# UNIVERSITY DEPARTMENTS ANNA UNIVERSITY CHENNAI : : CHENNAI 600 025 REGULATIONS - 2009 CURRICULUM I TO IV SEMESTERS (FULL TIME) M.TECH. FOOD TECHNOLOGY

#### SEMESTER I

SL. NO	COURSE CODE	COURSE TITLE	L	Т	Ρ	С			
THE	THEORY								
1.	FD 9111	Principles of Mechanical Engineering, Refrigeration & Cold Chain	3	0	0	3			
2.	FD 9112	Principles of Chemical Engineering in Food Industry	3	0	0	3			
		(for Science stream graduates)							
3.	FD 9113	Basic Food Chemistry and Microbiology	3	0	0	3			
		(for Engineering stream graduates)							
4.	FD 9114	Principles of Food Processing & Preservation	3	0	0	3			
		(for Graduates without Food background)							
5.	FD 9115	Food and Ingredient Functionality	3	0	0	3			
		(for Graduates with Food background)							
6.	FD 9116	Applied Statistics for Food Technology	3	0	0	3			
	FD 9117	Numerical Methods & Computer Programming	3	0	0	3			
7.	E1	Elective I							
8.	E2	Elective 2							
PR/	PRACTICAL								
9.	FD 9118	Chemical and Microbial Analysis of Food - Lab	0	0	6	3			
10	FD 9119	Advanced Food Analysis Techniques – Lab	0	0	6	3			
		TOTAL CREDITS	18	1	2	20			

#### SEMESTER II

SL. NO	COURSE CODE	COURSE TITLE	L	Т	Р	С			
THE	THEORY								
1.	FD 9121	Advanced Food Chemistry and Microbiology	3	0	0	3			
2.	FD 9122	Fermentation Technology	3	0	0	3			
3.	FD 9123	Food Process Engineering	3	0	0	3			
4.		Elective 3	3	0	0	3			
5.		Elective 4	3	0	0	3			
6.		Elective 5	3	0	0	3			
PRACTICAL									
7.	FD 9124	Food Processing & Quality Control Lab	0	0	6	3			
8.	FD 9125	Fermentation Technology Lab	0	0	6	3			
		TOTAL CREDITS	18	0	12	24			

# SEMESTER III

SL. NO	COURSE CODE	COURSE TITLE	L	Τ	Ρ	С		
THE	THEORY							
1.		Elective 6	3	0	0	3		
2.		Elective 7	3	0	0	3		
3.		Elective 8	3	0	0	3		
PRACTICAL								
4.	FD 9131	Project work – Phase I	0	0	12	6		
		TOTAL CREDITS	9	0	12	15		

### **SEMESTER IV**

SL. NO	COURSE CODE	COURSE TITLE	L	Т	Ρ	С		
PRACTICAL								
1.	FD 9141	Project work – Phase II	0	0	24	12		
		TOTAL CREDITS	9	0	24	12		

# LIST OF ELECTIVES SEMESTER I

SL.	COURSE	COURSE TITLE	L	Т	Ρ	С
NO	CODE					
1.	FD 9151	Economics and Trade in Food	3	0	0	3
2.	FD 9152	Cereal & Pulse Technology	3	0	0	3
3.	FD 9153	Sensory Attributes of Foods	3	0	0	3
4.	FD 9154	Food Laws & Regulatory Issues	3	0	0	3
5.	FD 9155	Enzymes in Food Technology	3	0	0	3

### SEMESTER II

SL.	COURSE	COURSE TITLE	L	Т	Ρ	С
NO	CODE					
1.	BT 9123	Immunotechnology	З	0	0	3
2.	FD 9156	Environmental Issues in Food Industry	3	0	0	3
3.	FD 9157	Food Product Design & Development	3	0	0	3
4.	BT 9162	Metabolic Process and Engineering	З	0	0	3
5.	FD 9158	Fruit & Vegetable Technology	3	0	0	3
6.	FD 9159	Food Plant Equipments	3	0	0	3

