources</li> <li>3. Hypothesise mechanisms underlying the experiments suggested in the syllabus</li> <li>4. Apply principles of biotechnology in food production</li> <li>5. Explore and utilise Bioinformatic web tools such as BLAST, etc.</li> <li>6. Establish correlation between experiment observations and theoretical principles</li> </ol>

<b>COURSE CODE</b>	FTC-513
<b>COURSE TITLE</b>	NORMAL AND CLINICAL NUTRITION
<b>NUMBER OF CREDITS</b>	3

<b>PRE-REQUISITES</b>	The student should have knowledge of human physiology
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>To acquaint students with the nutritional requirements at various stages of human growth and development.</li> <li>To familiarize students with dietary modifications necessitated by disease and disorder.</li> </ol>

<b>CONTENT</b>		
<b>1</b>	<b>DIET THERAPY</b>	<b>5 hours</b>
1.1	Definition and Principles; Scope of Dietetics; Responsibilities of a Dietitian	
1.2	Progression of Hospital Diets	
1.3	Enteral and Parenteral Nutrition	

<b>2</b>	<b>NUTRITION THROUGH THE YEARS</b>	<b>10 hours</b>
2.1	Nutrient Requirements of Infants, Pre-Schoolers, School Children, Adolescents, Adults, and the Elderly – <i>dietary issues and special formulations</i>	
2.2	Dietary Recommendations during Pregnancy and Lactation	
2.3	Nutritional Care of the Low Birth Weight and Pre-term Infant & Children with Special Needs	

<b>3</b>	<b>DIET THERAPY FOR CLINICAL CONDITIONS</b>	<b>20 hours</b>
3.1	Overweight, Obesity, and Underweight	
3.2	Hormonal Disorders (PCOD and Thyroid Disorders)	
3.3	Diabetes (IDDM, NIDDM, and Gestational Diabetes)	
3.4	Cardiovascular Disease (Hypertension and Atherosclerosis)	
3.5	Hepatic Disease (Hepatitis, Cirrhosis, Gall Bladder Disease)	
3.6	Renal Disorders (Glomerulonephritis, Nephrotic Syndrome, Urinary Calculi, ESRD)	
3.7	Gastrointestinal Disorders (Peptic Ulcers, Diarrhoea, Constipation, Irritable Bowel Syndrome, Inflammatory Bowel Disease)	
3.8	Cancer	
3.9	Osteoporosis	

<b>4</b>	<b>EMERGING NUTRITIONAL NEEDS</b>	<b>10 hours</b>
4.1	Allergies and Intolerances	
4.2	Sports Nutrition	
4.3	Nutrition at High Altitudes	
4.4	Nutrition in Space	
4.5	Ergogenic Aids	
4.6	Nutri-genomics	
4.7	Current Needs	
4.8	Drug-Nutrient Interactions	

<b>PEDAGOGY</b>	Lectures/ Assignments/ Seminars
<b>REFERENCE BOOKS</b>	Antia FP and Abraham P. 1998. <i>Clinical Dietetics and Nutrition</i> . Fourth Edition. OUP India.
	Joshi SA. 2017. <i>Nutrition and Dietetics</i> . Fourth Edition. McGraw Hill.
	Mahan LK and Escott-Stump S. 2003. <i>Krause's Food, Nutrition, and Diet Therapy</i> . Eleventh Edition. Saunders.
	McIntosh SN. 2013. <i>William's Basic Nutrition and Diet Therapy</i> . Fourteenth Edition. Mosby.
	Robinson CH, Lawler MR, Chenoweth WL, and Garwick AE. 1990. <i>Normal and Therapeutic Nutrition</i> . Seventeenth Edition. MacMillan Publishing Company.
	Srilakshmi B. 2007. <i>Dietetics</i> . Seventh Edition. New Age International Publishers.
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Conceptual knowledge in the principles of human nutrition in relation to human physiology</li> <li>2. Obtain skills on different methods of estimating total energy expenditure and requirements</li> <li>3. Illustrate food groups, food exchange list, food pyramid and to identify the foundations of a balanced diet</li> <li>4. Comprehend and apply the concepts of nutrition to evaluate, address and improve the disease conditions of individuals</li> <li>5. Learn the different aspects of nutritional problem and its treatment</li> <li>6. Ascertain nutritional needs in balanced menus for individuals across various age groups, and for different income levels</li> </ol>

<b>COURSE CODE</b>	FTC-514
<b>COURSE TITLE</b>	LAB IN NORMAL AND CLINICAL NUTRITION
<b>NUMBER OF CREDITS</b>	2

<b>PRE-REQUISITES</b>	The student should have knowledge about food and human disease
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To make students competent in planning diets for different age groups and physiological conditions</li> <li>2. To acquaint students with the link between therapeutic diets and food technology</li> </ol>

<b>CONTENT</b>		
<b>1</b>	<b>DIET PLANNING REQUISITES</b>	<b>10 hours</b>
1.1	Food Exchange List	
1.2	Recommended Dietary Allowances & Estimated Average Requirements	
1.3	Steps in Diet Planning	

<b>2</b>	<b>DIET PLANS</b>	<b>40 hours</b>
2.1	Pre-Schoolers, School Children with Packed Meals, Adolescents, Pregnant and Lactating Women, Geriatric Adults	
2.2	Individuals with Weight Issues – <i>Obese and Underweight</i>	
2.3	Diabetes Mellitus	
2.4	Hypertension and Coronary Heart Disease	
2.5	Gastrointestinal Disturbances – <i>Lactose and Gluten Intolerance, Constipation, Diarrhoea, Irritable Bowel Syndrome, Peptic Ulcers</i>	
2.6	Liver Disorders – <i>Hepatitis and Cirrhosis</i>	
2.7	Renal Disorders – <i>Glomerulonephritis and Urinary Calculi</i>	
2.8	Sports persons	
2.9	Space Travel (Astronauts)	

<b>3</b>	<b>ROLE OF FOOD TECHNOLOGY IN THERAPEUTIC NUTRITION</b>	<b>10 hours</b>
3.1	Industrial food formulations for the above clinical conditions	

<b>PEDAGOGY</b>	Planning Diets and Experiments in the Laboratory
<b>REFERENCES</b>	As suggested in FTC-513
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Conduct relevant investigations on medical conditions and propose appropriate diet charts</li> <li>2. Sharpen skills on estimating total energy expenditure and requirements</li> <li>3. Calculate and interpret nutrient composition of foods; Apprehend the factors affecting meal planning</li> <li>4. Assess and propose dietetic treatment based on clinical, biochemical and pharmacological principles of nutrition and dietetics</li> </ol>

	<ol style="list-style-type: none"> <li>5. Exhibit skills in modifying normal diets and preparing appropriate therapeutic diets</li> <li>6. Formulate products to alleviate symptoms or prevent various medical conditions from expressing</li> </ol>
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<b>COURSE CODE</b>	FTC-515
<b>COURSE TITLE</b>	BAKERY, CONFECTIONERY, AND CONVENIENCE FOOD TECHNOLOGY
<b>NUMBER OF CREDITS</b>	3

<b>PRE-REQUISITES</b>	The student should be aware of types of processed foods
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To acquaint students with the principles of bakery and confectionery technology</li> <li>2. To familiarize students with processing techniques, quality parameters, and nutritional comparisons of baked products</li> </ol>

<b>CONTENT</b>		
<b>1</b>	<b>BAKERY TECHNOLOGY</b>	<b>15 hours</b>
1.1	Principles of Baking	
1.2	Raw Material and their Role – <i>flour, leavening agents, sweeteners, fats, additives, spice</i>	
1.3	Types of Bakery Products and Technology for their Manufacture – <i>dough and batters; cakes, pies, pastries, bread, biscuits</i>	
1.4	Icings and Fillings	
1.5	Quality Parameters of Bakery Products - <i>chemistry of dough and batters; rheological testing and interpretation of data; sensory evaluation</i>	
1.6	Staling and Nutrient Losses in Bakery Products	
1.7	Sanitation and Hygiene in a Bakery Unit	
1.8	Equipment used in the Bakery Industry	

<b>2</b>	<b>CONFECTIONERY TECHNOLOGY</b>	<b>15 hours</b>
2.1	Principles of Confectionery Manufacture	
2.2	Raw Material & their Role including Interfering Agents and Inversion of Sugars	
2.3	Types of Confectionery Products and Technology for their Manufacture	
2.4	Quality Parameters of Confectionery Products	
2.5	Nutrient and other Losses in Confectionery Products	
2.6	Sanitation and Hygiene in a Confectionery Unit	
2.7	Equipment used in the Confectionery Industry	
2.8	Manufacture of Indian Confectioneries	

<b>3</b>	<b>CONVENIENCE FOOD TECHNOLOGY</b>	<b>15 hours</b>
3.1	Sugar – <i>raw material, types, and manufacture</i>	
3.2	Chocolate – <i>raw material, types, and manufacture</i>	
3.3	Chewing Gum - <i>raw material, types, and manufacture</i>	
3.4	Lozenges - <i>raw material, types, and manufacture</i>	
3.5	Pan Coating – <i>hard and soft panning; problems in coating; glazing, polishing, and tableting</i>	
3.6	Nutritional Value	
3.7	Quality Parameters	



<b>PEDAGOGY</b>	Lectures/ Assignments/ Seminars
<b>REFERENCE BOOKS</b>	Dubey SC. 2002. <i>Basic Baking</i> . The Society of Indian Bakers, New Delhi.
	Francis FJ. 2000. <i>Wiley Encyclopedia of Food Science &amp; Technology</i> . John Wiley & Sons.
	Manley D. 2000. <i>Technology of Biscuits, Crackers &amp; Cookies</i> . Second Edition. CRC Press.
	Pyler EJ. <i>Bakery Science &amp; Technology</i> . Third Edition. Vols. I, II. Sosland Publ.
	Qarooni J. 1996. <i>Flat Bread Technology</i> . Chapman & Hall.
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Distinguish between bakery, confectionary and convenience foods</li> <li>2. Summarise the role of ingredients, and equipment in the manufacture of bakery and confectionary products</li> <li>3. Predict nutrient loss in bakery products; prioritize sanitation in industry</li> <li>4. Illustrate the raw material, types, manufacturing of various convenience foods</li> <li>5. Recall the quality parameters and nutritional value of convenience foods</li> <li>6. Devise protocols for maintenance of hygiene; create HACCP charts</li> </ol>

<b>COURSE CODE</b>	FTC-516
<b>COURSE TITLE</b>	LAB IN BAKERY, CONFECTIONERY, AND CONVENIENCE FOOD TECHNOLOGY
<b>NUMBER OF CREDITS</b>	1

<b>PRE-REQUISITES</b>	The student should be able to handle various types of food material
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To acquaint students with techniques involved in advanced baking and confectionery</li> <li>2. To familiarize students with quality analysis procedures of baked products</li> </ol>

<b>CONTENT</b>		
1.	Tests for the Rheological Properties of Dough	<b>30 hours</b>
2.	Preparation of Advanced Bakery Products – <i>sourdoughs, pastries, croissants, doughnuts</i>	
3.	Preparation of Filled and Iced Cakes	
4.	Preparation of Chocolate	
5.	Preparation of Coated Confectionery	
6.	Quality Evaluation of the Bakery Products, Filled and Iced Cakes, Chocolate, and Coated Confectionery	
7.	Determination of Nutritional Value of Bakery and Confectionery Products	
8.	HACCP considerations for Industrial Production of the above products	
9.	Overview of equipment/ instruments used in the bakery/ confectionary/ convenience food industry	

<b>PEDAGOGY</b>	Experiments in the Laboratory
<b>REFERENCES</b>	As suggested in FTC-515
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Analyse the rheological properties of dough</li> <li>2. Measure and relate different rheological parameters used in dough analysis</li> <li>3. Formulate various bakery and confectionery products</li> <li>4. Distinguish between fresh and stale products</li> <li>5. Evaluate quality of developed bakery and confectionery products</li> <li>6. Determine the nutritional value of bakery and confectionery products</li> </ol>

<b>COURSE CODE</b>	FTC-517
<b>COURSE TITLE</b>	FOOD ENGINEERING
<b>NUMBER OF CREDITS</b>	2

<b>PRE-REQUISITES</b>	The student should have an understanding of the physical characteristics of food
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To acquaint students with the principles and processes of food engineering</li> <li>2. To familiarize students with basic operations and calculations of importance in the food industry</li> </ol>

<b>CONTENT</b>		
<b>1</b>	<b>THERMODYNAMICS AND HEAT TRANSFER</b>	<b>7 hours</b>
1.1	Principles; Thermal Properties of Foods; Mass Transfer	
1.2	Modes of Heat Transfer – <i>in solids and liquids; radiative heat transfer</i>	
1.3	Steady and Unsteady State Heat Transfer, Enthalpy Balance in Heat Exchange Equipment	
1.4	Microwave Heating	
1.5	Fourier's Law; Stefan Boltzmann Law	
1.6	Application of the above Principles to Machinery utilised in the Food Industry	

<b>2</b>	<b>RHEOLOGY OF FOODS</b>	<b>8 hours</b>
2.1	Properties and Classification of Fluids	
2.2	Newton's Law of Viscosity, Newtonian and Non-Newtonian Fluids	
2.3	Basic Equations of Fluid Flow, Hagen Poiseuille Equation	
2.4	Bernoulli's Equation	
2.5	Flow-Measuring Devices and Flow Rate Calculations	
2.6	Handling of Fluids, Pipe Fittings and Valves, Pumps – <i>Classification, Centrifugal and Positive Displacement Type, Peristaltic</i>	
2.7	Application of the above Principles to Machinery utilised in the Food Industry	

