

ANNA UNIVERSITY, CHENNAI
UNIVERSITY DEPARTMENTS
REGULATIONS – 2015
CHOICE BASED CREDIT SYSTEM
M. Tech. FOOD TECHNOLOGY

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) :

- I. To prepare students as a qualified food technologists for Food industries, research organization and teaching.
- II. To provide students with a solid foundation in basic sciences related to food technology, food science and food technology & engineering.
- III. To enable the students with good scientific and engineering knowledge so as to comprehend, design, and create food products and device for food industry and provide solutions for the challenges in food industry as well as in agriculture.
- IV. To train students in professional and ethical attitude, effective communication skills, teamwork skills and multidisciplinary approaches related to food technology and engineering.
- V. To provide student with an academic environment aware of excellence, leadership, written ethical codes and guidelines, and the life-long learning needed for a successful professional career.

PROGRAMME OUTCOMES (POs):

On successful completion of the programme,

1. Graduates will demonstrate knowledge of mathematics, food science and engineering.
2. Graduates will demonstrate an ability to identify, formulate and solve engineering problems related to food sector/industry.
3. Graduate will able to focus on the importance of safe processed nutritious food.
4. Graduates will demonstrate an ability to design or process food products as per the needs and specifications.
5. Graduates will demonstrate an ability to work in Food industries, research organization and teaching.
6. Graduate will demonstrate skills to use modern tools, immunological kits and equipment to analyze food prone infection and food spoilage.
7. Graduates will demonstrate knowledge of professional and ethical responsibilities.
8. Graduate will be able to understand economic importance of food products and food laws.
9. Graduate will show the understanding of impact of engineering solutions on the society and also will be aware of contemporary issues.
10. Graduate will develop confidence for self education and ability for life-long learning.

Programme Educational Objectives	Programme Outcomes									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
I		✓		✓	✓		✓			
II	✓	✓			✓				✓	
III	✓	✓		✓	✓					
IV						✓	✓	✓	✓	
V							✓	✓	✓	✓

			P O 1	P O 2	P O 3	P O 4	P O 5	P O 6	P O 7	P O 8	P O 9	P O 10	
YEAR 1	SEM 1	Food Chemistry and Microbiology	✓		✓			✓					
		Mechanical Engineering, Refrigeration and Cold Chain	✓	✓		✓					✓		
		Applied Statistics for Food Technology		✓									
		Food Processing and Preservation		✓	✓	✓	✓					✓	
		Elective 1			✓							✓	
		Elective 2			✓						✓	✓	
		Elective 3			✓							✓	
		Food Chemistry and Microbiology Lab	✓		✓		✓	✓					
	SEM 2	Food Process Engineering and Technology	✓			✓	✓						
		Safety and Quality Assurance in Food Processing					✓				✓		✓
		Food Fermentation Technology			✓		✓				✓		
		Elective 4			✓							✓	
		Elective 5			✓							✓	
		Elective 6					✓			✓	✓		✓
Elective 7						✓			✓	✓		✓	
Food Processing and Quality Control Lab					✓	✓			✓				
YEAR 2	SEM 3	Project Work Phase I		✓		✓	✓				✓	✓	
		Food Fermentation Technology Lab		✓	✓		✓						
		Advanced Food Analysis Techniques Lab			✓		✓	✓					
	SEM 4	Project Work Phase II		✓		✓	✓		✓		✓	✓	

ANNA UNIVERSITY : CHENNAI – 600 025.

UNIVERSITY DEPARTMENTS

REGULATIONS – 2015

CHOICE BASED CREDIT SYSTEM

I – IV SEMESTERS CURRICULUM AND SYLLABUS

M. TECH. FOOD TECHNOLOGY

SEMESTER – I

Sl.No	Course Code	Course Title	Category	Contact Periods	L	T	P	C
Theory								
1.	FD7101	Applied Statistics for Food Technology	FC	3	3	0	0	3
2.	FD7102	Food Chemistry and Microbiology	FC	4	4	0	0	4
3.	FD7103	Food Processing and Preservation	PC	3	3	0	0	3
4.	FD7104	Mechanical Engineering, Refrigeration and Cold Chain	FC	4	4	0	0	4
5.		Elective I	PE	3	3	0	0	3
6.		Elective II	PE	3	3	0	0	3
7.		Elective III	PE	3	3	0	0	3
Practicals								
8.	FD7111	Food Chemistry and Microbiology Lab	FC	4	0	0	4	2
TOTAL				27	23	0	4	25

SEMESTER – II

Sl.No	Course Code	Course Title	Category	Contact Periods	L	T	P	C
Theory								
1.	FD7201	Food Fermentation Technology	PC	3	3	0	0	3
2.	FD7202	Food Process Engineering and Technology	PC	3	3	0	0	3
3.	FD7203	Safety and Quality Assurance in Food Processing	PC	3	3	0	0	3
4.		Elective IV	PE	3	3	0	0	3
5.		Elective V	PE	3	3	0	0	3
6.		Elective VI	PE	3	3	0	0	3
7.		Elective VII	PE	3	3	0	0	3
Practicals								
8.	FD7211	Food Processing and Quality Control Lab	PC	4	0	0	4	2
TOTAL				25	21	0	4	23

SEMESTER - III

Sl.No	Course Code	Course Title	Category	Contact Periods	L	T	P	C
Practicals								
1.	FD7311	Advanced Food Analysis Techniques Lab	PC	4	0	0	4	2
2.	FD7312	Food Fermentation Technology Lab	PC	4	0	0	4	2
3.	FD7313	Project work Phase I	EEC	12	0	0	12	6
Total				20	0	0	20	10

SEMESTER – IV

Sl.No	Course Code	Course Title	Category	Contact Periods	L	T	P	C
Practicals								
1.	FD7411	Project work – Phase II	EEC	12	0	0	24	12
Total				12	0	0	24	12

TOTAL CREDITS : 70

Foundation Core (FC)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.		Food Chemistry and Microbiology	FC	4	4	0	0	4
2.		Mechanical Engineering, Refrigeration and Cold Chain	FC	4	4	0	0	4
3.		Applied Statistics for Food Technology	FC	3	3	0	0	3
4.		Food Chemistry and Microbiology Lab	FC	4	0	0	4	2

Professional Core (PC)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.		Food Process Engineering and Technology	PC	3	3	0	0	3
2.		Food Processing and Preservation	PC	3	3	0	0	3
3.		Safety and Quality Assurance in Food Processing	PC	3	3	0	0	3
4.		Food Fermentation Technology	PC	3	3	0	0	3
5.		Food Fermentation Technology Lab	PC	4	0	0	4	2
6.		Advanced Food Analysis Techniques Lab	PC	4	0	0	4	2
7.		Food Processing and Quality Control Lab	PC	4	0	0	4	2

Professional Electives (PE)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	FD7002	Chemical Engineering in Food Industry	PE	3	3	0	0	3
2.	FD7006	Food Packaging Technology	PE	3	3	0	0	3
3.	FD7001	Cereal, Pulse and Oilseed Technology	PE	3	3	0	0	3
4.	FD7008	Fruit and Vegetable Technology	PE	3	3	0	0	3
5.	FD7010	Meat, Fish and Poultry Technology	PE	3	3	0	0	3
6.	FD7005	Flavour, Spices and Plantation Products	PE	3	3	0	0	3
7.	FD7003	Control of Food Infestations	PE	3	3	0	0	3

8.	FD7004	Environmental Issues in Food Industry	PE	3	3	0	0	3
9.	FD7011	Sensory Attributes and Evaluation of Foods	PE	3	3	0	0	3
10.	FD7007	Food Plant Equipment	PE	3	3	0	0	3
11.	FD7009	Functional Foods and Ingredients	PE	3	3	0	0	3
12.	BT7076	Metabolic Process and Engineering	PE	3	3	0	0	3

Employability Enhancement Courses (EEC)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.		Project work – Phase I	EEC	8	0	0	8	6
2.		Project work – Phase II	EEC	24	0	0	24	12
3.		Food Product Design and Development	EEC	3	3	0	0	3
4.		Food Supply Chain Management	EEC	3	3	0	0	3
5.		New Process and Production Systems for Food	EEC	3	3	0	0	3
6.		Dairy Processing	EEC	3	3	0	0	3
7.		Establishment and Management of Food Industry Systems	EEC	3	3	0	0	3
8.		Economics and Trade in Food	EEC	3	3	0	0	3

OBJECTIVE

The Course is aimed to explain the use of statistical methods which are mostly used in food and biotechnology and the corresponding basics in form of case studies. The focus should be on understanding how and when to use the appropriate statistical techniques. Emphasis has to be placed on prerequisites (statistical reasoning and planning of experiments) and the appropriate use of parametric statistical methods.

UNIT I PROBABILITY AND ITS DISTRIBUTIONS 6

Axioms of Probability-Addition and Multiplication theorems- Binomial, Poisson and Normal Distributions.

UNIT II CURVE FITTING AND TIME SERIES 9

Curve fitting by method of Least Square - Regression analysis - Least Square Approximation - Fitting of non-linear curves; Correlation and Rank correlation coefficients; partial and multiple correlation and regression; Time Series-Moving Average method - Method of least squares - Measures of Seasonal variation.