# SEMESTER III

SL.	COURSE	COURSE TITLE	L	Т	Ρ	С
NO	CODE					
1.	FD9160	Bioreactor Design	3	0	0	3
2.	FD9161	Bio-thermal Process Engineering	3	0	0	3
3.	FD9162	Quality Assurance & Safety in Food Processing	3	0	0	3
4.	FD9163	Food Packaging Technology	3	0	0	3
5.		New Process Principles and Production Systems for	3	0	0	3
	FD9104	Food				
6.	FD9165	Animal Product Technology	3	0	0	3

#### FD 9111 PRINCIPLES OF MECHANICAL ENGINEERING, REFRIGERATION & COLD CHAIN L T P C 3 0 0 3

### UNIT I ENGINEERING MATERIALS

Ferrous and Non Ferrous CI, Steel, S.S. Lead, Tin, AI, Cu – Types – Properties – Mechanical, Thermal & Chemical Corrosion and Prevention.

#### UNIT II JOINING

Vc and gas welding – Threaded joints – Shafts and Couplings – Belt drives, Chain drives, gear trains – Types of gears – flywheel – springs – Pressure Vessels.

### UNIT III PUMPS

Types – Centrifugal – Reciprocating and other types – Components of – Prevention of Leaks – Seals. Heat exchangers – Principle – Types – applications – Compressors and blowers.

#### UNIT IV BASIC PRINCIPLES OF THERMODYNAMICS

Laws of Thermodynamics – application – simple applied problems.

### UNIT V PRINCIPLE OF REFRIGERATION

Vapour compression and absorption systems – complete cycle – Definition of terms – Design of cold storage and air conditioning systems - types of loads in cold storage and their calculations, design of cold storage for food products, construction of cold storage, equipment selection, insulating materials, vapour barriers, care and maintenance of cold storage; concept of freezing – refrigeration requirements – Packing of frozen foods.

#### TEXT BOOKS / REFERENCES

- 1. Khanna, O.P. "Material Science and Metallurgy", Dhanpat Rai Publication, 1995.
- 2. Rajput "Thermal Engineering", S. Chand Publication, 2000.
- 3. Nag, P.K. "Engineering Thermodynamics" V.B. Bhandari.
- 4. Anand, M.L. "Design of Machine Elements Tata McGraw Hill.
- 5. Refrigeration and Air-conditioning Asian Books Pvt. Ltd.,

### FD 9112 PRINCIPLES OF CHEMICAL ENGINEERING IN FOOD INDUSTRY (for Science stream graduates)

#### UNIT I MATERIAL AND ENERGY BALANCE

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

#### UNIT II FLUID MECHANICS

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

#### UNIT III HEAT TRANSFER

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

### TOTAL: 45 PERIODS

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#### UNIT IV MASS TRANSFER

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

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

#### TEXT BOOKS

#### TOTAL: 45 PERIODS

- 1. McCabe, W.L. and J.C. Smith "Unit Operations in Chemical Engineering", 5<sup>th</sup>, 6<sup>th</sup>, & 7<sup>th</sup>, Editions, McGraw Hill, 1993, 2001, 2005.
- 2. Geankoplis, C.J., "Transport Processes and Separation Processes", 4<sup>th</sup> Edition, Prentice Hall India, 2003.

#### REFERENCES

- 1. Treybal, R.E. "Mass Transfer Operations", 3<sup>rd</sup> Edition, McGraw Hill, 1981.
- 2. Perry, R.H. and D. W. Green "Perry's Chemical Engineer's Handbook", 7<sup>th</sup> Edition, McGraw Hill, 1998.

### FD 9113 BASIC FOOD CHEMISTRY AND MICROBIOLOGY (for Engineering Stream Graduates)

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### UNIT I CARBOHYDRATES

Monosaccharides, Disaccharides, Oligosaccharides – Chemical reactions – Functional properties of Sugars in foods.

Polysaccharides: Starches - Sources – Structure and composition – Gelatinization – Gelation. Starch uses in food system - Modified starches – Waxy starches.

Pectin in foods - Sources – Gel formation, Uses in Jelly making – Gums and Seaweed polysaccharides.