<b>3</b>	<b>REFRIGERATION AND FREEZING</b>	<b>8 hours</b>
3.1	Parts and Functions of a Refrigerator	
3.2	Refrigeration Cycle	
3.3	Refrigerants	
3.4	Concept of Refrigerator Load ( <i>tons, kilowatts, CFM, and related terminology</i> )	
3.5	Freezing, VCRS, Freezing Time, Freeze Drying	
3.6	Cryogenic Freezing and Individual Quick Freezing	

<b>4</b>	<b>MECHANICAL OPERATIONS IN FOOD PROCESSING</b>	<b>7 hours</b>
4.1	Size Reduction and Related Laws	
4.2	Energy and Power Requirement and Consumption	
4.3	Screening, Types of Screens, Filtration, Principle of Constant Pressure and Constant Rate Filtration, Settling Classifiers, Floatation, Centrifugal Separation	

<b>PEDAGOGY</b>	Lectures/ Assignments/ Seminars/ Numerical
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<b>REFERENCE BOOKS</b>	Rao DG. 2009. <i>Fundamentals of Food Engineering</i> . PHI.
	Sharma K, Mulvaney SJ, and Rizvi SSH. 2012. <i>Food Process Engineering: Theory and Laboratory Experiments</i> . Wiley-India.
	Singh RP and Heldman DR. 2013. <i>Introduction to Food Engineering</i> . Fifth Edition. AP.
	Badger, W.L., Banchero, J.T., Introduction to Chemical Engineering, MGH
	Foust, A.S., Wenzel, L.A., et.al. Principles of Unit Operations, 2nd edition, JWS
	Toledo RT. 2000. <i>Fundamentals of Food Process Engineering</i> . Second Edition.
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Recall the principles of thermodynamics and heat transfer</li> <li>2. Illustrate the concept of steady and unsteady state heat transfer in heat exchange equipment</li> <li>3. Classify fluids and summarize their physicochemical properties</li> <li>4. Explain fluid flow behaviour, discuss various theorems; apply formulae to different flow measuring devices</li> <li>5. Understand the concepts of refrigeration load, freezing time; select appropriate freezers for commercial set-ups</li> <li>6. Suggest appropriate equipment for obtaining a desired outcome</li> </ol>

## Discipline Specific Elective Courses (4 credits)

<b>COURSE CODE</b>	FTC-518
<b>COURSE TITLE</b>	SPICE AND PLANTATION CROP TECHNOLOGY
<b>NUMBER OF CREDITS</b>	2

<b>PRE-REQUISITES</b>	The student should be aware of the common spices and the plantation crops in use
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To acquaint students with the types of plantation crops and their processing techniques</li> <li>2. To familiarize students with the processing of spices and condiments</li> </ol>

CONTENT		
<b>1</b>	<b>PLANTATION CROPS</b>	<b>10 hours</b>
1.1	Definition and Classification	
1.2	Coffee – <i>Chemical Constituents, Harvesting, Bean Processing, Types and Varieties, Manufacture, Quality and Grading, Chicory Chemistry and Use</i>	
1.3	Tea - <i>Chemical Constituents, Harvesting, Leaf Processing, Types and Varieties, Manufacture, Quality and Grading</i>	
1.4	Cocoa – <i>Production, Composition, Grading, Processing, Cocoa Products (cocoa mass, cocoa powder, cocoa butter, cocoa-based beverages, malted beverages, cocoa liquor)</i>	
1.5	Coconut – <i>Production, Composition, Grading, Post-Harvest Technology, Processing and Products (coconut milk, desiccated coconut)</i>	
1.6	Cashew (nut) – <i>Harvesting, Processing, and Products</i>	

<b>2</b>	<b>SPICE TECHNOLOGY</b>	<b>10 hours</b>
2.1	History of Spices	
2.2	Classification and Composition of Spices	
2.3	Fumigation and Irradiation of Spices	
2.4	Pepper, Cardamom, Red and Green Chilli, Cumin, Coriander, Cinnamon, Fenugreek, Nutmeg, Cloves, Turmeric - <i>Production, Chemistry, Constituents, Use in Food, and Functional Benefits</i>	
2.5	Post-Harvest Technology – <i>spice oils, spice powders, oleoresins, flavour components, concentrates</i>	
2.6	Plant Suspension Cultures	
2.7	Enzymatic Synthesis of Flavour Identicals	
2.8	Adulteration in Spices, Quality Standards and Specifications	

<b>3</b>	<b>CONDIMENTS, FLAVOURINGS, AND HERBS</b>	<b>10 hours</b>
3.1	History of Condiment Use in Foods	
3.2	Seasonings & Culinary Herbs ( <i>Vinegar, Salt, Celery, Garlic, Ginger, Onion, Mint, Thyme, Basil, Mustard, Cilantro, Dill, Oregano, Parsley, Rosemary, Sage, Fennel, Paprika, Bay Leaf, Vanilla, Monosodium Glutamate</i> ) - <i>Production, Chemistry, Constituents, Use in Food, and Functional Benefits</i>	
3.3	Post-Harvest Technology and Quality Standards	
3.4	Packaging of Spices and Condiments	

<b>PEDAGOGY</b>	Lectures/ Assignments/ Seminars
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<b>REFERENCE BOOKS</b>	Banerjee B. 2002. <i>Tea Production and Processing</i> . Oxford Univ. Press.
	Minifie BW. 1999. <i>Chocolate, Cocoa and Confectionery Technology</i> . Third Edition. Aspen Publ.
	NIIR. 2004. <i>Handbook on Spices</i> . National Institute of Industrial Research Board, Asia Pacific Business Press Inc.
	Sivetz M and Foote HE. 1963. <i>Coffee Processing Technology</i> . AVI Publ.
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Acquire knowledge of the chemical composition and value of various spices plantation crops and herbs</li> <li>2. Recall the methodology of spice harvesting, processing, product manufacturing and quality grading</li> <li>3. Discriminate between spices and crops of similar function and application; identify common adulteration tactics</li> <li>4. Devise protocols for sanitation and hygiene in post-harvest and manufacturing of spice and herb-based products</li> <li>5. Apply principles of biotechnology in development of enhanced enzyme preparations, flavour identical products, etc.</li> <li>6. Develop novel spice/ plantation-based products using theoretical knowledge</li> </ol>

<b>COURSE CODE</b>	FTC-519
<b>COURSE TITLE</b>	LAB IN SPICE AND PLANTATION CROP TECHNOLOGY
<b>NUMBER OF CREDITS</b>	2

<b>PRE-REQUISITES</b>	The student should be theoretically aware of the constituents of spices
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To acquaint students with quality analysis of spices and plantation crops</li> <li>2. To make students practically competent in rudimentary spice processing</li> </ol>

<b>CONTENT</b>		
1.	Market Survey of Plantation Crops and their Products	<b>60 hours</b>
2.	Market Survey of Spices, Condiments, Herbs, and their Products	
3.	Preparation of Spice Powders	
4.	Detection of Adulteration in Spices	
5.	Determination of Capsaicin Content of Chillies	
6.	Estimation of Curcumin in Turmeric	
7.	Preparation of Virgin Coconut Oil	
8.	Processing of Cashew Nut through Steam Roasting	
9.	Processing of Cashew Apple for Beverages	

<b>PEDAGOGY</b>	Experiments in the Laboratory
<b>REFERENCES</b>	As suggested in FTC-518
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Distinguish different classes of spices and plantation crop-based products through market survey</li> <li>2. Process and develop value-added products from various cash crops such as cashews and coconut</li> <li>3. Demonstrate application of theoretical knowledge in practice</li> <li>4. Identify and evaluate methods to isolate/ determine content of important valuable phytochemicals from spices</li> <li>5. Evaluate techniques to isolate/ determine presence of adulterants in commercially sold spices and herbs</li> <li>6. Formulate recipes/ design products to showcase the nutraceuticals potential of spices</li> </ol>

<b>COURSE CODE</b>	FTC-520
<b>COURSE TITLE</b>	NUTRACEUTICALS AND HEALTH FOODS
<b>NUMBER OF CREDITS</b>	2

<b>PRE-REQUISITES</b>	The student should have knowledge of food chemistry
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To familiarize students with the emerging trend of nutraceuticals with respect to the types, mechanisms of action, and manufacture of selected nutraceuticals</li> <li>2. To acquaint students with nutraceutical product development, clinical testing and toxicity aspects</li> </ol>

<b>CONTENT</b>		
<b>1</b>	<b>INTRODUCTION TO NUTRACEUTICALS</b>	<b>10 hours</b>
1.1	Definition and Basis of Claims – <i>nutraceuticals, health foods, functional foods</i>	
1.2	Regulatory Issues for Nutraceuticals and Health Foods including CODEX	
1.3	Foods as Nutraceuticals – <i>cereals, pulses, minor millets, vegetables, fruits, dairy, flesh foods, nuts, mushrooms, edible insects and ferns</i>	
1.4	Present and Future Prospects of Nutraceuticals – <i>Nutraceuticals as a bridge between foods and drugs</i>	

<b>2</b>	<b>MANUFACTURE OF NUTRACEUTICALS</b>	<b>10 hours</b>
2.1	Flora, Fauna, and Microbes as a Source for the Production of Nutraceuticals	
2.2	Production of Select Nutraceuticals such as Isoflavonoids, Prebiotics and Probiotics, Glucosamine, Phytosterols, Vitamins (carotenoids, tocopherols, folic acid, ascorbic acid), MUFA, PUFA, $\omega$ -3 Fatty Acids	
2.3	Formulation of Functional Foods containing Nutraceuticals – <i>stability and analytical issues, labelling issues</i>	
2.4	Nutrigenomics – <i>Golden Rice, Quality Protein Maize (QPM)</i>	
2.5	Clinical Testing of Nutraceuticals and Health Foods	

<b>3</b>	<b>CLINICAL ROLE OF NUTRACEUTICALS</b>	<b>10 hours</b>
3.1	Nutraceutical Use in Disease and Disorder (need for and mechanism of action) – <i>cardiovascular disease, cancer, diabetes, obesity, immunity, bone and joint issues, macular degeneration, gastrointestinal disturbances, hepatic and renal disorders, hormonal problems, behavioural disorders</i>	
3.2	Nutraceutical Use in Sports	
3.3	Dosage, Contraindications, and Toxicity of Nutraceuticals	
3.4	Interactions between Nutraceuticals and Prescription Drugs	

<b>PEDAGOGY</b>	Lectures/ Assignments/ Seminars
<b>REFERENCE BOOKS</b>	Brigelius-Flohé, J and Joost HG. 2006. <i>Nutritional Genomics: Impact on Health and Disease</i> . Wiley VCH.
	Cupp J and Tracy TS. 2003. <i>Dietary Supplements: Toxicology and Clinical Pharmacology</i> . Humana Press.
	Gibson GR and William CM. 2000. <i>Functional Foods - Concept to Product</i> .
	Goldberg I. 1994. <i>Functional Foods: Designer Foods, Pharma Foods</i> .



	Losso JN. 2007. <i>Angi-angiogenic Functional and Medicinal Foods</i> . CRC Press.
	Manson P. 2001. <i>Dietary Supplements</i> . Second Edition. Pharmaceutical Press.
	Campbell JE and Summers JL. 2004. <i>Dietary Supplement Labelling Compliance</i> .
	Neeser JR and German BJ. 2004. <i>Bioprocesses and Biotechnology for Nutraceuticals</i> . Chapman & Hall.
	Robert EC. 2006. <i>Handbook of Nutraceuticals and Functional Foods</i> . Second Edition. Wildman.
	Shi J. (Ed.). 2006. <i>Functional Food Ingredients and Nutraceuticals: Processing Technologies</i> . CRC Press.
	Webb GP. 2006. <i>Dietary Supplements and Functional Foods</i> . Blackwell Publ.
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Understand basic concept and regulatory requirements of nutraceuticals</li> <li>2. Recognise the importance and prospects of food as nutraceuticals</li> <li>3. Identify nutraceuticals in food and its role in disease management</li> <li>4. Illustrate importance of formulation and various aspects related to nutraceuticals</li> <li>5. Explain core concept involving development of functional foods, bioactive compounds and nutrigenomics</li> <li>6. Outline the importance of clinical testing, dosage and toxicity of nutraceuticals</li> </ol>

<b>COURSE CODE</b>	FTC-521
<b>COURSE TITLE</b>	LAB IN NUTRACEUTICALS AND HEALTH FOODS
<b>NUMBER OF CREDITS</b>	2

<b>PRE-REQUISITES</b>	The student should have knowledge of food chemistry
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To acquaint students with extraction procedures of nutrients and functional components from foods</li> <li>2. To develop food labelling knowledge and competency in students</li> </ol>

<b>CONTENT</b>		
1.	Market Survey and Classification of Health Foods and Nutraceuticals	<b>60 hours</b>
2.	Extraction and Estimation of proteins and fatty acids of various food samples	
3.	Estimation of amino acid content of various food samples	
4.	Extraction and Estimation of Vitamin C from Plant Sources	
5.	Extraction and Estimation of Folic Acid from Plant Sources	
6.	Extraction and Estimation of Carotenoids and Pigments from Plant Sources	
7.	Extraction and Estimation of Lycopene from Plant Sources	
8.	Extraction and Estimation of Asthaxanthene from Plant Sources	
9.	Extraction and Estimation of Curcumin content of Turmeric	
10.	Extraction and Estimation of Capsaicin content in Chillies	
11.	Extraction and Estimation of Allicin content in Garlic and Onion	
12.	Estimation of caffeine in different products	
13.	Development of Labels for Health Foods	
14.	Estimation of Phytochemicals in Plant sources	
15.	Extraction of Prebiotics from Plant Sources	
16.	Estimation of mineral content in different products	
17.	Isolation and culture of probiotics/Lactic acid bacteria (LAB) bacteria	
18.	Estimation of biological potential and claim of phytochemicals or nutraceuticals	