UNIT III SAMPLING DISTRIBUTIONS 9

Introduction to sampling techniques and their application to Food Technology-Fundamental concepts of acceptance sampling plans; single; double and sequential sampling plans; use of sampling inspection tables for selection of single and double sampling plans; introduction to sampling techniques and their application to consumer preference studies; acceptance sampling by attributes and variables. Tests based on Normal, students 't' test , F and chi-square test- Goodness of fit Type I and Type II Error – Simple Problems.

UNIT IV DESIGN OF EXPERIMENTS AND QUALITY CONTROL 12

Analysis of variance - One-way classification - Completely Randomized Design -Two way classification - Latin Square Design connected to Food Technology - limits missing plot technique - Factorial experiments; experimental designs in sensory evaluation.

UNIT V QUALITY CONTROL PERTAINING TO FOOD TECHNOLOGY 9

Introduction to statistical quality control; control charts for variables and Process Control; histogram; mean and range charts; statistical basis - Process control, control charts of measurements and attributes, tolerance limits.

TOTAL: 45 PERIODS**OUTCOME**

On completion of the course the students are expected to gain knowledge on

- Analyzing and representing data
- Clear picture of sampling distribution Designing experiments
- Statistical quality control techniques pertain to Food Technology

REFERENCES:

1. Gurumani, N. "An Introduction to Bio Statistics", MJP Publishers, 2004
2. Kapur, J.N. and Saxena, H.C. "Mathematical Statistics", S.C Chand, 1997
3. Vittal, P.R. and Malini, V. "Statistical and Numerical Methods", Margham Publications, 2007
4. Veerarajan, T. "Probability, Statistics and Random Processes", 2nd Edition -Tata McGraw-Hill, 2004

OBJECTIVE

The course is targeted to develop the knowledge of students in Food Chemistry and Food Microbiology at advanced level. This is necessary for effective understanding of food processing and technology subjects. This course will enable students to appreciate the similarities and complexities of the chemical and microbial components in foods.

UNIT I WATER RELATIONS IN FOOD 6

Water relationships in foods: water activity and its relevance to deteriorative processes in foods (chemical, enzymatic, physical and microbial changes); Glass transitions and molecular mobility in foods, their relevance to quality and shelf life of food systems; Anticaking agents – definition, role in preventing spoilage, mode of action, permitted list of anticaking agents and food application- INS numbering - JECFA and Food Chemical Codex standards- permissible levels under Indian food laws.

FOOD LIPIDS, ANTIOXIDANTS 6

Chemistry of oils and fats (Review), free radical chemistry, reactive oxygen, photosensitized oxidation, metal catalyzed reactions, Antioxidants: chemistry and mechanisms of action, techniques of evaluation of antioxidant activity, uses - INS numbering - JECFA and Food Chemical Codex standards- permissible levels under Indian food laws.

UNIT II FOOD PROTEINS AND ENZYMES; STARCH, HYDROCOLLOIDS AND GUMS 12

Chemistry, structure and functions of amino acids and proteins (Review). Chemistry and structure of food proteins, enzymic reactions, kinetics, Maillard reactions, enzymic browning, Role of enzyme in food processing. Functional properties of proteins: modified proteins, application in product formulation. Starch, hydrocolloids and gums: occurrence, functions in food systems, properties, gelatinization, retro gradation and modified starches; Food carbohydrates: structural, analytical, physicochemical, nutritional and functional aspects of small molecular weight carbohydrates and polysaccharides of plant and microbial origin; Emulsifiers- role of emulsifiers, different classes of emulsifiers and their chemical structure; Selection of emulsifier based on Hydrophilic and Lipophilic balance (HLB) and its application; role of different stabilizers and other substances in emulsion stability; Thickeners - definition, chemical structure, role in food processing and product end characteristics, list of permitted thickeners and food applications; INS numbering - JECFA and Food Chemical Codex standards - permissible levels under Indian food laws.

UNIT III COLOURS AND FLAVOURS 12

Colour – Natural and synthetic food colors, their chemical structure, shades imparted, stability, permitted list of colours, usage levels and food application. Chemistry of food flavour; Philosophy and definitions of flavour, Flavourmatics / flavouring compounds, Technology for flavour retention- off flavours & food taints; INS numbering - JECFA and Food Chemical Codex standards - permissible levels under Indian food laws.

UNIT IV FOOD SPOILAGE 12

History of microbiology of food; Microbial growth pattern, physical and chemical factors influencing destruction of micro-organisms; Types of micro-organism normally associated with food-mold, yeast and bacteria; Microbial growth in food: intrinsic, extrinsic and implicit factors; Micro-organism in natural food products and their control; Contaminants of food-stuffs, vegetables, cereals, pulses, oilseeds, milk and meat during handling and processing; Biochemical changes caused by microorganisms, deterioration of various types of food products.

UNIT V FOOD PATHOGENS**12**

Food poisoning and microbial toxins, Food borne intoxicants and mycotoxins; Microbial interactions; Use of antimicrobial chemicals - organic acids, sugars, sodium chloride, nitrites, phosphates, sulphites, benzoates, sorbates / propionates naturally occurring antimicrobials – Their mode of action; Tolerance of microbes to chemical and physical methods in various foods; Effects on enzymes and other proteins; death kinetics of microbes; Combination systems. Adaptation phenomena and stress phenomena; Effect of injury on growth or survival; Microbial standards for different foods.

TOTAL : 60 PERIODS**OUTCOME**

On completion of the course the students are expected to

- Be able to understand the significant role of food biomolecules.
- Grasp the functional role of food components and their interaction in food products in terms of color, flavor, texture and nutrient composition
- Understand the significance and role of microbes in fermentation, spoilage and food borne infectious diseases

REFERENCES:

1. Chopra, H.K and Panesar, P.S. "Food Chemistry", Narosa, 2010
2. Damodaran, S., Parkin, K.L. and Fennema, O.R. "Food Chemistry", 4th Edition, CRC / Taylor & Francis, 2008
3. Belitz, H.D., Grosch, W and Schieberle, P. "Food Chemistry", 3rd Edition, Springer, 2004
4. Walstra, P. "Physical Chemistry of Foods", Marcel Dekker, 2003
5. Adams, M.R. "Food Microbiology", New Age International, 1995
6. Frazier, William M.C and Dennis, C.W. "Food Microbiology", 4th Edition, Tata Mc-Graw-Hill, 1988
7. Vijaya, R.K. "Food Microbiology", MJP, 2007

FD7103**FOOD PROCESSING AND PRESERVATION****L T P C****3 0 0 3****OBJECTIVE**

To expose the students to the principles and different methods of food processing and Preservation

UNIT I INTRODUCTION TO FOOD PROCESSING AND PRESERVATION**6**

Sources of food, Importance of food processing, principles and methods of food processing, Perishable and Non-perishable foods, Factors affecting food spoilage, Scope and benefits of industrial food preservation.

UNIT II PROCESSING AND PRESERVATION BY HIGH TEMPERATURE METHODS**12**

Use of High temperature- Principle and equipments: Canning- The art of appertizing; categories of foods for canning; spoilage of canned foods, storage of canned foods; Influence of canning on the quality of food ,blanching, pasteurization, sterilization, drying, concentration.

UNIT III PROCESSING AND PRESERVATION BY LOW TEMPERATURE METHODS**9**

Use of low temperature – Principles, equipment and effect on quality: Chilling, cold storage. Principles of food freezing: freezing point of foods, Psychrometric chart, Freeze concentration, freeze drying, IQF.

UNIT IV PROCESSING AND PRESERVATION BY NON-THERMAL METHODS 12

Preservation of foods by chemicals, antioxidants, mould inhibitors, antibodies, acidulates, Preservation by salt & sugar – Principle, Method, Equipment and effect on food quality, Ultrasonic processing: Properties of ultrasonic, application of ultrasonic as processing techniques, IR heating, inductive heating and pulsed X-rays in food processing and preservation. Nanotechnology: Principles and applications in foods, Hurdle technology: Types of preservation techniques and their principles, concept of hurdle technology and its application.

UNIT V ROLE OF PACKAGING IN FOOD PRESERVATION 6

Packaging– Concepts, definition, Significance, classification; Packaging– Development, Retail/Unit, Packaging of foods –fresh and processed; Basic packaging materials, types of packaging, packaging for different types of foods.

TOTAL: 45 PERIODS

OUTCOME

- To understand the principles of food processing and preservation.
- To understand the role of different methods of preservation on different foods and their impact on the shelf life, quality, and other physical and sensory characteristics of foods.
- To familiarize with the recent methods of minimal processing of foods
- To understand the materials and types of packaging for foods

REFERENCES

1. Desrosier, N.W and Desrosier, J.N. “The Technology of Food Preservation”, 4th Edition, CBS, 1987
2. Khetarpaul, N. “Food Processing and Preservation”, Daya Publications, 2005
3. GopalaRao, “Essentials of Food Processing Engineering”, BS Publications, 2006
4. Fellows, P. J. “Food Processing Technology: Principles and Practices”, Wood Head Publishing, 1997
5. Ranganna, S. “Handbook of Canning and Aseptic Packaging” Vol. I, II & III, Tata McGraw – Hill, 2000

FD7104 MECHANICAL ENGINEERING, REFRIGERATION AND COLD CHAIN

L T P C
4 0 0 4

OBJECTIVE

The course is aimed to impart basic knowledge about engineering materials and cold chain value addition.