#### UNIT II FATS AND OILS , PROTEINS & FOOD GROUPS & COMPOSITION 6 a) Fats And Oils

Structure and composition - Nomenclature – Physical and chemical properties of oils and fats; Processing of Oils and Fats – Refining, Hydrogenation, Interesterfication and winterization; Deterioration of Oils – Hydrolytic rancidity, Oxidative rancidity - Prevention – Fat replacements.

#### b) Proteins

Properties & reactions of proteins in food systems: Dissociation, optical activity, solubility, hydration, swelling, foam formation & stabilization, gel formation, emulsifying effect, thickening & binding, amino acids in Maillard reaction, denaturation; Food enzymes; Texturized proteins; Food sources, functional role and uses in foods.

#### c) Food groups & Composition

Food groups, proximate composition, food composition tables- uses, food composition data bases.

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### UNIT III MICROBIAL NUTRITION, GROWTH AND METABOLISM

Nutritional requirements of bacteria; different media used for bacterial culture; growth curve and different methods to quantify bacterial growth; aerobic and anaerobic bioenergetics and utilization of energy for biosynthesis of important molecules.

#### UNIT III MICROBES ASSOCIATED WITH FOODS & FOOD SPOILAGE

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. Microbiological spoilage problems associated with typical food products; Factors affecting spoilage of foods; Biochemical changes caused by micro-organisms.

### UNIT V FOOD BORNE INFECTIONS

Food borne infections and food poisoning, Microbial toxins, Gram Negative and Gram positive food borne pathogens; Toxigenic algae and fungi; Food borne viruses; helminths, nematodes and protozoa. Detection & Enumeration of microbes in foods; Indicator organisms and microbiological criteria; Microbial standards for different foods.

### **TOTAL: 45 PERIODS**

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### **TEXT BOOKS**

- 1. Vaclavik, V.A. and E.W. Christian "Essential of Food Science", 2<sup>nd</sup> Edition, Springer, 2005.
- 2. Belitz, H.D., W. Grosch and P. Schieberle "Food Chemistry", 3<sup>rd</sup> Rev. Edition, Springer, 2003.
- 3. Jay, J.M. "Modern Food Microbiology", 4<sup>th</sup> Edition, CBS, 2003.
- 4. Adams, M.R. and M.O. Moss "Food Microbiology", 2<sup>nd</sup> Edition, Panima, 2002.
- 5. Khetarpaul, Neelam "Food Microbiology" Daya Publishers, 2006.

#### REFERENCES

- 1. Gopalan C., B.V. Rama Sastri and Balasubramanian, S.C. "Nutritive Value of Indian Foods, NIN, ICMR, 1989.
- 2. Walstra, P. "Physical Chemistry of Foods", Marcel Dekker, 2003.
- 3. Cui, S.W. "Food Carbohydrates : Chemistry, Physical Properties and Applications, CRS / Taylor & Francis, 2005.
- 4. Rajah, K.K. "Fats in Food Technology", Blackwell Publishing, 2004.
- 5. Montville, T.J. and K.R. Matthews "Food Microbiology: An Introduction", ASM Press, 2005.
- 6. Labb'e, R.G. and S. Garcia "Guide to Food Borne Pathogens" John Wiley, 2001.

#### FD 9114 PRINCIPLES OF FOOD PROCESSING & PRESERVATION (for Graduates without Food background)

#### UNIT I PRINCIPLES OF FRESH FOOD STORAGE

Nature of harvested crop, plant and animal; Product storage; Effect of cold storage and quality- storage of grains; Principles of refrigerated gas storage of food- Gas packed refrigerated foods; Sub atmospheric storage; gas atmospheric storage of foods.

Principles of food freezing: development of frozen food Industry, the freezing point of foods, freezing of bakery products. Psychrometric chart, freezing and cold storage. freeze concentration, dehydro-freezing, freeze drying, IQF; calculation of refrigeration load, design of freezers and cold storages.

# UNIT II PRINCIPLES OF CANNING AND DRYING

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; improvement in canning technology.Transport phenomena with respect to foods; Factors affecting heat and mass transfer; Study of heat transfer and its application in the design of thermal processes; calculation of process time temperature-schedules.