<b>PEDAGOGY</b>	Experiments in the Laboratory
<b>REFERENCES</b>	As suggested in FTC-520
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Outline different classes of health foods and nutraceuticals</li> <li>2. Conduct a market survey of different classes of health foods and nutraceuticals</li> <li>3. Illustrate importance of developing health food labels</li> <li>4. Identify and evaluate methods to isolate/ determine prebiotics in plant sources</li> <li>5. Evaluate techniques to isolate/ determine different naturally occurring phytochemicals.</li> <li>6. Understand/ evaluate potential of nutraceuticals</li> </ol>

**SEMESTER III**  
**GENERIC ELECTIVE COURSES (12 credits)**

<b>COURSE CODE</b>	FTC-601
<b>COURSE TITLE</b>	CEREAL, LEGUME, AND OILSEED PROCESSING TECHNOLOGY
<b>NUMBER OF CREDITS</b>	3

<b>PRE-REQUISITES</b>	The student should be aware of the major agricultural crops of India and their basic market uses
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To acquaint students with major agricultural crops of India and their processing techniques</li> <li>2. To familiarize students with nutritional value differences as a result of crop processing</li> </ol>

<b>CONTENT</b>		
<b>1</b>	<b>CEREALS AND CEREAL PRODUCTS</b>	<b>15 hours</b>
1.1	Structure, Composition, Nutritional Value, and Market Varieties of Cereals and Minor Millets such as Rice, Wheat, Maize, <i>Jowar, Bajra, Ragi</i> , Barley	
1.2	Farming, Consumption and Industrial Utilization Trends of Cereals in India and Internationally	
1.3	Post-Harvest Technology – <i>storage, transportation, handling, prevention of spoilage and post-harvest losses, fumigation, and related aspects</i>	
1.4	Processing Methods – <i>parboiling, germination, fermentation, malting</i>	
1.5	Milling – <i>classification and types</i>	
1.6	Products of Processing – <i>flours; semolina; breakfast cereals; flaked, puffed, and popped products; infant foods; corn syrup; corn starch; corn oil; extruded products; convenience foods (ready-to-eat and ready-to-cook)</i>	
1.7	Effect of Processing on Composition and Nutritive Value	
1.8	Fortification and Value Addition of Cereal Products	
1.9	Quality Control and Standards for Cereal-based Products	
1.10	Packaging of Cereals and Cereal Products	

<b>2</b>	<b>LEGUMES AND PULSES</b>	<b>15 hours</b>
2.1	Structure, Composition, Nutritional Value, Toxic Constituents, and Market Varieties of Pulses including Soybean	
2.2	Farming, Consumption and Industrial Utilization Trends of Pulses in India and Internationally	
2.3	Post-Harvest Technology – <i>storage, transportation, handling, prevention of spoilage and post-harvest losses, fumigation, and related aspects</i>	
2.4	Processing Methods – <i>sprouting, fermentation</i>	
2.5	Products of Processing – <i>grits, nuggets, isolates, concentrates</i>	
2.6	Effect of Processing on Composition and Nutritive Value	
2.7	Fortification and Value Addition of Pulse Products	
2.8	Quality Control and Standards for Pulse-based Products	
2.9	Packaging of Pulses and Pulse Products	

<b>3</b>	<b>OILSEEDS</b>	<b>15 hours</b>
3.1	Structure, Composition, Nutritional Value, Toxic Constituents, and Market Varieties of Oilseeds	
3.2	Farming, Consumption and Industrial Utilization Trends of Oilseeds in India and internationally	
3.3	Post-Harvest Technology – <i>storage, transportation, handling, prevention of spoilage and post-harvest losses, fumigation, and related aspects</i>	
3.4	Processing Methods and Manufacture of Oils and Fats	
3.5	Products of Processing – <i>grits, nuggets, isolates, concentrates, low-cost protein foods, oils</i>	
3.6	Effect of Processing on Composition and Nutritive Value	
3.7	Fortification and Value Addition of Oilseed Products	
3.8	Quality Control and Standards for Oilseed-based Products	
3.9	Packaging of Oilseeds	

<b>PEDAGOGY</b>	Lectures/ Assignments/ Seminars
<b>REFERENCE BOOKS</b>	Chakrabarty MM. 2003. <i>Chemistry and Technology of Oils and Fats</i> . Prentice Hall.
	Dendy DAV and Dobraszczyk BJ. 2001. <i>Cereal and Cereal Products</i> . Aspen.
	Hamilton RJ & Bhati A. 1980. <i>Fats and Oils - Chemistry and Technology</i> . App. Sci. Publ.
	Hoseney RS. 1994. <i>Principles of Cereal Science and Technology</i> . Second Edition. AACC.
	Kay DE. 1979. <i>Food Legumes</i> . Tropical Products Institute.
	Kent NL. 1983. <i>Technology of Cereals</i> . Fourth Edition. Pergamon Press.
	Kulp K and Ponte GJ. 2000. <i>Handbook of Cereal Science and Technology</i> . Second Edition. Marcel Dekker.
	Lorenz KL. 1991. <i>Handbook of Cereal Science and Technology</i> . Marcel Dekker.
	Marshall WE and Wadsworth JI. 1994. <i>Rice Science and Technology</i> . Marcel Dekker.
	Mathews RH. 1989. <i>Legumes Chemistry, Technology and Human Nutrition</i> . Marcel Dekker.
	Matz SA. 1969. <i>Cereal Science</i> . AVI Publ.
	Paquot C. 1979. <i>Standard Methods of Analysis of Oils, Fats and Derivatives</i> . Pergamon Press.
	Pomeranz Y. 1987. <i>Modern Cereal Science &amp; Technology</i> . VCH Publ.
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Understand the composition, structure and processing characteristic of cereal grains, legumes and oilseeds</li> <li>2. Examine different processing procedures and types of processed products</li> <li>3. Outline the recent trends of farming, utilization, and consumption</li> <li>4. Estimate the effect of the various methods of processing on composition and nutritive value</li> <li>5. Evaluate the effective ways to process and package agricultural crops and products</li> <li>6. Elaborate different post-harvest technology, quality standards and value-added products made from cereals, legumes and oilseeds</li> </ol>

<b>COURSE CODE</b>	FTC-602
<b>COURSE TITLE</b>	LAB IN CEREAL, LEGUME, AND OILSEED PROCESSING TECHNOLOGY
<b>NUMBER OF CREDITS</b>	1

<b>PRE-REQUISITES</b>	The student should have theoretical knowledge regarding components of cereals, pulses, and oilseeds
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To familiarize students with elementary analytical methods required to determine the quality of agricultural produce</li> <li>2. To acquaint students with rudimentary processing of pulses and oilseeds</li> </ol>

<b>CONTENT</b>		
1.	Market Survey of Cereals, Legumes, Minor Millets, Oilseeds and their Products	<b>30 hours</b>
2.	Physicochemical Tests for Quality of Cereals, Legumes, and Oilseeds	
3.	Determination of Amylose in Rice	
4.	Extraction of Gluten from Cereals	
5.	Development of Simulated Milk and Milk Products from Soy	
6.	Preparation of Extruded Products from Pulses	
7.	Preparation of Peanut Butter	
8.	Determination of Fractional Properties of Cereals and Pulses (bulk density, true density, angle of repose, angle of friction)	
9.	Determination of Anti-Nutritional Factors in Legumes	

<b>PEDAGOGY</b>	Experiments in the Laboratory
<b>REFERENCES</b>	As suggested in FTC-601
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Survey different products of cereal, legume, and oilseed in the market</li> <li>2. Understand physiochemical test and quality parameters of cereals</li> <li>3. Determine fractional properties of cereals and pulses</li> <li>4. Justify the steps involved in processing of different cereal, legume or oilseed products</li> <li>5. Analyse and extract different components affecting nutritive value</li> <li>6. Develop products using cereal, legume or oilseed</li> </ol>

**COURSE CODE** FTC-603  
**COURSE TITLE** MEAT, POULTRY, FRESHWATER, AND MARINE FOOD TECHNOLOGY  
**NUMBER OF CREDITS** 3

<b>PRE-REQUISITES</b>	The student should be aware of the contribution of flesh foods to human nutrition
<b>COURSE OBJECTIVES</b>	1. To acquaint students with the types and grades of meat, poultry, and sea foods 2. To familiarize students with processing techniques used for the production of commercial meat, poultry, and sea foods

<b>CONTENT</b>		
<b>1</b>	<b>MEAT PROCESSING</b>	<b>15 hours</b>
1.1	Muscle Structure, Meat Composition, Nutritional Value, Slaughtering and Post-Mortem Chemistry, Colours, and Flavours of Livestock – <i>buffaloes, sheep, goat, pigs, rabbits</i>	
1.2	Ante-Mortem Handling of Livestock	
1.3	Microbiology and Safety of Livestock	
1.4	Grading of Livestock and Quality of Meat	
1.5	Storage, Preservation, and Sensory Evaluation of Meat and Meat Products	
1.6	Meat and Processed Meat Products – <i>pickling, canning, drying, curing, smoking, kebabs, mince, salami, sausages, corned, intermediate moisture and dried meat products</i>	
1.7	Dressing of Meat – <i>offal handling and inspection</i>	
1.8	By-product Utilization	
1.9	Packaging of Meat and Meat Products	

<b>2</b>	<b>POULTRY PROCESSING</b>	<b>15 hours</b>
2.1	Muscle Structure, Composition, Nutritional Value, Meat Processing Operations, Colours and Flavours – <i>chicken, duck, quail</i>	
2.2	Ante-Mortem Handling of Poultry Species	
2.3	Microbiology and Safety of Poultry Species	
2.4	Grading of Poultry Species and Eggs	
2.5	Storage, Preservation, and Sensory Evaluation Techniques	
2.6	Poultry Food Products – <i>mince, salami, sausages, egg powder</i>	
2.7	By-product Utilization	
2.8	Packaging of Poultry and Poultry Products	

<b>3</b>	<b>FRESHWATER AND MARINE FOOD PROCESSING</b>	<b>15 hours</b>
3.1	Muscle Structure, Composition, Nutritional Value, Processing Operations, Colours and Flavours – <i>fleshy fish and shell fish</i>	
3.2	Post-Mortem Chemistry of Marine Foods	
3.3	Microbiology and Safety of Marine Foods	
3.4	Grading of Marine Foods	
3.5	Storage, Preservation, and Sensory Evaluation Techniques	
3.6	Marine Food Products	
3.7	By-product Utilization	
3.8	Packaging of Marine Food Products	

<b>PEDAGOGY</b>	Lectures/ Assignments/ Seminars
<b>REFERENCE BOOKS</b>	Forrest JC. 1975. <i>Principles of Meat Science</i> . Freeman.
	Govindan TK. 1985. <i>Fish Processing Technology</i> . Oxford & IBH.
	Hui YH. 2001. <i>Meat Science and Applications</i> . Marcel Dekker.
	Kerry J. et al. 2002. <i>Meat Processing</i> . Woodhead Publ. CRC Press.
	Levie A. 1984. <i>Meat Hand Book</i> . Fourth Edition. AVI Publ.
	Mead M. 2004. <i>Poultry Meat Processing and Quality</i> . Woodhead Publ.
	Mead GC. 1989. <i>Processing of Poultry</i> . Elsevier.
	Pearson AM and Gillett TA. 1996. <i>Processed Meat</i> . Third Edition. Chapman & Hall.
	Stadelman WJ and Cotterill OJ. 2002. <i>Egg Science and Technology</i> . Fourth Edition. CBS.
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Understand the compositional, nutritional and technological aspects of meat, poultry and fish</li> <li>2. Recall the pre- and post-slaughter techniques involved in production of edible meat</li> <li>3. Recognise the role of ante-mortem and post-mortem handling procedures in obtaining safe meat</li> <li>4. Judge quality of products through proper grading techniques; suggest appropriate packaging methods</li> <li>5. Design appropriate protocols for storage, preservation, and sensory evaluation of products</li> <li>6. Devise protocols for hygienic production of meat, poultry and seafood products</li> </ol>

<b>COURSE CODE</b>	FTC-604
<b>COURSE TITLE</b>	LAB IN MEAT, POULTRY, FRESHWATER, AND MARINE FOOD TECHNOLOGY
<b>NUMBER OF CREDITS</b>	1

<b>PRE-REQUISITES</b>	The student should have knowledge about the nutrient value of flesh foods
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To make students practically competent in analysing characteristics of importance in meats, poultry, and sea foods</li> <li>2. To enable students to formulate and prepare processed meat, poultry, and sea food products</li> </ol>

<b>CONTENT</b>		
1.	Inspection and Grading of Eggs	<b>30 hours</b>
2.	Development, Preparation, and Analysis of Meat Products	
3.	Development, Preparation, and Analysis of Poultry Food Products	
4.	Development, Preparation, and Analysis of Freshwater and Marine Food Products	
5.	Preparation and Analysis of Preserved Meat, Poultry, and Marine Food Products	
6.	Estimation of Meat: Bone Ratios	
7.	Shelf-life Studies on Processed Meat Products	