UNIT I MATERIALS, PROPERTIES AND EQUIPMENTS 12

Introduction - Classification of Engineering Materials - Materials for Food Processing : Selection and, Physical, Chemical and Mechanical Properties - Design considerations - Corrosion and its Prevention- Process and equipment's - Arc and gas welding, Threaded joints, Shafts and Couplings, Belt drives, Chain drives, gear trains, Types of gears, Flywheel, Springs and Pressure Vessels.

UNIT II FANS, BLOWERS AND PUMPS 12

Introduction to turbo machines, Transfer of energy to fluids, Performance characteristics, Selection of centrifugal, axial and mixed flow machines for food processing applications – Problems

UNIT III THERMODYNAMICS AND HEAT TRANSFER**12**

Laws of Thermodynamics – Cycles for heating and cooling applications — Introduction to Heat transfer, Heat exchanger and its types - Mass transfer - vaporization - combined heat and mass transfers - Simple applied problems

UNIT IV REFRIGERATION SYSTEMS**12**

Introduction – Refrigerants – Properties - Vapor Compression Refrigeration Cycle – Analysis- Multi-pressure System, Cascade Systems - Vapor Absorption Systems- Heat pumps – Refrigeration system components - Compressors, Evaporators, Condensers and expansion devices and their functional aspects, system balancing and controls

UNIT V DESIGN OF COLD STORAGE**12**

Introduction, scope and importance of cold chain in food processing industry and retail chain, components of cold chain and integration, Design of cold storage and air conditioning systems - types of loads in cold storage and their calculations, Products going in cold chain, their temperature and humidity requirements, construction of cold storage, equipment selection, insulating materials, vapor barriers, design of cold storage for food products, care and maintenance of cold storage, packaging needs and their compatibility in cold chain, Temperature recording devices used during transport, documentation and traceability.

TOTAL: 60 PERIODS**OUTCOME**

On completion of the course the students are expected to have a

- Basic understanding about engineering materials, pumps, heat exchangers
Knowledge about principles of thermodynamics, refrigeration
- Problem solving ability on types of loads and capability to design cold storage systems for food products

REFERENCES :

1. Anand, M.L. "Refrigeration and Air-conditioning", Asian Books, 2002
2. Nag, P.K. "Engineering Thermodynamics", Tata McGraw-Hill, 2008
3. Khanna, O.P. "Material Science and Metallurgy", Dhanpat Rai Publication, 1995
4. Rajput, R.K. "Thermal Engineering", S. Chand Publication, 2000
5. Khurmi, R.S. and Gupta, J.K, Theory of machines, Eurasia Publication House, 1994.
6. Khurmi R.S and Gupta J.K, A Textbook of Machine Design, Euarsia publication house, 2005.
7. S. Yanniotis, B. Sunden, Heat Transfer in Food Processing, Recent Developments and Applications, WIT Press, Southampton, 2007
8. C. V. J. Dellino, Cold and Chilled Storage Technology, Springer II Edition, 1997

FD7111**FOOD CHEMISTRY AND MICROBIOLOGY LAB****L T P C****0 0 4 2****OBJECTIVE**

To develop skills related to chemical and microbial analysis of food using various techniques

EXPERIMENTS

1. Moisture estimation by Karl Fischer Titration
2. Determination of Soluble and insoluble Dietary Fibre
3. Determination of Fatty Acids in fats
4. Detection of allergens in Foods: soya, peanut
5. Estimation of Vitamin B by HPLC
6. Estimation of Fat soluble vitamins by HPLC
7. Determination of Antioxidant activity of foods / Determination of Proteins by Bradford and Microkjeldahl methods
8. Detection of Salmonella by ELISA
9. Rapid methods for hygiene monitoring in equipments and plants
10. Membrane filtration in detection of pathogens, enrichment and detection

TOTAL: 60 PERIODS

OUTCOME

The students will have the practical skills for: the sampling of foods and be able to apply physical, chemical and microbial techniques of analysis

FD7201

FOOD FERMENTATION TECHNOLOGY

L	T	P	C
3	0	0	3

OBJECTIVE

To acquaint with importance of food fermentation and its application in food sector.

UNIT I: FERMENTATION PATHWAYS FOR INDUSTRIAL PRODUCTS 9

Biochemical pathways of metabolic reactions for utilization of carbon sources and formation of different metabolites by micro organisms; possibility of control of the reactions for the increased formation of useful metabolites.

Strain Development - Various techniques of modifying the strains for increased production of industrial products. Use of chemicals, UV rays, genetic engineering to produce newer strains.

UNIT II: MEDIA FOR FERMENTATION 6

Importance of media components for production of industrial products by fermentation; use of different sources of carbon, nitrogen, minerals and activators for commercial fermentation; importance of pH, temperature and aeration in fermentation; optimization of fermentation media.

UNIT III: DIFFERENT TYPES OF FERMENTERS 9

Laboratory and plant fermenters; shake flasks and advantages; laboratory fermentation systems with various controls and sampling and data collection provisions; aeration and agitation; production fermenters; sterilization of media; cooling systems; inoculation, temperature and pH control systems; scale-up of fermentation process.

UNIT IV: DOWNSTREAM PROCESSING 9

Various equipments for product recovery; micro-filters and Ultra-filtration systems for separation of cells and fermentation medium and for concentration of medium containing product; chromatographic systems of separation; extraction of product with solvent; evaporation and crystallization; centrifugation, different types of centrifuges; drying techniques; instrumentation and controls.

UNIT V: FERMENTATIVE PRODUCTION

a) Foods

6

Processes for preparing fermented products including Yogurt (curd) and other Traditional Indian Products like idli, dosa, dhokla, shrikhand, etc., Soya based products like soya sauce, natto, etc., Cocoa, Cheese etc.; control of quality in such products. Alcoholic Beverages based on fruit juices (wines), cereals (whisky, beer, vodka etc.), sugar cane (rum) etc. Process description, quality of raw materials, fermentation process controls etc.

b) OTHER PRODUCTS FOR FOOD INDUSTRY APPLICATIONS

6

Fermentative Production of Organic acids like (Citric Acid, Lactic Acid), Amino Acids (Glutamic acid, Lysine), Antibiotics (Erythromycin, Penicillin), Oligosaccharides (GOS, FOS) and Polysaccharides (Dextran, Xanthan) etc.; flavour components and industrial enzyme production by micro-organisms; process descriptions and key controls for optimal production.

TOTAL: 45 PERIODS

OUTCOME

The students will learn the following skills

- To understand working principle behind fermentation and fermenter.
- To optimize the parameters for fermentation.

TEXTBOOKS

1. Joshi, V.K. and Ashok Pandey "Biotechnology: Food Fermentation, Microbiology, Biochemistry and Technology", Vol. I & vol. II Educational Publisher, 1999.
2. Pepler, H.J. and D. Perlman "Microbial Technology : Fermentation Technology", 2nd Edition, Vol. II Academic Press / Elsevier, 2004.
3. Potter, Norman N, and J.H. Hotchkiss "Food Science", 5th Edition, CBS Publishers, 1996.
4. Stanbury, P.F., A. Whitaker and S.J. Hall "Principles of Fermentation Technology", 2nd Edition Aditya Books (P) Ltd., 1997.

REFERENCES

1. Adams, M.R. and M.J.R. Nout "Fermentation and Food Safety", Aspen Publication, 2001.
2. Vogel, H.C. and C.L. Todaro "Fermentation and Biochemical Engineering Handbook : Principles, Process Design and Equipment", 2nd Edition, Standard Publishers, 2005.
3. El-Mansi, E.M.T. et al "Fermentation Microbiology and Biotechnology" 2nd Edition, CRC / Taylor & Francis, 2007.

FD7202

FOOD PROCESS ENGINEERING AND TECHNOLOGY

L T P C

3 0 0 3

OBJECTIVE

To acquaint with recent advances of Food Engineering and its Processes.

UNIT I: ENGINEERING PROPERTIES

9

Engineering properties of foods, their significance in equipment design, processing and handling of food and food products, steady state and unsteady state heat transfer, Numerical, graphical and analog methods in the analysis of heat transfer, Aerodynamics and hydrodynamic characteristics, drag coefficient, terminal velocity and Reynold's number, application of aerodynamic properties to the separation, pneumatic handling and conveying of food products, Mass transfer, molecular diffusion and diffusivity, equilibrium stage process, convective mass transfer co-efficient, mass transfer with laminar and turbulent flow.

UNIT II: THERMAL PROCESSING**6**

Advantages and disadvantages heat processing; heat resistance of microorganisms, concept of D, Z, Fo values and lethality in microbial inactivation, log reduction and Acceptable Quality levels; In Package and In flow thermal processing, heat penetration curves, cold point, calculation of processing time and temperature

UNIT III: MEMBRANE SEPARATION PROCESSING**6**

Theory of ultra-filtration and reverse osmosis, selection and types of membranes and properties, concentration polarization, mathematical description of flow through membrane, application and use in food industry.