Drying – A natural process: artificial drying, adiabatic driers, influence of drying on pigments and enzymes; Dehydration of fruits, vegetables, milk, animal products etc.

Rate of drying for food products; design parameters of different type of dryers; properties of air-water mixtures.

Newer methods of thermal processing- batch and continuous; application of infra-red microwaves; ohmic heating.

# UNIT III PRINCIPLES OF FOOD CONCENTRATES

Control of water activity; preservation by concentration and dehydration; osmotic methods; High solid- high acid foods; Pectin and gel formation; Use of sugar and Invert sugar, jelly making, other food products,

# UNIT IV NON-THERMAL METHODS

Chemical preservatives - Food additives, functional chemical additives applications. Chemical preservatives and antibiotics; Preservation by ionizing radiations- technology aspects of the radiations, pasteurization of foods; public health aspects, microbiology of irradiated foods; Ultrasonics, high pressure, fermentation, curing, pickling, smoking, membrane technology. Hurdle technology.

# UNIT V FOOD PACKAGING

Packaging– Concepts, definition, Significance, classification; Packaging– Development, Retail/Unit; Packaging of foods –fresh and processed;Basic packaging materials, types of packaging, packaging design, packaging for different types of foods, retort pouch packing, vacuum packaging; MAP, costs of packaging and recycling of materials.

# TOTAL : 45 PERIODS

- **TEXT BOOKS** 1. Sivasankar, B. "Food Processing & Preservation", Prentice Hall of India, 2002.
- 2. Desrosier, N.W. and Desrosier, J.N. "The Technology of Food Preservation", 4<sup>th</sup> Edition, CBS, 1987.
- 3. Khetarpaul, Neelam, "Food Processing and Preservation", Daya Publications, 2005.
- 4. Vaclavik, V.A. and Christian, E.W. "Essentials of Food Science", 2<sup>nd</sup> Edition, Springer, 2003.
- 5. Potter, Norman N. "Food Science" 5<sup>th</sup> Edition, CBS, 1996.
- 6. Majumdar, A.S. "Dehydration of Products of Biological Origin" Oxford / IBH, 2004.
- 7. Gopala Rao, Chandra "Essentials of Food Processing Engineering", BS Publications, 2006.
- 8. Singh, M.K. "Food Preservation", Discovery Publishing, 2007.

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#### REFERENCES

- 1. Fellows, P. J. "Food Processing Technology: Principles and Practices", Wood Head Publishing, 1997.
- "Biotechnological Innovations in Food Processing" (Biotechnology by Open Learning BIOTOL Series). Butterworth – Heinemann, 1991.
- 3. Agilera, J.M. and Stanley, D.W. "Microstructural Principles of Food Processing and Engineering", 2<sup>nd</sup> Edition, Aspen Publishers, 1999.
- 4. Rahman, M.S. "Handbook of Food Preservation", Marcel Dekker, 1999.
- 5. Ranganna, S. "Handbook of Canning and Aseptic Packaging" Vol. I, II & III, Tata McGraw Hill, 2000.

#### FD 9115 FOOD AND INGREDIENT FUNCTIONALITY (for Graduates with Food background)

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#### UNITI NEED FOR FUNCTIONAL FOODS

Lifestyle Changes & Diet, Lifestyle Diseases like Cardiovascular Diseases, Diabetes, cancer and effects of diet in their control

#### UNIT II NUTRACEUTICALS & PHYTOCHEMICALS

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.

#### UNIT III PRE- & PROBIOTICS

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

#### 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

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**

#### TEXT BOOK

1. Vaclavik, V.A. and E. W .Christian "Essential of Food Science", 2<sup>nd</sup> Edition, Springer, 2005.

#### REFERENCE

1. Schmidl, Mary K. and Theodore P. Labuza "Essentials of Functional Foods" Aspen Publications, 2000.

#### FD 9116 APPLIED STATISTICS FOR FOOD TECHNOLOGY L T P C

### UNIT I PROBABILITY AND ITS DISTRIBUTIONS

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

#### UNIT II CURVE FITTING AND TIME SERIES

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

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

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

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**

#### **TEXT BOOKS / REFERENCES**

- 1. Gurumani, N. "An Introduction to Bio Statistics"
- 2. Kapoor and Saxena, H. C Mathematical Statistics, S.C Chand & Company Ltd., New Delhi, 1997.
- 3. Vittal, P.R., "Statistical and Numerical Methods", Margham publications,
- 4. Veerarajan, T. "Probability, Statistics and Random Processes", 2<sup>nd</sup> Edition-Tata McGraw-Hill,