<b>PEDAGOGY</b>	Experiments in the Laboratory
<b>REFERENCES</b>	As suggested in FTC-603
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Inspect and Grade eggs as per standard guidelines</li> <li>2. Prepare processed products from raw materials (meat, poultry, seafood) and assess the influence of extrinsic and intrinsic factors</li> <li>3. Evaluate efficacy of existing methods of preservation of meat, poultry and seafood products</li> <li>4. Develop novel methods to extend shelf-life or add value to meat products</li> <li>5. Suggest appropriate shelf-life studies to evaluate quality of the product</li> <li>6. Design studies to evaluate stability of processed and unprocessed products</li> </ol>



<b>COURSE CODE</b>	FTC-605
<b>COURSE TITLE</b>	DAIRY TECHNOLOGY
<b>NUMBER OF CREDITS</b>	3

<b>PRE-REQUISITES</b>	The student should have knowledge of chemistry and microbiology
<b>COURSE OBJECTIVES</b>	1. To acquaint students with the varied types of dairy products 2. To familiarize students with processing techniques specific to the dairy industry

<b>CONTENT</b>		
<b>1</b>	<b>MILK</b>	<b>15 hours</b>
1.1	Definition, Sources, Composition, Nutritive Value, and Procurement of Milk	
1.2	Quality Tests, Grading, and Labelling of Milk	
1.3	Storage and Transportation	
1.4	Processing and Packaging	
1.5	Sensory Evaluation of Dairy and Dairy Products: <i>terminology; score card for milk, butter, cream; defects</i>	

<b>2</b>	<b>MILK PRODUCTS</b>	<b>15 hours</b>
	Manufacture, Composition, Quality Standards, Varieties, and Nutritive Value of the following:	
2.1	Types of Milk – <i>whole milk, low-fat milk, toned milk, double toned milk, fortified milk, flavoured milk, spray dried milk</i>	
2.2	Processed Milk Products – <i>cream, butter, dairy whiteners, condensed milk, ice creams</i>	
2.3	Fermented Milk Products – <i>cheese, yoghurt, curds, lassi, shrikhand, buttermilk</i>	
2.4	Other Milk Products – <i>ghee, khoa, chenna, paneer, rasogulla, shrikhand, barfi, kalakhand, kulfi</i>	

<b>3</b>	<b>ADVANCES IN DAIRY TECHNOLOGY</b>	<b>15 hours</b>
3.1	Application of Membrane Technology ( <i>ultrafiltration, monofiltration, microfiltration, reverse osmosis, ion exchange and electrodialysis processes</i> ) in Fluid Milk Processing	
3.2	Irradiation of Milk	
3.3	Application of Stabilizers and Emulsifiers in Dairy Products	
3.4	Application of Enzymes and Developments in Biotechnology for Milk Products	
3.5	Probiotics – <i>definition and products</i>	
3.6	Packaging of Dairy Products	

<b>PEDAGOGY</b>	Lectures/ Assignments/ Seminars
<b>REFERENCE BOOKS</b>	Aneja RP, Mathur BN, Chandan RC and Banerjee AK. 2002. <i>Technology of Indian Milk Products</i> . Dairy India Publ.
	De S.1980. <i>Outlines of Dairy Technology</i> . Oxford Univ. Press.
	Henderson JL. 1971. <i>Fluid Milk Industry</i> . AVI Publ.

	Rathore NS et al. 2008. <i>Fundamentals of Dairy Technology- Theory &amp; Practices</i> . Himanshu Publications
	Spreer E. 1993. <i>Milk and Dairy Products</i> . Marcel Dekker.
	Walstra P. 1999. <i>Dairy Technology</i> . Marcel Dekker.
	Walstra P. (Ed.). 2006. <i>Dairy Science and Technology</i> . Second Edition. Taylor & Francis.
	Web BH, Johnson AH and Lansford JA. 1987. <i>Fundamentals of Dairy Chemistry</i> . Third Edition. AVI Publ.
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Understand the compositional, nutritional and technological aspects of milk</li> <li>2. Recall the techniques involved in production, storage, transportation, processing and packaging of milk</li> <li>3. Outline the manufacture, composition, quality standards, varieties, and nutritive value of milk and milk products</li> <li>4. Classify products based on their nutritive composition; suggest appropriate packaging material</li> <li>5. Discuss novel milk processing technologies; Incorporate principles of biotechnology in dairy technology</li> <li>6. Devise protocols for hygienic production of milk and milk-based products</li> </ol>

**COURSE CODE** FTC-606  
**COURSE TITLE** LAB IN DAIRY TECHNOLOGY  
**NUMBER OF CREDITS** 1

<b>PRE-REQUISITES</b>	The student should have knowledge of chemistry and microbiology
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To acquaint students with quality control tests specific to the dairy industry</li> <li>2. To make students competent in practically performing fundamental dairy processing techniques</li> </ol>

CONTENT		
1.	Market Survey of Milk and Milk Products	<b>30 hours</b>
2.	Platform Tests in Raw Milk	
3.	Nutrient Analysis of Milk – Fat, Lactose, SNF	
4.	Preparation and Evaluation of Curds	
5.	Preparation and Evaluation of Butter, Ghee, and <i>Paneer</i>	
6.	Preparation and Evaluation of Indian Milk Sweets ( <i>rasgulla, shrikhand, gulab jamun</i> )	
7.	Development of a high-protein, low-fat Dairy Product	

<b>PEDAGOGY</b>	Experiments in the Laboratory
<b>REFERENCES</b>	As suggested in FTC-605
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Recreate popular dairy-based products and understand the role of intrinsic and extrinsic factors on quality of product</li> <li>2. Suggest appropriate procedures to detect forms of adulterants in milk</li> <li>3. Identify differences in sensory characteristics of laboratory vs commercially prepared products</li> <li>4. Determine the nutrient content of milk and other dairy products</li> <li>5. Suggest and devise appropriate shelf-life studies to evaluate quality of the product</li> <li>6. Formulate novel products like low-fat/ low calorie/ high protein dairy products</li> </ol>

<b>COURSE CODE</b>	FTC-607
<b>COURSE TITLE</b>	BEVERAGE TECHNOLOGY
<b>NUMBER OF CREDITS</b>	3

<b>PRE-REQUISITES</b>	The student should have knowledge of chemistry and microbiology
<b>COURSE OBJECTIVES</b>	1. To acquaint students with the particulars of manufacturing industrial beverages 2. To familiarize students with the quality requirements of bottled beverages

<b>CONTENT</b>		
<b>1</b>	<b>WATER AS AN INDUSTRIAL BEVERAGE</b>	<b>5 hours</b>
1.1	Status of the Beverage Industry in India and Globally	
1.2	Types of Bottled Water – <i>Mineral Water, Spring Water, Flavoured Water, Carbonated Water</i>	
1.3	Packaged Drinking Water – <i>Manufacturing Process, Raw and Processed Water, Water Treatment</i>	
1.4	Quality Standards of Bottled and Packaged Water	

<b>2</b>	<b>CARBONATED AND NON-CARBONATED BEVERAGES</b>	<b>20 hours</b>
2.1	Beverage Ingredients and their Functions – <i>sweeteners, bulking agents, acidulants, flavourings, preservatives, Oxygen Radical Absorbance Capacity (ORAC) value</i>	
2.2	Concentrated Beverages – <i>ingredients, processing techniques, standards, and sensory evaluation</i>	
2.3	Carbonated Beverages - <i>ingredients, processing techniques, standards, and sensory evaluation</i>	
2.4	Fruit- and Vegetable-based Beverages – <i>ingredients, processing techniques, standards, and sensory evaluation</i>	
2.5	Synthetic Beverages - <i>ingredients, processing techniques, standards, and sensory evaluation</i>	
2.6	Beverages used in the Sports industry – <i>types, ingredients, processing techniques, standards, and sensory evaluation</i>	
2.7	Indigenous Beverages for Domestic and Commercial Use – <i>sugarcane juice, cashew apple extract, coconut palm sap, kadhas (traditional decoctions)</i>	
2.8	Tea, Coffee, and Cocoa - <i>production, processing, types, standards, and sensory evaluation</i>	

<b>3</b>	<b>ALCOHOLIC BEVERAGES</b>	<b>20 hours</b>
3.1	Distillation and Distilled Liquors – <i>whisky, rum, gin, vodka, brandy</i>	
3.2	Fermentation and Fermented Alcohols – <i>wine, ciders, sake</i>	
3.3	Carbonated Alcohols – <i>beer, champagne</i>	
3.4	Indigenous Alcohol Production – <i>urak, feni, toddy</i>	
3.5	Liqueurs and Aperitifs	
3.6	Sensory Evaluation	

<b>PEDAGOGY</b>	Lectures/ Assignments/ Seminars
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<b>REFERENCE BOOKS</b>	Hui YH et al 2004. <i>Handbook of Food and Beverage Fermentation Technology</i> . Marcel Dekker.
	Priest FG & Stewart GG. 2006. <i>Handbook of Brewing</i> . Second Edition. CRC.
	Richard P Vine. 1981. <i>Commercial Wine Making - Processing and Controls</i> . AVI Publ.
	Varnam AH and Sutherland JP. 1994. <i>Beverages: Technology, Chemistry and Microbiology</i> . Chapman & Hall.
	Woodroof JG and Phillips GF.1974. <i>Beverages: Carbonated and Non-Carbonated</i> . AVI Publ.
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Recall national and international status of beverages, summarise information on beverages native to Goa</li> <li>2. Outline the process design in manufacture of water and other beverages</li> <li>3. Explain functions of various ingredients used in beverage preparation</li> <li>4. Elaborate on ingredients, processing techniques, standards and sensory evaluation of different types of beverages</li> <li>5. Discuss the manufacturing process of liquor, aperitifs, distilled, fermented, carbonated, indigenous alcohols and CCP for each</li> <li>6. Construct/ retrace a formulation based on knowledge of ingredients</li> </ol>

**COURSE CODE**                      FTC-608  
**COURSE TITLE**                    LAB IN BEVERAGE TECHNOLOGY  
**NUMBER OF CREDITS**        1

<b>PRE-REQUISITES</b>	The student should have knowledge of chemistry and microbiology
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To acquaint students with the production of industrial beverages</li> <li>2. To familiarize students with the quality control tests of importance in the beverage industry</li> </ol>

<b>CONTENT</b>		
1.	Preparation of Non-Carbonated Beverages	<b>30 hours</b>
2.	Preparation and Evaluation of Wine	
3.	Estimation of Sulphur Dioxide in Beverages	
4.	Estimation of Ascorbic Acid Content of Commercial Juices	
5.	Estimation of Phenolic Content in Beverages	
6.	Analysis of Mineral Content of Bottled Water	
7.	Analysis of Nutrient Content in Sports Drinks	

<b>PEDAGOGY</b>	Experiments in the Laboratory
<b>REFERENCES</b>	As suggested in FTC-607
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Formulate beverages; assess product quality and acceptability</li> <li>2. Estimate concentrations of preservatives in beverages and justify their application</li> <li>3. Recommend appropriate procedures to estimate phytochemicals and vitamins in samples of commercial beverages</li> <li>4. Identify differences in sensory characteristics of laboratory vs commercially prepared products</li> <li>5. Determine the nutrient content of sports drinks and other functional beverages</li> <li>6. Suggest and devise appropriate shelf-life studies to evaluate quality of the product</li> </ol>

<b>COURSE CODE</b>	FTC-609
<b>COURSE TITLE</b>	PRE- AND POST-HARVEST TECHNOLOGY OF HORTICULTURE PRODUCE
<b>NUMBER OF CREDITS</b>	3

<b>PRE-REQUISITES</b>	The student should have knowledge of food microbiology and chemistry
<b>COURSE OBJECTIVES</b>	1. To acquaint students with the principles and methods of preserving fruits and vegetables 2. To familiarize students with the processing techniques of horticultural produce

CONTENT		
<b>1</b>	<b>VEGETABLES</b>	<b>15 hours</b>
1.1	Classification, Types, Composition, and Nutritive Value of Vegetables	
1.2	Harvesting Indices	
1.3	Storage of Fresh Produce – <i>principles, methods, and techniques</i>	
1.4	Transportation, Packaging, and Marketing of Fresh Produce	
1.5	Spoilage and Quality Control Measures	
1.6	Principles of Genetics and Cytogenetics	

<b>2</b>	<b>FRUITS</b>	<b>15 hours</b>
2.1	Classification, Types (simple and aggregate), Composition, and Nutritive Value of Fruits	
2.2	Harvesting Indices	
2.3	Storage of Fresh Produce – <i>principles, methods, and techniques</i>	
2.4	Transportation, Packaging, and Marketing of Fresh Produce – <i>storage and ascorbic acid drip</i>	
2.5	Spoilage and Quality Control Measures	
2.6	Dry land and Ornamental Horticulture	

<b>3</b>	<b>PROCESSING TECHNOLOGY</b>	<b>15 hours</b>
3.1	Quality Requirements of Raw Material for Processing	
3.2	Primary Processing Techniques – <i>minimal processing, grading, sorting, cleaning, washing, peeling, slicing, blanching</i>	
3.3	Processing for Pulps, Purees, and Concentrates	
3.4	Processing for Pickles, Gravies, Powders, Sauces, Soups	
3.5	Processing for Jams, Jellies, Marmalades, Confectioneries	
3.6	Dehydrated & Osmotically Dehydrated Fruits and Vegetables	

<b>PEDAGOGY</b>	Lectures/ Assignments/ Seminars
<b>REFERENCE BOOKS</b>	Kadar AA.1992. <i>Post-harvest Technology of Horticultural Crops</i> . Second Edition. University of California.
	Lal G, Siddapa GS and Tandon GL.1986. <i>Preservation of Fruits and Vegetables</i> . ICAR.