UNIT IV: MODELING AND SIMULATION - DEHYDRATION AND FREEZING**12**

Thermodynamic properties of moist air, kinetics of water absorption, Evaporation and dehydration of foods, design of single and multi-effect evaporators, mechanics of movement of air through stationary bed, thin layer and thick layer bed drying, simulation models for drying systems, use of weather data for drying operations, design of dryers, New direction in freeze bed drying, cyclic pressure freeze drying, types of dryers including Microwave drying and vacuum drying, efficient drying systems, infrared heating, freezing of foods, types of freezing equipments, freeze concentration and drying, freezing point curves, phase diagrams, methods of freeze concentration, design problems.

UNIT V: EMERGING PROCESSING TECHNOLOGIES**12**

Principles of radiation processing, applications like disinfection, pasteurization and sterilization, extending shelf life of plant products, advantages and limitations; ionizing radiations, mechanisms of action, dosage for different applications in terms of products; equipment for generating ionizing radiation and exposure, Safety and Regulations governing irradiation of foods – India and abroad; product permitted to be irradiated and the levels; special labeling requirements of irradiated foods; Irradiation facilities in India; High Pressure Processing – principles, mechanism of action, advantages and disadvantages over conventional processing; Equipment and applications in food industry; Pulsed electric field processing - principles, mechanism of action, advantages and disadvantages over conventional processing; Equipment and applications in food industry. Ohmic heating of foods - principles, mechanism of action, advantages and disadvantages over conventional processing; Equipment and applications in food industry, Infra – red heating – principles, mechanism of action food application

TOTAL: 45 PERIODS**OUTCOME**

To understand and apply engineering principle to food processing

REFERENCES

1. Toledo, R.M. "Fundamentals of Food Process Engineering", 3rd Edition, Springer, 2007
2. Chandra, G.R. "Essential of Food Process Engineering", BS Publications, 2006.
3. Das, H. "Food Processing Operations Analysis", Asian Books, 2005.
4. Smith, P.G. "Introduction to Food Process Engineering", Springer, 2005.
5. Fellows, P.J. "Food Processing Technology: Principles and Practice", Wood head Publishing, 1997
6. Barbosa-Canovas, Gustavo *et al.*, "Novel Food Processing Technologies", Marcel Dekker/CRC, 2005

FD7203 SAFETY AND QUALITY ASSURANCE IN FOOD PROCESSING

L T P C

3 0 0 3

OBJECTIVE

To create awareness and understanding of quality control and assurance, risk assessments and GMPs, regulations in the food sector

UNIT I: QUALITY CONTROL AND ASSURANCE IN THE FOOD INDUSTRY 10

Defining quality, Objectives, importance and functions of quality control and quality assurance, quality cost; statistical quality control; material specifications, different types of defects, incoming and finished product inspection, acceptable quality levels, attributes and variables, role of distribution, acceptance by variable and attribute sampling, different sampling methods, process control and role of control charts; application examples in food industry.

UNIT II: ASSESSMENT OF FOOD SAFETY 9

Definition of food safety, importance of food safety; Causes of unsafe food; food hazards – biological, chemical and physical, allergens; sources and effects of food hazards; Risk assessment covering risk analysis, risk management and risk communication; GMO food and ingredient and its safety; concept of Acceptable Daily Intake of additives and its role in setting of standards.

UNIT III: GOOD MANUFACTURING PRACTICES AND HACCP IN FOOD INDUSTRY 10

Food chain, Food safety hazards, probability of occurrence, severity of food safety hazard and its risk, different control measures against the food safety hazards; Objectives and role of GMP; essentials, implementation and maintenance of GMP in a food factory. CODEX guidelines, FSSA and ISO standards on GMP; Role of HACCP, seven principles of HACCP, categorization and monitoring of control measures, HACCP implementation and maintenance

UNIT IV: FOOD REGULATION 10

Need for food laws and regulations, consumer protection; Indian Food Laws governing food industry- Food Safety and Standards Act 2006 and Regulations made there under, structure and functions of Food Safety and Standard Authority of India, detailed understanding of Labeling and claim Regulations and regulations related to product standards, novel foods and novel ingredients and product approval; Legal Metrology Act and Packaged commodity rules; mandatory BIS certification of food products, and Infant Milk Substitute Act; International standards and regulations – An overview of CODEX, EFSA, USFDA

UNIT V: FOOD SAFETY MANAGEMENT SYSTEMS 6

International organization of standardization (ISO), Food safety and quality management system, essentials of ISO 9001 and ISO 22000, accreditation and certification

TOTAL: 45 PERIODS

OUTCOME

- To understand the process control, sampling methods, and quality control applied /used in food industry
- To appreciate the mandatory concept of HACCP and pre-requisite programmes
- To be aware of food safety management systems and updated Food regulations

REFERENCES

1. Entis, P, "Food Safety: Old Habits, New Perspectives", ASM/Blackwell Publishing, 2007

2. Mortimone, S and Wallace, C. "HACCP" (Food Industry Briefing Series), Blackwell Science, 2007
3. Schmidt, R. H and Rodrick, G.E. "Food Safety Handbook", Wiley Interscience, 2005
4. Mehta, R and George, J. "Food Safety Regulations Concerns and Trade": The Developing Country Perspective", Macmillan, 2005
5. Paster, T. "The HACCP: Food Safety Training Manual", John Wiley, 2006

FD7211

FOOD PROCESSING AND QUALITY CONTROL LAB

L T P C
0 0 4 2

OBJECTIVE

To enable the students to understand the principles and methods of processing foods

EXPERIMENTS

1. Determination of absorbed oil content in fried foods.
2. Monitoring the primary and secondary oxidative rancidity in oils.
3. Determination of thermal load and Packaging of food products by retort processing of food products.
4. Determination of browning and color measurement in foods.
5. Preparation of fruit jams and their chemical analysis.
6. Canning of vegetables & fruits - fruit juices, squashes, syrups and ready-to-serve beverages.
7. Drying and osmotic dehydration of fruits and vegetables, quality control of processed products.
8. Spray drying of liquid foods
9. Freezing of foods.
10. Determination of Water activity and Shelf life calculation for moisture sensitive and oxygen sensitive foods.
11. Estimation of shelf life of seasonal fresh vegetables & fruits.
12. Food Packaging properties- Bursting strength, Tear resistance, Tensile strength, OTR, Gas transmission rate, Water vapor transmission rate.

TOTAL: 60 PERIODS

OUTCOME

The students will learn the following skills

- To apply different methods of extracting food components to analyze the quality of foods
- To understand and use different techniques of food processing to preserve foods
- To use instruments that analyze the physical properties

FD7311

ADVANCED FOOD ANALYSIS TECHNIQUES LAB

L T P C
0 0 4 2

OBJECTIVE

To enable the students to understand the principles and methods of advanced techniques in the analysis of foods

EXPERIMENTS

1. Determination of beta-carotene/lycopene in fruits using spectrophotometer
2. Estimation of nickel content in Hydrogenated vegetable oil by AAS.
3. Determination of added vitamin A in vanaspathy
4. Determination of sugars in soft drinks by HPLC.
5. Screening of corn/groundnuts for Aflatoxins by TLC method.
6. Determination of Refractive Index of oils
7. Detection of adulteration of honey using Polarimetry
8. Determination of antioxidant activity of foods by DPPH method
9. Measurement of colour of whole, liquid and semi-solid foods.
10. Texture Measurement of foods using Texture Analyser

TOTAL: 60 PERIODS

OUTCOME

The students will learn the following skills:

To apply different methods of extracting food components.

To use instruments that analyze the physical properties of foods

FD7312 FOOD FERMENTATION TECHNOLOGY LAB

L	T	P	C
0	0	4	2

OBJECTIVE

To enable the students to understand the processing and production of fermented food products and enzymes.

EXPERIMENTS

- 1) Production of fermented beverages by batch cultivation.
- 2) Plackett Burman Design and Response Surface Methodology for optimisation.
- 3) Production of probiotic food products.
- 4) Fermentation using enzymes- Cheese production.
- 5) Preparation of fermented soy products.
- 6) Production of food enzymes - amylase, protease, lipase.
- 7) Optimization and production of fermented bakery products.
- 8) Fermentative production of organic acids - Vinegar, citric acid, Lactic acid.
- 9) Production of any Indian fermented food product.
- 10) Fermented vegetable products – sauerkraut.
- 11) Cell disruption by homogenization.
- 12) Protein precipitation and aqueous two phase extraction.

TOTAL: 60 PERIODS

OUTCOME

The students will learn the following skills

- To operate the bioreactor.
- To optimize the parameters for fermentation.

REFERENCES

1. Bailey, J.E. and Ollis, D.F. "Biochemical Engineering Fundamentals", 2nd Edition, McGraw – Hill, 1988.
2. Lee, J.M. "Biochemical Engineering", PHI, 1992

3. Stanbury, P.F. *et al.*, "Principles of Fermentation Technology", 2nd Edition, Butterworth – Heinemann / Elsevier, 1995.
4. El-Mansi, E.M.T. *et al.*, "Fermentation Microbiology and Biotechnology", 2nd Edition, CRC / Taylor & Francis, 2007.
5. Pepler, H.J. and Perlman, D. "Microbial Technology" (vol. I Microbial Processes and Vol. II Fermentation Technology), 2nd Edition, Academic Press / Elsevier, 2004.

FD7313

PROJECT WORK – PHASE I

L	T	P	C
0	0	12	6

Students should identify one project that can be carried out in two phases either in-house or in industry or research institutes. When working outside, an internal guide from the department will monitor and review progress of work.

FD7411

PROJECT WORK – PHASE II

L	T	P	C
0	0	24	12

Students should extend their projects based on the preliminary research work during phase I. When working outside, an internal guide from the department will monitor and review progress of work.

FD7002

CHEMICAL ENGINEERING IN FOOD INDUSTRY

L	T	P	C
3	0	0	3

OBJECTIVE

To understand the principles of process calculations and principles of fluid mechanics and its application

UNIT I: MATERIAL AND ENERGY BALANCE

9

Units – dimensions – composition Material Balances – Steady state, unsteady state – energy balance – steady state and unsteady state.

UNIT II: FLUID MECHANICS

9

Fluids – concepts of fluid statics – flow through pipes – energy balance – flow measurement – pumps – fittings – valves.

UNIT III: HEAT TRANSFER

9

Phenomena of heat transfer – concepts and application of conduction – convection and radiation – Heat transfer equipments.

UNIT IV: MASS TRANSFER

9

Concepts of diffusion and mass transfer coefficients – application in mass transfer operations – Absorption, Distillation, Extraction, Leaching, Adsorption, Ion exchange, operations – Drying – Crystallisation.

UNIT V: MECHANICAL OPERATIONS**9**

Size Reduction – Principles – Equipments – Separation Techniques – Screening – Settling– Sedimentation – Filtration – Centrifugal separation – Ultrafiltration – Membrane Separation – Agitation – Mixing.

TOTAL: 45 PERIODS**OUTCOME**

To perform calculations pertaining to processes and operations To apply fluid mechanics principles to applied problems

REFERENCES

1. McCabe, W.L. and Smith, J.C. "Unit Operations in Chemical Engineering", 5th, 6th, & 7th, Editions, McGraw - Hill, 1993, 2001, 2005
2. Geankoplis, C.J. "Transport Processes and Separation Processes", 4th Edition, Prentice Hall India, 2003
3. Treybal, R.E. "Mass Transfer Operations", 3rd Edition, McGraw – Hill, 1981.
4. Perry, R.H and Green, D. W. "Perry's Chemical Engineer's Handbook", 7th Edition, McGraw – Hill, 1998

FD7006**FOOD PACKAGING TECHNOLOGY**

L	T	P	C
3	0	0	3

OBJECTIVE

The course aims to develop the knowledge of students in the area of packaging of foods and the related technology used. This course will enable students to appreciate the application of scientific principles in the packaging of foods.

UNIT I: INTRODUCTION TO FOOD PACKAGING**6**

An over view of packaging; Historical back ground of packaging; Packaging – Dimensions, Concepts, Functions, Definition, Significance, Classification; Hazards to the Packaging – Climatic Hazards, Mechanism of spoilage, Mechanical Hazards; Packaging Components – Unit/Retail Packaging, Intermediate/Secondary Packaging, Bulk/Transport Packaging; Traditional Packaging Materials; Importance of Packaging in Food industry; Status of current packaging.

UNIT II: FOOD PACKAGING MATERIALS AND TECHNIQUES**10**

Primary packaging media; Flexible packaging materials – Manufacturing, Properties and applications of Papers, Specialty Papers and Paper boards, Cellulose films, Polymer films, Aluminum Foils, Flexible Laminates, Co-extruded Films; Aluminium Collapsible Tubes, Flexible plastic tubes, Flexible Lamitubes; Rigid Packaging Materials – Manufacturing, Properties and Applications of Glass Bottles / Jars, Tin containers, Aluminium Containers, Composite Containers, Rigid Plastic Containers; Bulk Packaging Media; Manufacturing, Properties and Applications of Corrugated Fiber Board Boxes, Plastic Corrugated Boxes, Metal Drums, Fiber Board Drums, Plastic Drums, Ply-wood & Wooden Boxes; Ancillary Packaging Materials – Caps & Closures, Labels, Tapes, Reinforcement Materials, Angle Boards/Edge Guards, Cushioning Materials, adhesives, inks and lacquers.

UNIT III: PACKAGING SYSTEMS AND METHODS**12**

Bag-in-box; Microwave packaging; Active packaging; Intelligent packaging, Antimicrobial packaging ; Bio-degradable packages, Non-migratory bioactive polymers (NMBP) in food packaging, Advantages of NMBP, limitations, inherently bioactive synthetic polymers: types and applications, Polymers with immobilized bioactive compounds; Edible packages; Use of smart packaging by the food industry; Industrial packaging: unitizing – Shrink and Stretch Wrapping, palletizing, containerizing, Vacuum packaging, Gas flush packaging, Tamper-evident packaging; Modified Atmosphere Packaging (MAP), Controlled Atmosphere Packaging (CAP) & Aseptic Packaging, Retort pouch technology, Rigid and semi-rigid containers; Thermoformed packages – skin packaging and Blister Packaging; Flexible containers; form-fill-seal systems; Shelf-Life Studies; Testing & evaluation of packaging materials & packages– Time-temperature indicators (TTIs), Defining and classifying TTIs, Requirements for TTIs, The development of TTIs, Current TTI systems, Maximizing the effectiveness of TTIs, Using TTIs to monitor shelf-life during distribution, Using TTIs to optimize distribution and stock rotation. retail packs, transport packages and ancillary packaging materials.

UNIT IV: PACKAGING EQUIPMENTS**6**

Equipment and method- packaging equipment for solid, liquid semi-liquid food-types of fillers- filler for glass bottle, paper bottle, pouches, plastic cup thermoforming equipments; form -fill - seal equipments, sealing equipment, labeling, capping, canning and cartoningequipments.

PACKAGING OF FRESH AND PROCESSED FOODS**6**

Packaging requirements for different foods and processing methods- General classification and packaging types, varieties and trends; packaging of convenience foods; Packaging of Food products – Fresh Fruits and vegetables, Packaging of Fruit juices, Packaging of Jams and Jellies, Packaging of Pickles and Chutnies, Packaging of Fats and Edible oils, Packaging of Break-fast cereals, Packaging of Tea, Coffee & other Beverage products; Packaging of Soft Drinks; Packaging of Bakery products- Bread, Biscuits & Cakes; Packaging of Snack foods; Packaging of Ready-cook products; Packaging of Spices, Condiments, Oleoresins ; Packaging of Meat and Poultry Products; Packaging of Fish and other Sea-foods; Packaging of Dairy Products; Packaging requirements for Thermal-processed, Dehydrated, Frozen, Irradiated and other specially processed foods.

UNIT V: PACKAGING DESIGN & LAWS**5**

Food marketing and role of packaging- Packaging aesthetic and graphic design; Coding and marking, including bar coding; RFID in packaging and Consumer attitudes to food packaging materials.

Packaging – Laws and regulations, safety aspects of packaging materials; sources of toxic materials and migration of toxins into food materials; Packaging material residues in food products; Environmental & Economic issues, recycling and waste disposal.

TOTAL: 45 PERIODS**OUTCOME**

The students will gain knowledge on

- The different types of materials and media used for packaging foods.
- Hazards and toxicity associated with packaging materials and laws, regulation and the monitoring agencies involved in food safety, labeling of foods
- Methods of packaging, shelf life and food factors affecting packaging

REFERENCES

1. Robertson, G.L. "Food Packaging: Principles and Practice" (2nd Edition.), Taylor & Francis, 2006
2. Ahvenainen, R (Ed.) "Novel Food Packaging Techniques", CRC Press, 2003
3. Mathlouthi, M. "Food Packaging and Preservation", Aspen Publisher 1999
4. Han, J.H. (Ed.) "Innovations in Food Packaging", Elsevier /Academic Press, 2005
5. Crosby, N. T. "Food Packaging Materials", Applied Science Publishers, 1981

FD7001

CEREAL, PULSE AND OILSEED TECHNOLOGY

L T P C

3 0 0 3

OBJECTIVE

The course aims to develop the knowledge of students in the area of Cereal, pulse and oilseed processing and technology. This is necessary for effective understanding specific aspects of food processing related to these foods.

UNIT I: MAJOR CEREALS

15

Cereal Grains- new varieties, production trends of wheat, rice, barley, oat, corn, sorghum, pearl millet and minor millets in India; Structure and nutrient distribution in cereals, wheat types, Processing: Wheat- milling, (Atta and maida), quality aspects of flour, wheat proteins and their function, rheology of flour; Rice- Milling, milling machine, effect of different factors on milling yield and rice quality, parboiling of rice, effect of aging of rice, rice products-enrichment with vitamin and minerals, byproduct utilization; Parboiling, Quick cooking rice, Corn- Wet and dry milling, Barley-pearling and malting of barley. Oats- Milling

UNIT II: MAJOR CEREAL PRODUCTS

8

wheat based baked products – Bread, Biscuit, Cakes, Extruded products, Pizza, Chapattis, malting and malt products; Traditional Indian Products- Puffed Rice, flaked rice, Idli/Dosa/vada mixes and other savouries; Traditional and Fermented cereal products; Corn Products – Corn flakes, Corn starch, its derivatives syrup, germ oil; canned corn products, puffed product, Oat Products – Steel cut, rolled oats, quick cooking.