	Pantastico B. 1975. <i>Post-Harvest Physiology, Handling and Utilization of Tropical and Subtropical Fruits and Vegetables</i> . AVI Publ.
	Salunkhe DK, Bolia HR and Reddy NR. 1991. <i>Storage, Processing and Nutritional Quality of Fruits and Vegetables. Vol. I. Fruits and Vegetables</i> . CRC.
	Thompson AK. 1995. <i>Post-Harvest Technology of Fruits and Vegetables</i> . Blackwell Sci.
	Verma LR. & Joshi VK. 2000. <i>Post-Harvest Technology of Fruits and Vegetables</i> . Indus Publ.
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Compile biological, chemical, physical properties of fruits and vegetables</li> <li>2. Perceive the theory and working principle of processes and products developed from fruits and vegetables</li> <li>3. Outline production and post harvesting processing, value-addition and preservation of fruits and vegetables</li> <li>4. Interpret biological properties, chemical composition and physiological changes post-harvest</li> <li>5. Understand treatment methods and factors affecting shelf life and methods to improve the shelf life</li> <li>6. Recall existing and compare with newer technology behind effective product development, quality control and storage</li> </ol>



<b>COURSE CODE</b>	FTC-610
<b>COURSE TITLE</b>	LAB IN PRE- AND POST-HARVEST TECHNOLOGY OF HORTICULTURE PRODUCE
<b>NUMBER OF CREDITS</b>	1

<b>PRE-REQUISITES</b>	The student should have knowledge of food chemistry
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To practically acquaint students with fundamental fruit and vegetable processing techniques</li> <li>2. To familiarize students with quality control tests specific to the horticulture industry</li> </ol>

<b>CONTENT</b>		
1.	Preparation of Vegetable Products	<b>30 hours</b>
2.	Preparation of Fruit Products	
3.	Preparation of Dehydrated Vegetables	
4.	Preparation of Banana and Potato Wafers	
5.	Preparation of Dried Figs and Raisins	
6.	Vegetable and Fruit Maturity Index Determination and Calculation	
7.	Quality Standard Measurements of Vegetable and Fruit Products	

<b>PEDAGOGY</b>	Experiments in the Laboratory
<b>REFERENCES</b>	As suggested in FTC-609
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Outline the theory and principle behind the steps involved in developing various products from fruits and vegetables</li> <li>2. Identify and assess the quality of fruit and vegetables</li> <li>3. Develop various fruit and vegetable products with quality assurance and safety measures</li> <li>4. Illustrate methods to understand principles of preservation of fruits and vegetables</li> <li>5. Demonstrate proficient skill in value-addition of perishables</li> <li>6. Summarize quality specifications for processing fruit and vegetables</li> </ol>

<b>COURSE CODE</b>	FTC-611
<b>COURSE TITLE</b>	SNACK FOOD TECHNOLOGY
<b>NUMBER OF CREDITS</b>	3

<b>PRE-REQUISITES</b>	The student should have knowledge of the types of food
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To acquaint students with the scientific principles involved in the manufacture of commercial snack foods</li> <li>2. To familiarize students with equipment of importance in the snack food industry</li> </ol>

<b>CONTENT</b>		
<b>1</b>	<b>GRAIN-BASED SNACKS</b>	<b>15 hours</b>
1.1	Technology for Whole Grains Snacks – <i>roasted, toasted, puffed, popped, flaked</i>	
1.2	Technology for Coated Grain Snacks – <i>salted, spiced, sweetened</i>	
1.3	Technology for Batter-Based and Dough-Based Products	
1.4	Technology for Formulated Products – <i>chips, wafers, papads, instant pre-mixes</i>	

<b>2</b>	<b>HORTICULTURE PRODUCE-BASED SNACKS</b>	<b>15 hours</b>
2.1	Technology for Fruit-Based Snacks	
2.2	Technology for Vegetable-Based Snacks	
2.3	Technology for Coated Nuts	

<b>3</b>	<b>EXTRUDED SNACKS</b>	<b>15 hours</b>
3.1	Formulation and Processing Technology (pasta, chips, <i>chakli</i> , vermicelli, etc.)	
3.2	Colouring and Flavouring	
3.3	Packaging	
3.4	Machinery and Equipment – <i>Types, Use and Care</i>	
3.5	Chemical and Nutritional Changes in Food during Extrusion	

<b>PEDAGOGY</b>	Lectures/ Assignments/ Seminars
<b>REFERENCE BOOKS</b>	Edmund WL. <i>Snack Foods Processing</i> . AVI Publ.
	Frame ND. 1994. <i>The Technology of Extrusion Cooking</i> . Blackie Academic.
	Gordon BR. 1997. <i>Snack Food</i> . AVI Publ
	Samuel AM. 1976. <i>Snack Food Technology</i> . AVI Publ.
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Discuss basic technology utilised in production of various kinds of snacks</li> <li>2. Explain the influence of extrinsic and intrinsic factors on quality of snacks</li> <li>3. Predict chemical and nutritional changes in foods during processing</li> <li>4. Describe the machinery required for production of snacks; devise protocols to maintain hygiene in the industry</li> </ol>

	<p>5. Outline the role of ingredients in production of quality snacks; recognise advanced technology in processing of raw material</p> <p>6. Suggest and justify appropriate material for packaging of snacks</p>
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<b>COURSE CODE</b>	FTC-612
<b>COURSE TITLE</b>	LAB IN SNACK FOOD TECHNOLOGY
<b>NUMBER OF CREDITS</b>	1

<b>PRE-REQUISITES</b>	The student should be aware of the different types of fast foods
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To practically acquaint students with processing techniques utilized for snack foods</li> <li>2. To familiarize students with evaluation methods for the quality of snack foods</li> </ol>

CONTENT		
1.	Preparation of Snack Foods based on Cereals	<b>30 hours</b>
2.	Preparation of Snack Foods based on Pulses	
3.	Preparation of Snack Foods based on Nuts	
4.	Preparation of Snack Foods based on Fruits	
5.	Preparation of Snack Foods based on Vegetables	
6.	Development of Instant Food Pre-Mixes	
7.	Determination of Shelf-Life and Quality Characteristics of Snack Foods	

<b>PEDAGOGY</b>	Experiments in the Laboratory
<b>REFERENCES</b>	As suggested in FTC 611
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Evaluate the effect of extrinsic and intrinsic factors on product quality</li> <li>2. Deduce the methodology and machinery used in commercial production of snacks</li> <li>3. Identify differences in sensory characteristics of laboratory vs commercially prepared products</li> <li>4. Demonstrate proficient skill in development of snacks through value-addition of perishables</li> <li>5. Suggest and devise appropriate shelf-life studies to evaluate quality of the product</li> <li>6. Formulate instant-food products and evaluate their sensory properties on reconstitution</li> </ol>

<b>COURSE CODE</b>	FTC-613
<b>COURSE TITLE</b>	ENTREPRENEURSHIP AND BUSINESS MANAGEMENT
<b>NUMBER OF CREDITS</b>	2

<b>PRE-REQUISITES</b>	The student should have basic understanding of business and marketing
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To familiarize students with business models and their planning and development</li> <li>2. To acquaint students with the principles and intricacies of managing an enterprise</li> </ol>

CONTENT		
1	BEING AN ENTREPRENEUR	6 hours
1.1	Definition and Qualities of an Entrepreneur	
1.2	Types of Industry – <i>cottage and small-scale industry</i>	
1.3	Market Structure – <i>macro and micro businesses</i>	
1.4	Creating a Business Model	
1.5	Brand Creation	
2	HUMAN RESOURCE MANAGEMENT	8 hours
2.1	Recruitment	
2.2	Training	
2.3	Performance Appraisals	
2.4	Workers’ Safety and Welfare	
2.5	Employees’ Union	
3	MARKETING MANAGEMENT	8 hours
3.1	Functions of Marketing	
3.2	Market Intelligence - <i>survey techniques, demand &amp; supply</i>	
3.3	Market Forecasting – <i>consumer behaviour and trends</i>	
3.4	Segmentation, Targeting, and Positioning	
3.5	Marketing Network	
3.6	E-Marketing and E-Procuring	
4	ADVERTISING AND COMMERCIALIZATION	8 hours
4.1	Objectives of Advertising	
4.2	Advertising Message	
4.3	Budgeting	
4.4	Media Selection	
4.5	Personal Selling and Publicity	
4.6	Sales Promotion	

<b>REFERENCE BOOKS</b>	Chhabra TN and Suria RK. 2001. <i>Management Process and Perspectives</i> . KitabMahal.
	Jhingan ML. 2005. <i>International Economics</i> . 5th Ed. Virnda Publ.
	Kotler P. 2000. <i>Marketing Management</i> . Prentice Hall.
	Reddy SS, Ram PR, Sastry TVN and Bhavani ID. 2004. <i>Agricultural Economics</i> . Oxford & IBH.
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Summarize systematic application of entrepreneurial way of thinking and problem solving</li> <li>2. Identify and create business opportunities that may be commercialized successfully</li> <li>3. Motivate leveraging industry's main drivers of innovation, customers, technology and business environment</li> <li>4. Perceive market survey and basic concepts of marketing of food items</li> <li>5. Prioritize marketing skills appropriate in business management</li> <li>6. Prove importance of human resource and team activities that lead to the development of collaborative work skills</li> </ol>

<b>COURSE CODE</b>	FTC-614
<b>COURSE TITLE</b>	FOOD PLANT LAYOUT AND DESIGN
<b>NUMBER OF CREDITS</b>	2

<b>PRE-REQUISITES</b>	The student should have basic knowledge of the types of equipment used for food production and processing
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>To familiarize students with floor plans required by food processing units</li> <li>To acquaint students with the principles of design needed to maintain hygiene and quality in a food processing unit</li> </ol>

<b>CONTENT</b>		
<b>1</b>	<b>FOOD PLANT DESIGN</b>	<b>12 hours</b>
1.1	Site Location, Plant Plan and Elevation, Feasibility Studies – <i>importance, method, and analysis</i>	
1.2	Plant Design Specifics – <i>flow charts, interconnections, raw material flows, permanent/temporary storage, shop facilities, office spaces, delivery and shipping facilities, access ways</i>	
1.3	Modernization, Automation, and Capacity Expansion of Existing Facilities	
1.4	Relocating an Existing Plant	
1.5	Principles for Hygienic Plant Design	
1.6	Legal Aspects	

<b>2</b>	<b>FOOD PLANT LAYOUT</b>	<b>12 hours</b>
2.1	Objectives of a Layout	
2.2	Types and Flow Patterns of Layouts (small-, medium-, and large- scale units)	
2.3	Utility Inclusions in Food Plants ( <i>water, steam, electricity, effluents</i> )	
2.4	Illumination and Ventilation – <i>importance and incorporating it in designs</i>	
2.5	Layout Design Procedure	
2.6	Symbols used in Design and Layout	
2.7	Building Materials – <i>factors for selection, properties of materials</i>	
2.8	Plant Flooring – <i>requirements, maintenance, structural aspects</i>	

<b>3</b>	<b>FOOD PROCESS SCHEDULE</b>	<b>6 hours</b>
3.1	Plant Operations – <i>models and techniques used in operation research (linear programming, dynamic programming, queuing theory, inventory theory, CPM and PERT techniques, Game Theory)</i>	
3.2	Benefits of Scheduling Operations	
3.3	Planning for Food Process Schedules	

<b>PEDAGOGY</b>	Lectures/ Assignments/ Seminars
<b>REFERENCE BOOKS</b>	Sharma A.K. and Kumbhar B.K. 2020. <i>Food Processing Plant Design and Layout</i> . KitabMahal.
	Lopez-Gomez A. and Barbosa-Canovas GV. 2005. <i>Food Plant Design</i> . CRC Press.
	Baker CGJ. 1995. <i>Handbook of Food Factory Design</i> . Springer.

<b>COURSE OUTCOMES</b>	<b>On completion of the course, the student will be able to:</b> <ol style="list-style-type: none"> <li>1. Understand the principles of design; devise blueprints to maintain hygiene and quality in a food processing unit</li> <li>2. Justify floor plans required by food processing units</li> <li>3. Recognise plant design specifics; outline the requirements for setting-up a food manufacturing plant</li> <li>4. Recall legal aspects and standards to be followed in designing a food unit</li> <li>5. Construct a layout design based on objectives and scale of the hypothetical unit</li> <li>6. Develop food processing schedules using programming techniques employed in operational research</li> </ol>
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## Research Specific Electives (8 Credits)

<b>COURSE CODE</b>	FTC-615
<b>COURSE TITLE</b>	RESEARCH METHODOLOGY
<b>NUMBER OF CREDITS</b>	2

<b>PRE-REQUISITES</b>	The student should possess basic understanding of collecting data for experiments
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To acquaint students with the principles and methods of scientific research</li> <li>2. To familiarize students with scientific methods of data collection and processing</li> </ol>

CONTENT		
<b>1</b>	<b>UNDERSTANDING RESEARCH</b>	<b>10 hours</b>
1.1	Significance, Purpose, and Types of Research	
1.2	Research Designs – <i>types and uses</i>	
1.3	Sampling Methods and Scaling Techniques	
1.4	Research Informatics	

<b>2</b>	<b>DATA COLLECTION AND PROCESSING</b>	<b>10 hours</b>
2.1	Types and Methods of Data Collection - <i>primary and secondary data, merits and demerits</i>	
2.2	Designing and Pre-Testing a Questionnaire	
2.3	Interviews – <i>types and techniques</i>	
2.4	Data Processing – <i>classification, coding, scrutinizing, editing, and coding data</i>	
2.5	Tabulation and Graphical Presentation of Data	

<b>3</b>	<b>THE RESEARCH PROCESS</b>	<b>10 hours</b>
3.1	Defining the Problem	
3.2	Research Questions, Objectives, and Hypothesis	
3.3	Planning the Research – <i>methodology and tools</i>	
3.4	Ethics and Misconduct in Research	

<b>PEDAGOGY</b>	Lectures/ Assignments/ Seminars
<b>REFERENCE BOOKS</b>	Kotahri, C.R. (2009): Research Methodology: Methods and Techniques, 2nd Revised Ed. Reprint, New Age International Publishers
	Singh YK. 2006. Fundamentals of Research Methodology and Statistics. New Age International Publishers.
	Krishnan V. 2011. Statistics for Beginners. Atlantic Publishers and Distributors (P) Ltd.
	Jackson SL. 2012. Research Methods and Statistics: A Critical Thinking Approach. Fourth Edition. Wadsworth Cengage Learning.

<b>COURSE OUTCOMES</b>	<b>On completion of the course, the student will be able to:</b> <ol style="list-style-type: none"> <li>1. Construct a strong hypothesis for an assigned research problem</li> <li>2. Identify the right sampling method for collection of data</li> <li>3. Design appropriate tools for collection of data</li> <li>4. Process and present data as complete tables or graphs</li> <li>5. Interpret findings and discover correlation between study objectives and results obtained</li> <li>6. Execute research studies following research ethics and avoiding any forms of misconduct</li> </ol>
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<b>COURSE CODE</b>	FTC-616
<b>COURSE TITLE</b>	ACADEMIC WRITING
<b>NUMBER OF CREDITS</b>	2

<b>PRE-REQUISITES</b>	The student should have a basic understanding of the difference between scientific and fictional writing
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To expose students to different forms of academic writing</li> <li>2. To inculcate scientific writing skills that prevent plagiarism</li> <li>3. To encourage students to practice writing so as to deliver quality literature review and analysis</li> </ol>

<b>CONTENT</b>		
<b>1</b>	<b>INTRODUCTION TO SCIENTIFIC WRITING</b>	<b>10 hours</b>
1.1	Importance and Rules of Academic Writing	
1.2	Styles of Research Writing	
1.3	Plagiarism – <i>definition, tools for the detection of plagiarism, avoiding plagiarism</i>	
1.4	Journal and Author Metrics – <i>Impact Factor, CiteScore, SNIP, Google Scholar Metrics, Eigenfactor, H-Index, G-Index, M-Index, UGC-Care Journals, Scopus-Indexed Journals</i>	
1.5	Challenges in Research Writing	

<b>2</b>	<b>LITERATURE REVIEW</b>	<b>10 hours</b>
2.1	Source of Literature and Process of Literature Review	
2.2	Online Literature Databases, Open Educational Resources for Learning and Research, and Literature Management Tools	
2.3	Referencing and Citation – <i>APA and MLA styles, in-text, bibliography</i>	
2.4	The Writing Process – <i>pre-writing, writing, re-writing</i>	
2.5	Paragraph Structure and Rhetorical Modes	
2.6	Effective use of Quotations, Paraphrase, and Summary; Stylistics (vocabulary and conciseness)	

<b>3</b>	<b>REPORT AND THESIS WRITING</b>	<b>10 hours</b>
3.1	Inclusions - <i>cover and title pages, abstract, introduction, table and figure formats, text, objectives, methodology, analysis, summary, conclusion, bibliography</i>	
3.2	Layouts – <i>fonts, spacing, visual effects, labelling, visual presentation of data, creating images using Biorender and Canva, and related aspects</i>	
3.3	Practical – Writing a Scientific Report/ Review Article	

<b>PEDAGOGY</b>	Lectures/ Assignments/ Seminars
<b>REFERENCE BOOKS</b>	Ajay Semalty, Academic Writing, 2021, ISBN: 9789390211739, BS Publications, Hyderabad, India; <a href="https://bspublications.net/book_detail.php?bid=1574">https://bspublications.net/book_detail.php?bid=1574</a>
	Ajay Semalty, Mona Semalty, Art of Writing and Publishing in Pharmaceutical Journals, 2021, ISBN: 9789386819994, Pharma Med Press, Hyderabad, India, <a href="https://bspublications.net/">https://bspublications.net/</a>

	Judith Clare Helen Hamilton, Writing Research: Transforming Data into Text, 2003, ISBN 9780443071829, Churchill Livingstone, <a href="https://www.elsevier.com/books/writing-research/clare/978-0-443-07182-9">https://www.elsevier.com/books/writing-research/clare/978-0-443-07182-9</a>
	Mathukutty M Monippally, Academic Writing: A Guide for Management Students and Researchers, ISBN 9788132104414, Sage Publications, New Delhi, India.
	Semalty A, Literature Search & Reference Management in Academic Writing, <a href="https://pharmastate.academy/courses/literature-search-reference-managements/">https://pharmastate.academy/courses/literature-search-reference-managements/</a>
	Semalty A, Genuine Book Writing, <a href="https://docstate.academy/courses/genuine-book-writing/">https://docstate.academy/courses/genuine-book-writing/</a>
	Semalty A, Systematic Review & Meta-analysis, <a href="https://docstate.academy/courses/systematic-review-meta-analysis/">https://docstate.academy/courses/systematic-review-meta-analysis/</a>
	Semalty A., Systematic Review & Meta-analysis (Advanced), <a href="https://docstate.academy/courses/systematic-review-and-meta-analysis">https://docstate.academy/courses/systematic-review-and-meta-analysis</a>
	Semalty A., Qualitative Research And Review Writing, <a href="https://docstate.academy/courses/qualitative-analysis-and-review-writing/">https://docstate.academy/courses/qualitative-analysis-and-review-writing/</a>
	Report Writing, IGNOU, <a href="https://egyankosh.ac.in/handle/123456789/14018">https://egyankosh.ac.in/handle/123456789/14018</a>
	Peter, V. John, Writing a Research Paper, IGNOU, <a href="https://egyankosh.ac.in/handle/123456789/35677">https://egyankosh.ac.in/handle/123456789/35677</a>
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Develop the basics of written communication for academic, social and professional situations.</li> <li>2. Critically assess and interpret scientific literature</li> <li>3. Understand the key components of the journal and author matrix</li> <li>4. Construct a research article with a justified idea, accompanied by a strong literature review</li> <li>5. Use the most appropriate and latest format for citing research material; identify errors in referencing styles</li> <li>6. Create research-specific original images using online applications</li> </ol>

<b>COURSE CODE</b>	FTC-617
<b>COURSE TITLE</b>	FUNDAMENTALS OF STATISTICS
<b>NUMBER OF CREDITS</b>	2

<b>PRE-REQUISITES</b>	The student should be knowledgeable about basic mathematics and computations
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To acquaint students with the principles of data processing and data inference</li> <li>2. To familiarize students with statistical principles and techniques</li> <li>3. To hone the analytical skills of students</li> </ol>

<b>CONTENT</b>		
<b>1</b>	<b>DESCRIPTIVE STATISTICS</b>	<b>8 hours</b>
1.1	Measures of Central Tendency – <i>Mean, Mode, and Mode for Grouped and Ungrouped Data</i>	
1.2	Measures of Variability – <i>Range, Variance, Standard Deviation, and Standard Error</i>	
1.3	Measures of Relative Positions - <i>Sigma Scores, Standard Scores, Interquartile Range, Percentiles, Percentile Ranks</i>	
1.4	Calculations and Interpretation of Statistical Procedures	

<b>2</b>	<b>DATA DISTRIBUTION AND INFERENCE</b>	<b>14 hours</b>
2.1	Probability – <i>Randomness, Probability Models, Probability Laws</i>	
2.2	Permutation, Combinations, and Binomial Distribution - <i>Mean &amp; Variance of Binomial Distribution, Properties of Binomial Distribution, Conditions under which it is applicable, Fitting of Binomial Distribution</i>	
2.3	Poisson Distribution - <i>Mean &amp; Variance of Poisson Distribution, Properties of Poisson Distribution, Conditions under which it is applicable, Fitting of Poisson Distribution</i>	
2.4	Normal and Gaussian Curve - <i>Normal Distribution and Standard Normal Distribution, Normal Probability Curve, Properties of Normal Distribution. Examples Based on Area under Normal Curve, Data Transformation</i>	
2.5	Measures of Distribution Curve - <i>Skewness, Kurtosis</i>	

<b>3</b>	<b>MEASURE OF RELATIONSHIP BETWEEN VARIABLES</b>	<b>8 hours</b>
3.1	Scatterplots and Correlation	
3.2	Regression and Regression Coefficients	
3.3	Linear and Multiple Regression	
3.4	Application of Correlation and Regression in Food Sciences	
3.5	Introduction to Parametric and Non-Parametric Tests	

<b>PEDAGOGY</b>	Lectures/ Assignments/ Problem-Solving
<b>REFERENCE BOOKS</b>	Krishnan V. 2011. Statistics for Beginners. Atlantic Publishers and Distributors (P) Ltd.
	Singh YK. 2006. Fundamentals of Research Methodology and Statistics. New Age International Publishers.

	Jackson SL. 2012. Research Methods and Statistics: A Critical Thinking Approach. Fourth Edition. Wadsworth Cengage Learning.
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Exposure to various statistical tools required to analyse the experimental data in food research and industry</li> <li>2. Understand descriptive statistics, estimation, and confidence intervals hypothesis testing</li> <li>3. Inspect relationship between variables to evaluate data and conclude results</li> <li>4. Interpret data analysis, distribution, interpretation and inference based on experimental data collected</li> <li>5. Summarize data characteristics, relevance of biological data analysis and form of data distribution</li> <li>6. Illustrate application of Statistical techniques for the analysis of biological data</li> </ol>

<b>COURSE CODE</b>	FTC-618
<b>COURSE TITLE</b>	CREATIVE AND SOCIAL MEDIA WRITING
<b>NUMBER OF CREDITS</b>	2

<b>PRE-REQUISITES</b>	The student should possess knowledge of verbal and written English
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To acquaint students with the nuances of creating social media content</li> <li>2. To familiarize students with creative writing techniques</li> </ol>

<b>CONTENT</b>		
<b>1</b>	<b>CONTENT WRITING</b>	<b>10 hours</b>
1.1	Types of Content Writing - <i>Articles, Blogs, E-Books, Newsletters</i>	
1.2	Content Distribution Channels - <i>Text, Voice, Videos, Posts, Infographics</i>	
1.3	Keyword Research - <i>Types of Keywords, Competitive Keywords, SEO</i>	
1.4	Internet Research Tools, Keyword Planners	
1.5	Plagiarism in Content Writing	

<b>2</b>	<b>SOCIAL MEDIA WRITING</b>	<b>10 hours</b>
2.1	Difference between Print, Speech, and Social Media Marketing	
2.2	Creative Writing in Digital Marketing, Content Writing vs Copywriting	
2.3	Social Media Marketing and Content Creation, Social Media Research Tools - <i>Twitter/Facebook Analytics, Surveybot, Social Mention</i>	
2.4	Hashtags and Video Scripting for Social Media Posts	
2.5	Content Feedback and Social Media Metrics: <i>Keyhole, Buffer</i>	

<b>3</b>	<b>PRACTICAL APPLICATION OF CONTENT WRITING</b>	<b>10 hours</b>
3.1	Google Analytics, Semrush, Google Developers Tool, Google My Business	
3.2	Google Trends, Keyword Planner, keyword.io	
3.3	Google Adsense, 3 <sup>rd</sup> Party Tools	
3.4	Vimeo, Facebook, Instagram, Reels	
3.5	Grammarly, Small SEO tools, Aminstitute Headline Analyzer	

<b>PEDAGOGY</b>	Lectures/ Assignments/ Seminars	
<b>REFERENCE BOOKS</b>	Ajayi, J. (2020) The Ultimate Beginner's Guide to Content Writing. Kindle.	
	Halvorson, K. and Rach, M. (2012) Content Strategy for the Web. New Riders.	
	Robinson, J. (2020) Content Writing Step-By-Step. Amazon Digital Services.	
<b>COURSE OUTCOMES</b>	<b>On completion of the course, the student will be able to:</b> <ol style="list-style-type: none"> <li>1. Identify different channels to communicate and deliver an effective message in oral or written format.</li> <li>2. Ensure qualitative writing with linguistic accuracy in content writing</li> </ol>	

	<ol style="list-style-type: none"> <li>3. Understand nuances of creating social media content and creative writing techniques</li> <li>4. Analyse various tools used in social media writing and demonstrate practical application of content writing</li> <li>5. Conclude the importance of target audience and purpose to select appropriate communication choices in social media marketing</li> <li>6. Emphasize on listening, critical and reflective thinking and appropriate response in social media writing</li> </ol>	
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<b>COURSE CODE</b>	FTC-619
<b>COURSE TITLE</b>	FOOD PRODUCT DEVELOPMENT AND INTERNATIONAL TRADE
<b>NUMBER OF CREDITS</b>	2

<b>PRE-REQUISITES</b>	The student should have basic understanding of the characteristics of food and the importance of marketing
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To acquaint students with techniques of Product Development and International Trade for the food sector</li> <li>2. To equip students with knowledge of Intellectual Property Rights (IPR), related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy</li> </ol>