UNIT III: MINOR MILLETS AND ITS PRODUCTS

8

Minor millets- Basic agricultural aspects, structure and composition; storage, insect control; processing - basic malting process, malting plant, malt storage, malt characteristics, malt extract, uses; Flaked and extruded products; Traditional and Nutritional products of minor millets.

UNIT IV: PULSES AND LEGUMES

9

Basic agricultural aspects, structure, composition, storage, insect control, processing- Milling/splitting, dhal milling; processing of pulses- fermented and traditional products– puffed, flakes, flour, legume-based traditional products, flour based Indian sweets and savouries, soya milk, soy protein Isolate, soya paneer

UNIT V: OIL SEEDS

5

Oil seeds processing: Groundnut, mustard, soybean, sunflower, safflower, sesame and other oil bearing materials. Processing and utilization of soybean for value added products. Innovative products from oilseeds

TOTAL: 45 PERIODS

OUTCOME

On completion of the course the students are expected to

- Be able to understand and identify the know-how technologies used for cereals, pulses, oilseeds
- Understand the application of scientific principles, processing and utilization of value added products
- Enable students to appreciate the application of scientific principles and technology in the processing of materials

REFERENCES

1. Matz, S.A. "The Chemistry and Technology of Cereals as Food and Feed", 2nd Edition, CBS, 1996
2. Agro-Food Processing: Technology Vision 2020- Cereals Current Status and Vision', TIFAC (DST) Report, 1996
3. Potter, N. "Food Science", 5th Edition, CBS, 1996
4. Vaclavik, V.A. and Christian, E. W. "Essentials of Food Science", 2nd Edition, Springer, 2003
5. Hamm, W and Hamilton, R.J. "Edible Oil Processing", Blackwell / Ane Books, 2004.

FD7008

FRUIT AND VEGETABLE TECHNOLOGY

L	T	P	C
3	0	0	3

OBJECTIVE

The course aims to develop the knowledge of students in the area of vegetable and fruit processing and technology. This course will enable students to appreciate the application of scientific principles in the processing of these materials.

UNIT I: INTRODUCTION

6

Fresh fruits and vegetables – classification, Stages of growth; Maturity criteria; Maturity indices-computational, physical, chemical and physiological methods; Fruit ripening- changes during ripening

UNIT II: POST HARVEST MANAGEMENT

6

Post harvest losses-Mechanical injury-types; Technologies to control postharvest losses; Respiration and transpiration loss; methods to measure respiration and transpiration losses; Spoilage of fruit and vegetable; Enzymatic browning and its control, Storage practices: Bead atmosphere, hypotactic storage, cool store, Zero emerge cool chamber, stores striation

PRE – PROCESSING

6

Handling, grading, cleaning, pretreatments, transportation, pre cooling, chilling, modified atmosphere packaging, Controlled atmosphere storage - packaging, transportation, quality assurance.

UNIT III: PROCESSING OF FRUITS AND VEGETABLES

9

Overview of preservation methods of fruits and Vegetables - Different freezing and drying methods and equipments, problems associated with specific fruits and vegetables. Fruit Processing: blanching, ascorbic acid dip, SO₂ dip, sugar syrup preservation, salt preservation, vacuum dehydration, concentration and drying,

Different unit operations involved in fruit and vegetable Pulp/juice extraction, concentration, Bulk aseptic packaging of fruit and vegetable pulps, juices and concentrates; aseptic packaging of fruit drinks, juices and other products, Bottling, canning - essential principles, different types of cans.

UNIT IV: JUICES AND CONCENTRATES

9

Fruit Juice / pulp/ Nectar/Drinks, concentrates – General and specific processing, different packing including aseptic; Vegetable Purees/pastes - General and specific processing, processing of Tomato and tomato products, Natural colors, Fruit and Vegetable Fibres - specific processing,

UNIT V: FRUIT AND VEGETABLE PRODUCTS AND STANDARDS

9

Mango: Pulp, RTS, Squash canned Mango pulp, Toffee, amchur, pickle, Mango Powder, fruit bar; Papaya: Jam, Candy, RTS, Nectar, Squash, and Papain; Guava; Jelly, Cheese, Juice, Canned guava, Squash, Toffee; Grape: Raisin, Juice, Wine; Citrus Fruits: Jelly, Marmalade RTS Squash, candy. Ginger: Preserve, Candy, dried, Ginger pickle, RTS, Syrup; Onion: Dried Onion, Powder; Garlic: Dried Garlic, Powder, Oil; Potato: Wafer, starch, Papad; Cauliflower and cabbage: Dried cauliflower and cabbage, Sauerkraut, Pickle; Leafy vegetables; Dried Leafy Vegetables. (Spinach, Fenugreek, Coriander leaves, Curry leaves). Product and package specifications and standards; food regulations with respect to fruit and vegetable products.

TOTAL: 45 PERIODS

OUTCOME

On completion of the course the students are expected to

- Be able to understand and identify the specific processing technologies used for vegetables and fruits and the various products derived from these materials.
- Understand the application of scientific principles in the processing technologies, product specification and regulations.
- Grasp the changes in the composition of foods with respect to the type of processing technology used

REFERENCES:

1. Indira, G and Mohanram, M. "Fruits" NIN, 1996
2. Arthey, D and Ashwat P.R. "Fruit Processing: Nutrition, Products, and Quality Management", 2nd Edition, Springer, 2005
3. Alzamora, S.M., Tapia, M.S. and Lopez – Malo, A. "Minimally Processed Fruits and Vegetables: Fundamental Aspects and Applications", Springer, 2005
4. Salunkhe, D.K. and Kadam, S.S. "Handbook of Fruit Science and Technology: Production, Composition, Storage, and Processing", Marcel Dekker, 2005
5. Valpuesta, V. "Fruit and Vegetable Biotechnology" CRC / Wood Head Publication, 2002.

FD7010

MEAT, FISH AND POULTRY TECHNOLOGY

L T P C
3 0 0 3

OBJECTIVE

This course developed to denote the significance and necessity of organized animal product sector, controlled-advanced processing for efficient slaughtering of animals and poultry, value added egg and marine products.

UNIT I: INTRODUCTION**6**

Sources of meat and meat products in India, its importance in national economy; Effect of feed, breed and management on meat production and quality

UNIT II: SLAUGHTERING OF ANIMALS AND POULTRY**9**

Common and commercially important meats; pre and post slaughter handling, meat inspection and grading; animal welfare and safety in slaughter plant; Factors affecting post-mortem changes, properties and shelf-life of meat; Meat quality evaluation; Mechanical deboning, meat tenderization.

UNIT III: MEAT PROCESSING**12**

Structure and composition of meat, carcass chilling, ageing; storage of fresh meat-Modified atmosphere packaging, packaging of retail cuts; Processing and preservation-artificial tenderizing, chilling, freezing, curing, smoking, sausage manufacture, ready-to-eat meats and meat products; Aging, pickling and smoking of meat; Meat plant sanitation and safety, Byproduct utilization; Recent trends in meat processing; MMPO, MFPO, radiation processing; meat safety. Kosher and Halal certification, safety issues, regulation and quality assurance.

UNIT IV: EGG AND EGG PRODUCTS**9**

Structure, composition, nutritive value and functional properties of eggs and its preservation by different methods. Factor affecting egg quality and measures of egg quality; egg products- egg powder and frozen liquid eggs

UNIT V: FISH AND MARINE PRODUCTS**9**

Types of fish, composition, post harvest quality changes, post harvest losses, methods for assessing and preventing losses; structure, post-mortem changes in fish; handling of fresh water fish and marine fish; processing of fish, crab, prawns, seaweeds, canning, smoking, freezing and dehydration of fish; Fish sausage and home making; Freezing techniques and irradiation process, value addition, preparation of fish products (fermented fish, fish products, fish soups, fish powder, prawn powder and cutlets), seaweed products like pickles, hydrocolloids and fish oil.