<b>CONTENT</b>		
<b>1</b>	<b>INNOVATIONS IN FOOD PRODUCT DEVELOPMENT</b>	<b>6 hours</b>
1.1	Definition and Need for Food Product Development	
1.2	Factors affecting Food Product Development – <i>corporate factors, market factors, technological pressures, government issues and legislations</i>	
1.3	Classes and Characteristics of New Food Products	
1.4	Line Extensions and Repositioning of Existing Products	
1.5	Reformulations and New Packaging as a means of New Product Development	
1.6	Ethics in Food Product Development	
<b>2</b>	<b>FOOD PRODUCT DEVELOPMENT PROCESS</b>	<b>6 hours</b>
2.1	Stages/ Phases of New Product Development – <i>idea generation, screening, feasibility studies, consumer research, financial review, product design and formulation</i>	
2.2	Process Development – <i>recipe development and scale-up, consumer trials, market testing</i>	
2.3	Quality Assessment of New Developed Products – <i>sensory evaluation, shelf-life testing</i>	
2.4	Packaging and Labelling Protocols	
2.5	Costing/ Pricing and Economic Evaluation of the Product	
2.6	Product Launch and Product Life Cycle	
<b>3</b>	<b>SPECIALITY FOOD PRODUCTS</b>	<b>6 hours</b>
3.1	Therapeutic and Medical Foods	
3.2	Infant Foods	
3.3	Geriatric Foods	
3.4	Functional Foods and Nutraceuticals	
3.5	Herbal Foods	
3.6	Sports Drinks	
3.7	Prebiotics and Probiotics	
<b>4</b>	<b>INTERNATIONAL TRADE</b>	<b>6 hours</b>
4.1	Salient Features of International Marketing	
4.2	International Marketing Environment	

4.3	Export Regulation – <i>direct, indirect, licensing and joint ventures</i>	
4.4	Product Promotion and Pricing, Distribution Channels	
4.5	World Trade Organization (WTO) – <i>role in international trade</i>	

<b>5</b>	<b>INTELLECTUAL PROPERTIES (IPs)</b>	<b>6 hours</b>
5.1	Historical Perspective and Need for the Introduction of Intellectual Property Right regime	
5.2	TRIPs and Provisions in TRIPs Agreement	
5.3	Intellectual Property Rights (IPR) - <i>benefits of securing IPRs</i>	
5.4	Indian Legislations for the protection of various types of Intellectual Properties	
5.5	Fundamentals of Patents, Copyrights, Geographical Indications, Trade Secrets, Traditional Knowledge, and Trademarks	
5.6	Protection of Plant Varieties and Farmers' Rights Act (PPV & FRA) and National Biodiversity Board	
5.7	Material Transfer Agreements, Research Collaboration Agreements, License Agreements	

<b>PEDAGOGY</b>	Lectures/ Assignments/ Seminars
<b>REFERENCE BOOKS</b>	Erbisch FH and Maredia K. 1998. <i>Intellectual Property Rights in Agricultural Biotechnology</i> . CABI, Wallingford.
	Ganguli, Prabudha. 2001. <i>Intellectual Property Rights: Unleashing Knowledge Economy</i> . McGraw-Hill, New Delhi.
	India, Ministry of Agriculture. 2004. <i>State of Indian Farmer. Vol. 5. Technology Generation and IPR Issues</i> . Academic Foundation, New Delhi.
	<i>Intellectual Property Rights: Key to New Wealth Generation</i> . 2001. NRDC and Aesthetic Technologies, New Delhi.
	Rothschild, Max & Newman, Scott (Ed.). 2003. <i>Intellectual Property Rights in Animal Breeding and Genetics</i> . CABI, Wallingford.
	Saha R. (Ed.). 2006. <i>Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies</i> . Daya, Delhi.
	The Indian Acts - Patents Act, 1970 & Amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 & amendments; Layout Design Act, 2000; PPV & FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Understand the principles underlying food product development process, design, development and commercialization</li> <li>2. Deconstruct the process of product development; generalise factors affecting the success, failure and marketability of commercially available food products</li> <li>3. Outline ethics involved in new food product development</li> <li>4. Design a process for a hypothetical product, retrace steps in process design for existing products</li> <li>5. Formulate and reformulate speciality food products as per standard guidelines</li> <li>6. Develop knowledge in approaching IPR; Infer global and national practice involving IPR</li> </ol>

<b>PRE-REQUISITES</b>	The student should have a basic understanding of food science and chemistry
<b>COURSE OBJECTIVES</b>	1. To acquaint students with the attributes of food that guide consumer acceptability 2. To equip students with the knowledge of designing appropriate sensory evaluation tests

<b>CONTENT</b>		
<b>1</b>	<b>FOOD AND BEVERAGE QUALITY</b>	<b>10 hours</b>
1.1	Need for Food Quality Control and Factors Influencing Food Quality - <i>soil, harvesting practices, processing procedures and conditions, packaging, transportation, storage conditions</i>	
1.2	Quality Attributes – <i>dominant and hidden attributes in food</i>	
1.3	Role of Colour in Quality Spectra – <i>types of colour-measuring instruments</i>	
1.4	Role of Viscosity in Food Quality – <i>types of fluids, types of viscometers</i>	
1.5	Food and Beverage Consistency – <i>methods used to measure consistency, difference between viscosity and consistency</i>	
1.6	Food Size and Shape – <i>methods used to find shape and size of food products, influence on consumer acceptability</i>	
1.7	Defects in Foods – <i>genetic, physiological, entomological, structural, mechanical, measurement of defects, preventing and overcoming defects</i>	

<b>2</b>	<b>SENSORY EVALUATION OF FOODS AND BEVERAGES</b>	<b>10 hours</b>
2.1	Overview of Sensory Evaluation Tests; Subjective vs. Objective Methods of Analysis	
2.2	Taste – <i>mechanism of taste perception, chemical dimensions of basic tastes (sweet, salt, sour, bitter and umami), factors affecting taste quality, reaction time, taste modification, absolute and recognition threshold, taste abnormalities, taste measurement</i>	
2.3	Odour/Aroma – <i>physiology and mechanism of odour perception, odour classification, chemical specificity of odour, odour measurement, olfactory abnormalities</i>	
2.4	Colour – <i>dimensions and attributes of colour, appearance factors, colour perception and abnormalities, measurement of colour</i>	
2.5	Texture/Mouth feel – <i>definition and importance of texture, texture perception and receptors involved, texture classification and measurement</i>	
2.6	Flavour – <i>definition, role in food quality, measurement of flavour</i>	
2.7	Trigeminal Sensations	
2.8	Threshold & Instrumental Measurements of Sensory Attributes of Foods & Beverages – <i>correlation of the latter with sensory perception</i>	
2.9	Product Development and Optimization based on Sensory Evaluation	

<b>3</b>	<b>FLAVOUR TECHNOLOGY</b>	<b>10 hours</b>
3.1	Problems in Flavour Research – <i>classification of food flavours, chemical compounds responsible for flavour</i>	
3.2	Flavour and Taste Perception - <i>flavour compounds, volatile flavour compounds, chemesthesis and chemesthetic responses, tactile response, aroma compounds, flavour profile, bio-flavour and reconstituted flavour</i>	
3.3	Flavour Concepts - <i>Onion-Beverage-Maillard reaction-Thio-stench, flavour legislation, flavour release, principles to predict the performance of polymeric flavour delivery systems, delivery of flavours from food matrices</i>	
3.4	Packaging and Flavour Compounds	
3.5	Use of Biotechnology to develop Flavours	

<b>PEDAGOGY</b>	Lectures/ Assignments/ Seminars
<b>REFERENCE BOOKS</b>	Krammer and Twigg. 1966. <i>Fundamentals of Quality Control for Food Industry</i> , Avi Publishing Company.
	Herschdoerfer. 2012. <i>Quality Control in Food Industry</i> . Elsevier.
	Civillie and Carr. 2015. <i>Sensory Evaluation Techniques</i> . CRC Press.
	Stone, Bleibaum and Thomas. 2012. <i>Sensory Evaluation Practices</i> . Academic Press.
	Fisher, Carolyn and Thomas R. Scott. “Food Flavours Biology and Chemistry”. The Royal Society of Chemistry, 1997.
	Heath, H.B. and G. Reineccius. “Flavour Chemistry and Technology”. CBS Publishers, 1996.
	Reineccius, Gary. “Flavour Chemistry and Technology”. 2 <sup>nd</sup> Edition, Taylor and Francis, 2006.
	Shahidi, Fereidoon and Chi-Tang Ho. “Flavour Chemistry of Ethnic Foods”. Kluwer Academic Plenum, 1999.
	Ashurst, Philip R. “Food Flavourings”. 3 <sup>rd</sup> Edition, Aspen Publications, 1999.
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Discuss the intrinsic and extrinsic factors that influence the quality of food and beverages</li> <li>2. Recall methods used to evaluate quality attributes of food</li> <li>3. Recognise flavour defects in food and beverages; devise solutions to overcome flavour loss</li> <li>4. Correlate sensory parameters of food products with perception using subjective and objective methods</li> <li>5. Identify and rectify problems with flavour retention and delivery</li> <li>6. Incorporate principles of biotechnology in production of novel, sustainable flavour compounds</li> </ol>

<b>COURSE CODE</b>	FTC-621
<b>COURSE TITLE</b>	INSTRUMENTATION AND PROCESS CONTROL
<b>NUMBER OF CREDITS</b>	2

<b>PRE-REQUISITES</b>	The students should have a basic understanding of math and science
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To enable students to apply basic knowledge of mathematics and science in practice for instrumentation and automation</li> <li>2. To provide students with a platform to develop basic instruments of use in food technology</li> <li>3. To assist students in applying the principles of controlled systems as sensed by instruments and feedback for effective control strategies</li> </ol>

<b>CONTENT</b>		
<b>1</b>	<b>THE CONCEPT OF INSTRUMENTATION</b>	<b>10 hours</b>
1.1	The Purpose & the Types of Instruments – <i>active, passive, null-type, deflection-type, indicating and signal-output instruments, zero, first and second order instruments</i>	
1.3	Precision, Repeatability, and Reproducibility of Instruments' Data	
1.4	Measurement Terminology and Calibration of Instruments – <i>measured variables, measured signals, sensitivity, errors, hysteresis, zero adjustments, and related terms</i>	
1.5	Thermodynamics and its Applications in Food Technology	
1.6	Basic Concepts of Fluid Mechanics	

<b>2</b>	<b>INSTRUMENTATION IN FOOD ANALYSIS</b>	<b>10 hours</b>
2.1	Chromatography – <i>types, principles and use</i>	
2.2	Spectrophotometry – <i>types, principles and use</i>	
2.3	Viscometry – <i>types, principles and use</i>	
2.4	Thermogravimetry – <i>types, principles and use</i>	
2.5	Cream Separators – <i>types, principles and use</i>	
2.6	Plate Freezers – <i>types, principles and use</i>	
2.7	Spray Dryers – <i>types, principles and use</i>	

<b>3</b>	<b>INDUSTRIAL PROCESS CONTROL</b>	<b>10 hours</b>
3.1	Functional Elements of an Instrument – <i>primary sensing element, variable conversion element, variable manipulation element, data transmission element, data storage and data conversion elements, and other related elements</i>	
3.2	Pasteurizer Control	
3.3	Dehydrator Control	
3.4	Storage Controls	

<b>PEDAGOGY</b>	Lectures/ Assignments/ Seminars
<b>REFERENCE BOOKS</b>	Smith & Vanness, Thermodynamics for Chemical Engineers, MGH Reference books.
	Richardson, J.F., Peacock, D.G.Coulson & Richardson's Chemical Engineering- Volume 3 ed., First Indian ed. Asian Books Pvt. Ltd. 1998.

	Process Systems Analysis and Control - Third Edition, McGraw Hill, New Delhi.
	Doebelin, E. O. (1990). Measurement Systems: Application and Design, International Edition, McGraw Hill, Singapore.
	Ogata, K. (2003). Modern Control Engineering, 5th Edition, Prentice-Hall, New Delhi.
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Recognise the types of instruments utilised in the food industry and their functions</li> <li>2. Recall the principles and application of various equipment involved in unit processes</li> <li>3. Understand and relate core concepts of Precision, Repeatability, and Reproducibility of Instruments'</li> <li>4. Apply principles of food engineering to process control</li> <li>5. Draw logical conclusions from presented information</li> <li>6. Detect inconsistencies or fallacies within a process or product</li> </ol>

<b>COURSE CODE</b>	FTC-622
<b>COURSE TITLE</b>	BUSINESS COMMUNICATION
<b>NUMBER OF CREDITS</b>	2

<b>PRE-REQUISITES</b>	Students should possess basic knowledge of English and grammar
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. The student should be able to understand and demonstrate the use of basic and advanced writing techniques that today's technology demands, including anticipating audience reaction</li> <li>2. Students should be able to write effective and concise letters and memos, and prepare informal and formal reports</li> </ol>

<b>CONTENT</b>		
<b>1</b>	<b>WRITTEN COMMUNICATION</b>	<b>10 hours</b>
1.1	Challenges in Communication – <i>the communication process, barriers and gateways to communication</i>	
1.2	Proof Reading – <i>importance and techniques</i>	
1.3	Business Letters – <i>parts, types, characteristics, and formats</i>	
1.4	Job Applications – <i>types, content, and format</i>	
1.5	Resumes and Covering Letters – <i>importance, parts, and formats</i>	

<b>2</b>	<b>RECRUITMENT AND EMPLOYMENT CORRESPONDENCE</b>	<b>10 hours</b>
2.1	E-mails and Memorandums – <i>importance, advantages, types, formats</i>	
2.2	Persuasive and Negative Messages	
2.3	Letters of Acceptance, Resignation, and Promotion	
2.4	Job Descriptions	
2.5	Testimonials and References	

<b>3</b>	<b>BUSINESS AND SOCIAL ETIQUETTE</b>	<b>10 hours</b>
3.1	Professional Conduct in a Business Setting – <i>principles, code of ethics</i>	
3.2	Workplace Hierarchy	
3.3	Making Introductions – <i>rules of personal and company introductions</i>	
3.4	Language in the Workplace	
3.5	Appropriate Business Attire	
3.6	Telephone and Table Etiquette	

<b>PEDAGOGY</b>	Lectures/ Assignments/ Seminars
<b>REFERENCE BOOKS</b>	Essentials of Business Communication, Sixth Edition, Mary Ellen Guffey, South-Western College Publishing.
	Association for Business Communication

<b>COURSE OUTCOMES</b>	<b>On completion of the course, the student will be able to:</b> <ol style="list-style-type: none"> <li>1. Demonstrate writing and speaking processes adequate for business environment</li> <li>2. Understand the importance communication choices involved in employment and recruitment.</li> <li>3. Interpret and appropriately apply modes of expression and communication</li> <li>4. Compare effective communication strategies and analyse importance of business ethics</li> <li>5. Assess organizational formats and channels used in developing and presenting business messages</li> <li>6. Prioritize analytical skills appropriate for business communication</li> </ol>
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**SEMESTER IV**  
**RESEARCH SPECIFIC COMPULSORY COURSE (16 Credits)**

<b>COURSE CODE</b>	FTC-623
<b>COURSE TITLE</b>	DISSERTATION
<b>NUMBER OF CREDITS</b>	16

<b>PRE-REQUISITES</b>	The student should have theoretical and practical knowledge of food science, processing, packaging, and analysis
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To enable the students to independently explore topics of research importance related to the food industry</li> <li>2. To empower students to design a research study based on the principles of scientific research</li> <li>3. To train students in interpreting, analysing, and reporting collated data related to a topic of study</li> <li>4. To endow students with skills required for scientific writing and publication</li> </ol>

<b>CONTENT</b>	Review of the State of Research in a Particular Problem Involving Food, and Development of a Hypothesis	<b>240 hours</b>
	Planning And Conducting the Experiment	
	Periodic Analysis of Data and Preparation of a Scientific Report	
	Final Preparation of Project Report as Dissertation to be Submitted in Partial Fulfilment of the M.Sc. Programme	

<b>PEDAGOGY</b>	Review of Literature/ Experimental Analysis/ Report Writing/ Presentation/Project carried out individually by each student throughout the academic year
<b>REFERENCES</b>	As required for the development of review and methodology
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Independently explore topics of research importance related to the food industry</li> <li>2. Design a study based on the principles of scientific research; construct methodology to obtain study objectives</li> <li>3. Interpret, analyse, and report collated data related to a topic of study</li> <li>4. Conclude experiment results with support of verified established data</li> <li>5. Defend observations and results in public settings (conferences, seminars, interviews)</li> <li>6. Write and publish quality articles</li> </ol>

## RESEARCH SPECIFIC ELECTIVE COURSES (4 Credits)

<b>COURSE CODE</b>	FTC-624
<b>COURSE TITLE</b>	ADVANCED STATISTICS
<b>NUMBER OF CREDITS</b>	2

<b>PRE-REQUISITES</b>	The student should be knowledgeable about basic sciences and computations
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To acquaint students with the principles and methods of data science</li> <li>2. To familiarize students with statistical methods for data analysis</li> <li>3. To acquaint students with statistical applications of MS Excel and SPSS</li> </ol>

<b>CONTENT</b>		
<b>1</b>	<b>PARAMETRIC TESTS IN DATA SCIENCE</b>	<b>10 hours</b>
1.1	Characteristics and Application of Parametric Tests	
1.2	Introduction to Hypothesis Testing	
1.3	Z-tests and T-tests: <i>Paired and Unpaired T-test</i>	
1.4	Pearson Correlation and Discriminant Analysis	
1.5	ANOVA, types of ANOVA: <i>One-Way, Two-Way, MANOVA</i>	
1.6	Chi-Square, Types of Chi-squares: <i>Goodness of Fit, Test of Independence, Test for Homogeneity</i>	

<b>2</b>	<b>NON-PARAMETRIC TESTS IN DATA SCIENCE</b>	<b>10 hours</b>
2.1	Characteristics and Application of Non-Parametric Tests	
2.2	Spearman Correlation	
2.3	Introduction to Wilcoxon Signed Rank test, Mann-Whitney and Kruskal-Wallis Test, and Friedman's ANOVA	
2.4	Application of the above Tests in Food and Nutrition-related Research	

<b>3</b>	<b>STATISTICAL PROCEDURES USING MICROSOFT EXCEL AND SPSS</b>	<b>10 hours</b>
3.1	Introduction to Microsoft Excel: <i>functions, menus, commands, shortcut keys, applications in statistics</i>	
3.2	Introduction to SPSS: <i>functions, menus, commands, shortcut keys, applications in statistics</i>	
3.3	Input of Data and Data Cleaning/Processing: <i>Establishing variables, manual and automatic input of data; Data transformation</i>	
3.4	Descriptive analysis using software: <i>Mean, Std. Deviation, Frequencies, Charts</i>	
3.5	Exercises on Linear and Multiple Regression, One-way and Two-way ANOVA, T-test, F-test	

<b>PEDAGOGY</b>	Lectures/ Assignments/ Seminars
<b>REFERENCE BOOKS</b>	Fundamentals of Applied statistics by Gupta & Kapoor
	A text book of operations research by S. D. Sharma.
	Statistical methods by J. Medhi.
	Fundamentals Mathematical Statistics by Gupta & Kapoor.
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Interpret characteristics and apply parametric tests to food science</li> <li>2. Interpret characteristics and apply non-parametric tests to food science</li> <li>3. Compile and arrange data using tools to draw an analytical conclusion</li> <li>4. Use statistical procedures and software for processing data</li> <li>5. Evaluate data and apply statistical principles to food science applications</li> <li>6. Utilise the most apt method of data analysis to plan and execute future investigations</li> </ol>

<b>COURSE CODE</b>	FTC-625
<b>COURSE TITLE</b>	EPIDEMIOLOGY AND HEALTH ECONOMICS
<b>NUMBER OF CREDITS</b>	2

<b>PRE-REQUISITES</b>	The student should be aware of non-communicable and communicable diseases
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. The student will be able to appreciate the role of epidemiologists in dictating food and nutrient needs of a population</li> <li>2. The student will be able to relate the understanding of epidemiology to the food processing industry</li> </ol>

<b>CONTENT</b>		
<b>1</b>	<b>FUNDAMENTALS OF EPIDEMIOLOGY</b>	<b>10 hours</b>
1.1	Definition, Objectives, Distribution, Determinants, Application, and Tools of Epidemiology and Public Health	
1.2	Historical Aspects and Evolution of Epidemiology	
1.3	Survey Methodology including Sampling and Census	
1.4	Epidemiological Aspects of Diseases of National & International Importance – <i>diarrhoea, tuberculosis, sexually transmitted diseases, malaria, diabetes, cardiovascular disease, mental health</i>	
1.5	Demography – <i>age-gender distribution, measures of fertility, mortality, and morbidity, demographic transition</i>	

<b>2</b>	<b>HEALTH MEASUREMENT AND STUDY DESIGN</b>	<b>10 hours</b>
2.1	Epidemiological Measures – <i>types, reliability, validity, accuracy</i>	
2.2	Observational Studies – <i>cross-sectional, descriptive, cohort, case control, before-after, historical perspective, international comparisons</i>	
2.3	Experimental Studies & Qualitative Research – <i>mixed designs, ecological studies, familial aggregation studies, and related aspects</i>	
2.4	Questionnaire Construction	
2.5	Index Construction and Scaling	
2.6	Diagnostic Tests – <i>types, sensitivity, specificity</i>	

<b>3</b>	<b>EPIDEMIOLOGICAL METHODS IN HEALTH MANAGEMENT</b>	<b>10 hours</b>
3.1	National and International Health Programmes – <i>societal responsibility</i>	
3.2	Role of Genetic and Environmental Factors in Health Calculation	
3.3	Principles and Economic Models of Health	
3.4	Health Insurance as a prerogative of the Food Industry	
3.5	Health and Economic Development – <i>pharmaceuticals, nutraceuticals, technological innovation</i>	

<b>PEDAGOGY</b>	Lectures/ Assignments/ Seminars
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<b>REFERENCE BOOKS</b>	Feldstein, Paul J. 2011. Health Care Economics, 7 <sup>th</sup> Edition. Cengage Learning. On reserve at Hagerty.
	Henderson, James W. 2014. Health Economics and Policy, 6 <sup>th</sup> Edition. Cengage Learning.
	Feldstein, Paul J. 2011. Health Policy Issues: An Economic Perspective, 5 <sup>th</sup> Edition. Health Administration Press.
	Bodenheimer, Thomas, and Kevin Grumbach. 2012. Understanding Health Policy: A Clinical Approach, 6 <sup>th</sup> Edition. McGraw Hill Lange.
	Morrisey, Michael A. 2013. Health Insurance, 2 <sup>nd</sup> Edition. Health Administration Press.
	Mankiw, N. Gregory. 2014. Principles of Microeconomics, 7 <sup>th</sup> Edition. Cengage Learning.
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Apply descriptive, analytic, and experimental epidemiological techniques to investigate scenarios involving healthcare</li> <li>2. Design surveys to assess health outcome, source of exposures, potential confounders and effect modifiers</li> <li>3. Construct activities to promote and manage public health</li> <li>4. Develop protocols to enhance functioning of the system through research on health care providers, hospitals and clinics</li> <li>5. Make rational choices about how to deploy funding for health care and make best possible use of the funds available</li> <li>6. Generate awareness on National and International health programmes</li> </ol>

<b>COURSE CODE</b>	FTC-626
<b>COURSE TITLE</b>	INTERNSHIP
<b>NUMBER OF CREDITS</b>	2

<b>PRE-REQUISITES</b>	The student should have knowledge of food science, processing, packaging, and safety
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To provide students an exposure to an industrial set-up</li> <li>2. To enable the students to observe, first hand, work flow and processes in food industries and associated enterprises</li> </ol>

<b>CONTENT</b>		
1.	Selection of an Industry Relevant to Food and Allied Products	<b>60 hours</b>
2.	Working in Department/s within the Selected Industry	
3.	Periodic Analysis of Data and Preparation of Report	
4.	Final Preparation of Internship Report	

<b>PEDAGOGY</b>	Hands-on working experience in the industry; Internship Report
<b>REFERENCES</b>	As suggested by the in-charge of internship in the selected industry
<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Find coherence in different concepts taught across different courses</li> <li>2. Monitor functioning of the industry and list skills required to sustain in the industry</li> <li>3. Apply theoretical concepts to practical components</li> <li>4. Deconstruct complex concepts/ machinery/ tests and therefore understand the concept better</li> <li>5. Observe company hierarchy, sharpen communication skills and gain experience for future interviews</li> <li>6. Develop a realistic view of the industrial sector and sharpen skills for better career prospects</li> </ol>

<b>COURSE CODE</b>	FTC-627
<b>COURSE TITLE</b>	STUDY TOUR
<b>NUMBER OF CREDITS</b>	2

<b>PRE-REQUISITES</b>	The student should have knowledge of food science, processing, packaging, and safety
<b>COURSE OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To provide students with a practical understanding of theoretical concepts</li> <li>2. To enable the students to observe, first hand, work flow and processes in food industries and associated enterprises</li> </ol>

<b>CONTENT</b>		
<b>1</b>	<b>A visit to any ten of the below-mentioned (and/or any other relevant) Food-related Industries</b>	
1.1	Food and Drug Administration	<b>25 hours</b>
1.2	Biotechnology or Pharmaceutical or Nutraceutical Company	
1.3	Fish Processing Unit	
1.4	Non-Alcoholic Beverage Processing Industry	
1.5	Alcoholic Beverage Processing Industry	
1.6	Slaughter House	
1.7	ICAR/ CFTRI	
1.8	Food Packaging Manufacturing Plant	
1.9	Sugarcane Industry	
1.10	Bakery and Confectionery Unit	
1.11	Dairy Industry	
1.12	Oilseed Processing Plant	
1.13	Sewage Treatment Plant	
1.14	Cereal Processing/ Snack Food Industry	
1.15	Food Start-up/ Innovation Hub	
1.16	Hospital, Airline Food Service, and/or Food Catering Establishments (industrial/quantity cooking institutions)	
1.17	Self-Help Groups	
1.18	Mushroom Cultivation Centres	
1.19	Fruit & Vegetable Cultivation/ Processing Units	
1.20	Spice Farms	
1.21	Cashew/ Coconut/ Coffee/Tea/Cocoa Plantations	
<b>2</b>	<b>Out-of-State Visit (3 to 5 days) to Food Processing Units</b>	<b>25 hours</b>
<b>3</b>	<b>Report Writing of Industrial &amp; Out-of-State Visits</b>	<b>10 hours</b>

<b>PEDAGOGY</b>	Visits and Reports
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<b>COURSE OUTCOMES</b>	<p><b>On completion of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Relate theoretical concepts with industrial practices; Observe application of laws and regulations in practice</li> <li>2. Illustrate mechanisms of unit operations observed in the industry</li> <li>3. Identify and justify processes involved in manufacture of products</li> <li>4. Obtain knowledge on equipment/ instruments/ tests not covered in syllabus</li> <li>5. Integrate and converge concepts taught across various courses into a particular application</li> <li>6. Appreciate the realistic view of the industry and sharpen skills for better career prospects</li> </ol>
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