TOTAL: 45 PERIODS**OUTCOME**

- Able to be aware of Feed, Breed Management on production and quality Get through Pre and Post slaughter handling techniques
- Capable of detailed understanding the detailed process flow of value added products from herbivores, poultry and marine species

REFERENCES:

1. Sofos, J.N. "Improving the Safety of Fresh Meat" Wood Head Publishing / CRC, 2005.
2. Toldra, F. "Handbook of Meat Processing", Wiley Blackwell, 2010
3. Kerry, J.P. "Improving the Sensory and Nutritional Quality of Fresh Meat", CRC/Wood Head, 2009
4. Venugopal, V. "Seafood Processing: Adding Value through Quick Freezing, Retort able Packaging and Cook-Chilling & other methods" (Food Science and Technology Vol. 13) , CRC press, 2006

OBJECTIVE

This course aims to explain the flavor, Spice and Plantation crops application in food industry

UNIT I: FLAVOR – INTRODUCTION**9**

Definition and Description of flavor, flavor profile. Measurement of flavor, particularly for wine, tea, coffee, spices and condiments. Natural and synthetic flavoring substances and their chemical characteristics. Flavor components/constituents of fruit and vegetables, coffee, tea and cocoa bean, spices and condiments

UNIT II: FLAVOR PROCESSING AND STABILITY STUDIES**9**

Effect of storage, cooking condition of various foods, processing, transportation and environmental condition on flavor components. Processing (industrial/commercial) technologies / methods of flavoring compounds of plant foods and their utilization and application; Recent developments in flavor research, processing and technology

UNIT III: PLANTATION CROPS**10**

Tea: Processing of tea, various types of tea, chemistry of constituents, fermentation, tea concentrates decaffeination process, Evaluation and grading of tea. Coffee: Processing of coffee, type of coffee, drying, fermentation, roasting and browning processes and their importance, chicory chemistry and technology. Analysis of tea and coffee, quality components - standards and specification of tea and coffee products. Processing and analysis of cocoa bean, beverages and study of factors that affect quality and uses for the consumers

UNIT IV: SPICES- CLASSIFICATION, QUALITY AND FUNCTIONAL VALUE**9**

Scope of spice processing in India, Types, spice qualities and specification, uses and physiological effects, components, antimicrobial and antioxidant properties, Medicinal value of condiments and spice products

UNIT V: SPICE PROCESSING**8**

Important spices added in food products, Processing and manufacturing of major Indian Spices: Pepper, cinnamon, cardamom, Nutmeg, saffron, turmeric and Ginger, minor spices- cloves, leafy spices, bay oregano, and seed spices. Spice processing machineries, packaging and handling of spices. Spice blends and extractives, essential and encapsulated oils, oleoresins – uses in processed foods

TOTAL: 45 PERIODS**OUTCOME**

- To understand the flavor profiling, analytical and processing techniques, quality aspects of flavor, spices and plantation products
- To acquire knowledge about stability studies on storage, processing, transportation

REFERENCES:

1. Heath, H.B. "Flavor Chemistry and Technology", CBS Publications, 2005
2. Spanier, A.M et al., "Food Flavor and Chemistry: Explorations into the 21st Century", RSC, 2005
3. Reineccius, G. "Flavor Chemistry and Technology", 2nd Edition, Taylor & Francis, 2006
4. Hirasa, K and Takemasa, M. "Spice Science and Technology", Marcel Dekker, 1998
5. Pruthi, S. "Quality Assurance in Spices and Spice Products (Modern methods of analysis)", Allied Publishers, 1999

CONTROL OF FOOD INFESTATIONS

L T P C

3 0 0 3

OBJECTIVE

This course is aimed to develop the knowledge about pest infestation, risk associated and its prevention

UNIT I: FOOD INFESTATION**9**

Post harvest problems of infestation in stored food grains, spices and processed foods and food processing units; Economic losses and safety issues.

UNIT II: COMMON PESTS**9**

Common pests involved in food storage and handling: pests and their habits: rodents, cockroaches, flies, ants, stored product insects – beetles, weevils, moths; birds and other vertebrates

UNIT III: RISK FROM PESTS**9**

Risk posed by pests to foods, food handlers and public; contamination, toxicology and microbiology, transmission of pathogens, food infection and food poisoning. Food hygiene: regulations, GHP and GMP relevant to pest control

UNIT IV: PEST PREVENTION**9**

Pest prevention- E-R-D Exclusion, restriction, destruction in food operations; building design and pest proofing, warehousing and storage areas, water and drains. Waste collection and disposal

UNIT V: PEST CONTROL**9**

Inspection and auditing, physical methods: use of monitoring traps/detectors – electric fly control units, pheromone traps; Chemical control methods – use of insecticides, pesticides and rodenticides, safety and environmental consideration of chemicals used for control, biopesticides; fumigation and disinfection; Pest awareness training and education. Integrated Pest Management in the food industry

TOTAL: 45 PERIODS**OUTCOME**

- To get awareness about post harvest issues in stored grains and processed foods caused by pests
- To improve the analyzing and problem-solving capabilities on risk assessments, prevention and control

REFERENCES:

1. Dennis, S. H. "Pests of Stored Foodstuffs and their Control", Springer, 2002
2. Hall, F.R and Menn, J.J. "Biopesticides: Use and Delivery", Humana Press, 1999
3. Rami, H., et al. "Integrated Pest Management: Potential, Constraints and Challenges Insect Pest Management: Field and Protected Crops", 2004
4. David Pimentel, Encyclopedia of Pest Management, Volume 2, CRC Press, 2007

OBJECTIVE

To create awareness about environmental issues in food industry

UNIT I: ENVIRONMENT AND POLLUTION**9**

Components of environment; Environmental pollutions, its measurements and management; Air pollution and its control; Water pollution and its control; Xenobiotic compounds; Pesticides and pest management; processes; Solid wastes and management; Microorganisms as components of the environment; microorganisms as indicators of environmental pollution; bioorganic pollution; microbial toxicants and pollutants, and their bio-degradation; biodegradation of plastics, biofouling and biofilms; bioremediation.

UNIT II: CONTROL OF AIR QUALITY**9**

Air duct design and room air distribution; air conditioning systems; clean-room air conditioning; important pollutants of air; properties of particulate matter and air pollution control methods; air quality in the processing plants, legal requirements.

UNIT III: WASTE WATER TREATMENT**9**

Waste water sources characteristics - standards for disposal of water, physical, chemical and biological characteristics of waste water; measurement of organic content in waste water; Physical unit operations in waste water treatment - screening; racks, mixing, flocculation, sedimentation, floatation, elutriation, vacuum filtration, incineration; chemical unit operations in waste water treatment - reaction kinetics; chemical precipitation, aeration and gas transfer process, rate of gas transfer, adsorption, disinfection; biological unit operations - aerobic and anaerobic

UNIT IV: STORAGE & DISPOSAL OF WASTE**9**

Types of waste generated; Non- degradable & biodegradable wastes, Solid waste storage and disposal methods- land-filling, burial, incineration, recycling; Biological treatment of food industry wastes, storage and disposal of liquid and gaseous waste; legal aspects related to storage and disposal; environmental laws; pests & their control.

UNIT V: UTILIZATION OF WASTE**9**

Methods of utilizing wastes to make value added products- generation of biogas, extraction of specific components, use in animal feeds, zero emission plants; recovery & recycling of materials.

TOTAL: 45 PERIODS**OUTCOME**

- To acquire knowledge about Environmental pollutions, its measurements and management To initiate projects on methods of utilizing wastes to make value added products
- To understand and design Air duct and room air distribution for the basic control of Air Quality, Waste Water Treatment

REFERENCES:

1. Moorthy, C.K. "Principles and Practices of Contamination Control and Clean rooms", Pharma Book Syndicate, 2003
2. Roday, S. "Hygiene and Sanitation in Food Industry", Tata McGraw – Hill Publishing, 1999
3. Wilson, C.L. "Microbial Food Contamination", 2nd Edition, CRC, 2008

4. Hester, R.E. and Harrison, R.M. "Food Safety and Food Quality", (Issues in Environmental Science and Technology), RSC, 2001
5. Potter, N. and Hotchkiss, J.H. "Food Science", 5th Edition, CBS, 1996

FD7011 SENSORY ATTRIBUTES AND EVALUATION OF FOODS

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OBJECTIVE

The course aims to develop the skills and knowledge of sensory science and analysis

UNIT I: SENSORY PERCEPTION

6

The perceptions of taste, smell and oral texture of foods; anatomy of the chemical senses- olfaction and taste; chemisthesis. Taste perception in food choice and control of eating.

UNIT II: SENSORY CHARACTERISTICS OF FOODS

9

Colour pigments in foods; artificial colours; colour perception. Classification of food flavours, Non-volatile and volatile flavour composition of foods; flavour perception. Rheology, classification of textural properties, structure and texture perception; Interactions between colour, flavour and texture.

UNIT III: SENSORY ANALYSIS OF FOODS

12

Basic requirements for sensory analysis- objectives, panel: size and screening, recruitment & training, testing environment & laboratory features, sensory threshold values: detection, difference, recognition & terminal thresholds analytical tests- discrimination tests- different types & descriptive tests- scaling procedures, flavour and texture profiling methods; simple and quantitative descriptive analysis. Measurement of off flavors and tastes; Data handling, analysis and presentation

UNIT IV: CONSUMER TESTING

9

Consumer surveys and tests; acceptance & preference tests, hedonic scales, ratio scales, ranking & rating tests, central location tests

UNIT V: SUBJECTIVE & OBJECTIVE METHODS OF EVALUATION

9

Instrumental methods of measuring sensory characteristics of foods- measurement of color, flavour and texture, electronic nose for aroma testing; relation between instrumental methods and sensory methods

TOTAL: 45 PERIODS

OUTCOME

- To understand the sensory perceptions, anatomy of chemical senses To understand sensory profiling methods and concepts
- To be aware of advanced analytical techniques for the sensory profiling using instrumentation methods

REFERENCES

1. Carpenter Lyon & Hasdell, "Guidelines for Sensory Analysis in Food Product Development and Quality Control", Springer, 2000
2. Marshall, David W. "Food Choice: And the Consumer", Blackie Academic & Professional / Chapman & Hall, 1995
3. Ashurst, P.R. "Food Flavorings", 3rd Edition, Aspen Publications, 1999
4. Reineccius, G. "Flavors Chemistry and Technology", 2nd Edition, Taylor & Francis, 2006
5. Otlés, S. "Methods of Analysis of Food Components and Additives", CRC/ Taylor & Francis, 2005
6. Moskowitz, H. R., et al. "Sensory & Consumer Research in Food Product Design & Development", Wiley-Blackwell, 2006

OBJECTIVE

To provide knowledge in the various type of equipment used for unit operations in food processing

UNIT I: MILLING AND EXTRUSION EQUIPMENTS**9**

Milling equipments used for rice and wheat, pearling and flaking equipment; dhal mills; Extrusion processing: principles; different types and design of extruders

UNIT II: WASHING, FILTRATION & CENTRIFUGATION EQUIPMENTS**9**

Different Fruits and Vegetable washing systems; Conveyor belts - types, material of construction, product specific conveyors; Design of screw, bucket, belt, oscillating and vibratory conveyors; filtration of liquid foods (dairy, fruit & vegetables); centrifugation systems: Solid bowl and disc bowl centrifuges; cyclone separator and self cleaning centrifuge.

UNIT III: MIXING, BLENDING & FILLING EQUIPMENTS**9**

Agitation and mixing of liquid foods, powders and pastes; Mixers -ribbon blenders, augur, nauta, cone.Liquid and powder filling machines - like aseptic system, form and fill (volumetric and gravimetric), bottling machines.

UNIT IV: HEAT PROCESSING & COOLING EQUIPMENTS**9**

Autoclaves - types, operation; Different drying systems - Spray, Fluidized bed, tunnel; evaporators; pasteurizers, steamer, roaster ovens, kettles, baking & confectionery equipmentsFreezing equipments - Plate, Tunnel, blast, IQF, Liquid nitrogen, Heat exchangers - Tubular and Plate; Refrigerated transport and transportation in insulated containers.

UNIT V: HYGIENIC DESIGN ASPECTS**9**

Basic principles: as applied to various equipment- sanitary pipes and fittings, pumps, machines, tanks, stirrers and mixers, pasteurizers; evaporators; thermo-compressors and; dryers; sterilizers and treatment by irradiation; waste water treatment installations, Clean-in-Place (CIP) system; corrosion process and their control.

TOTAL: 45 PERIODS**OUTCOME**

To get through the principles, design and significance of

- Milling and extrusion equipments
- Downstream processing equipments
- Mixing, Blending and Filling Equipments
- Waste water treatment installations, Clean-in-Place (CIP) system

REFERENCES:

1. Lopez, G.A. and Barbosa, C.G.V. "Food Plant Design", Taylor & Francis, 2005
2. Smith, P.G. "Introduction to Food Process Engineering", Springer, 2005.
3. Rao, M.A., Rizvi, S.S.H and Datta, A.K. "Engineering Properties of Food", 3rd Edition, Taylor & Francis, 2005
4. Proceedings of International Conference on Emerging Technology in Agricultural & Food Engg. IIT Kharagpur, "Food and Bio Process Engineering" Anamaya Publishers, 2005

OBJECTIVE

To impart the concept of nutraceuticals, functional ingredients and foods and their role in health and disease

UNIT I: NEED FOR FUNCTIONAL FOODS**6**

Lifestyle changes & diet, lifestyle diseases like cardiovascular diseases, diabetes, cancer and effects of diet in their control

UNIT II: NUTRACEUTICALS & PHYTOCHEMICALS**15**

Definition of Nutraceuticals and difference from nutrients. Traditional Health Sciences including Ayurveda, Unani, Chinese etc. Benefits of Nutraceuticals in controlling certain diseases; Natural Occurrence of certain phytochemicals and their usefulness in functional foods with following examples: Antioxidants and Flavonoids; Omega-3 Fatty Acids; Carotenoids; Dietary Fibre; Phytoestrogens; Glucosinolates; Organosulphur Compounds etc. their effectiveness in specific disease conditions; other functional ingredients in foods such as peptides, fatty acids, antimicrobial compounds; Clinical Studies including Structure-Activity relationship of active compound. Dosage for effective control of disease or health benefit with adequate safety; Studies with animals and humans; acute and chronic studies. Sea weeds as functional foods and as source of functional ingredients.

UNIT III: PRE- & PROBIOTICS**9**

Usefulness of Probiotics & Prebiotics in gastrointestinal health and other benefits. Examples of useful microbes and their benefits; Prebiotic ingredients in foods; types of prebiotics and their effects on gut microbes.

UNIT IV: PREPARATION OF PHYTOCHEMICALS FROM PLANT MATERIALS**6**

Care in handling and storage of raw material with minimal damage to sensitive bioactive compounds; Extractive methods for maximum recovery and minimal destruction of active material; Stability studies.

UNIT V: DEVELOPMENT OF FUNCTIONAL FOODS**9**

Developing Functional Foods; Use of bioactive compound in appropriate form with protective substances and activators; Effect of environmental conditions in food matrix on activity of bioactive compound; Effects of processing conditions and storage; Development of biomarkers to indicate efficacy of functional ingredients; Research frontiers in functional foods; delivery of immunomodulators / vaccines in functional foods.

TOTAL: 45 PERIODS**OUTCOME**

- To understand the different nutrient and non-nutrient functional ingredients and their sources
- To understand the role of phytochemicals and nutraceuticals in health and their therapeutic applications

REFERENCES

1. Wildman, Robert E.C. "Handbook of Nutraceuticals and Functional Foods", 2nd Edition, CRC/Taylor & Francis, 2007
2. Schmidl, M.K. and Labuza, T.P. "Essentials of Functional Foods", Aspen Publications, 2000
3. Vaclavik, V.A. and Christian, E.W. "Essential of Food Science", 2nd Edition, Springer, 2005

OBJECTIVES

To familiarize the student with quantitative approaches for analyzing cellular metabolism and the use of theoretical and experimental tools that can give insights into the structure and regulation of metabolic networks. A central aspect of the course is to identify the optimal strategy for introducing directed genetic changes in the microorganisms with the aim of obtaining better production strains. Case studies will be taken up on metabolically-engineered products and processes in various expression systems.

UNIT I - METABOLIC FLUX ANALYSIS**9**

Introduction to metabolic engineering, comprehensive models of cellular reactions with stoichiometry and reaction rates; metabolic flux analysis of exactly/over/under determined systems. Shadow price, sensitivity analysis.

UNIT II - TOOLS FOR EXPERIMENTALLY DETERMINING FLUX THROUGH PATHWAYS**9**

Monitoring and measuring the metabolome, Methods for the experimental determination of metabolic fluxes by isotope labeling metabolic fluxes using various separation-analytical techniques. GC-MS for metabolic flux analysis, genome wide technologies: DNA /phenotypic microarrays and proteomics.

UNIT III CONSTRAINT BASED GENOMIC SCALE METABOLIC MODEL**9**

Development of Genomic scale metabolic model, Insilico Cells:studying genotype-phenotype relationships using constraint-based models, case studies in E. coli, S.cerevisiae metabolic network reconstruction methods, optimization of metabolic network, Identification of targets for metabolic engineering; software and databases for genome scale modeling

UNIT IV METABOLIC CONTROL ANALYSIS AND KINETIC MODELING**9**

Fundamental of Metabolic Control Analysis, control coefficients and the summation theorems, Determination of flux control coefficients. Multi-substrate enzyme kinetics, engineering multifunctional enzyme systems for optimal conversion, and a multi scale approach for the predictive modeling of metabolic regulation.

UNIT V CASE STUDIES IN METABOLIC ENGINEERING**9**

Metabolic engineering examples for bio-fuel, bio-plastic and green chemical synthesis. Study of genome scale model in various systems for the production of green chemicals using software tools. Validation of the model with experimental parameters.

TOTAL : 45 PERIODS**OUTCOME**

This course work will provide essential knowledge for the students to make their career in bioprocess Industries

TEXT BOOKS

1. Stephanopoulos, G.N. "Metabolic Engineering: Principles and Methodologies". Academic Press / Elsevier, 1998.
2. Lee, S.Y. and Papoutsakis, E.T. "Metabolic Engineering". Marcel Dekker, 1998.
3. Nielsen, J. and Villadsen, J. "Bioreaction Engineering Principles". Springer, 2007.
4. Smolke, Christiana D., "The Metabolic Pathway Engineering Handbook Fundamentals", CRC Press Taylor & Francis, 2010.

REFERENCES

1. Voit, E.O. "Computational Analysis of Biochemical Systems : A Practical Guide for Biochemists and Molecular Biologists". Cambridge University Press, 2000.
2. Scheper, T. "Metabolic Engineering" Vol 73 (Advances in Biochemical Engineering Biotechnology) Springer, 2001.
3. Cortassa, S. et al, " An Introduction to Metabolic and Cellular Engineering", World Scientific Publishing, 2002.
4. Kholodenko, Boris N and H. V. Westerhoff "Metabolic Engineering in the Post Genomic Era", Horizon Bioscience, 2004.