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#### FD 9117 NUMERICAL METHODS & COMPUTER PROGRAMMING LTPC 3003

#### UNIT I SOLUTION OF EQUATIONS, INTERPOLATION

Iterative methods – Newton Raphson method for single variable – Simultaneous equations with two variables - Matrices - Solutions of simultaneous linear equation - Gaussian elimination - Gauss - Jordan Methods - Matrix inversion - Interpolation - Lagrange's Polynomials – Curve fitting – Least square approximation.

#### UNIT II NUMERICAL DIFFERENTIATION, INTEGRATION - INITIAL VALUE PROBLEMS OF ORDINARY DIFFERENTIAL EQUATIONS 9

Numerical differentiation – Backward, forward and central Difference relations – Their applications – Numerical Integration – Trapezoidal Rule – Simpson's Rule – Numerical solutions of ordinary differential equations - Euler - Modified Euler - Ruvge Kutta -Predictor – Corrector method.

#### UNIT III **BOUNDARY VALUE PROBLEMS**

Finite Difference Solutions for the second order ordinary differential equations - Their applications in heat equations - two dimensional Laplace equations.

#### UNIT IV **C – PROGRAMMING**

Overview of C, data types, constants, variables, operators, expression, I/o library functions, Program flow constructs: Decision making and branching - if, if ... else if, switch; Loop constructs: for, while, do... while. User defined functions, Arrays, Pointers.

#### FILE HANDLING, PROGRAMS FOR NUMERICAL METHODS UNIT V

Structure, Unions, File management in C, Developing C programs for numerical methods; Developing Matlab Programs for numerical methods.

### **TEXT BOOKS**

- 1. Grewal, B.S., "Numerical Methods in Engineering & Science", 40<sup>th</sup> Edition, Khanna Publishers, 2007.
- 2. Sastry, S.S., "Introductory Methods of Numerical Analysis", 3<sup>rd</sup> Edition, Prentice Hall of India.
- 3. Balaguruswamy, E., "Programming in ANSIC", 3<sup>rd</sup> Edition, Tata McGraw Hill, 2004.
- 4. Kirani Singh, Y. & B. B. Chaudhuri., "MATLAB Programming", Prentice Hall of India, 2007.

#### REFERENCES

- 1. Press, W. H. et al "Numerical Recipes in C: The Art of Scientific Computing", 2<sup>nd</sup> Edition, Cambridge University Press, 1993.
- 2. Kandasamy, P., Thilakavathy, K and Gunavathy, K. "Numerical Methods", S. Chand & Co., New Delhi.
- 3. Numerical Computing with MATLAB e-book : http:// www.mathworks.com/moler/chapters.html

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### **TOTAL: 45 PERIODS**

### FD 9118 CHEMICAL AND MICROBIAL ANALYSIS OF FOOD LAB

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- 1. Moisture estimation by Karl Fischer Titration
- 2. 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
- 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: 90 PERIODS**

#### FD 9119 ADVANCED FOOD ANALYSIS TECHNIQUES LAB L T P C 0 0 6 3

- Spectrophotometric Techniques, (UV-Visible, NMR, FTIR, ESR) Determination of beta-carotene/lycopene in fruits using spectrophotometer Estimation of nickel content in Hydrogenated vegetable oil by AAS. Determination of added vitamin A in vanaspathy
- 2. Electrophoretic Techniques principle and types, isoelectricfocussing
- Chromatographic Techniques: TLC, GC-MS, HPLC; Food Flavour Analysis by GC, gel-permeation, ion-exchange, affinity, chromatofocussing Determination of sugars in soft drinks by HPLC. Screening of Corn/Groundnuts for Afla toxins by TLC method.
- 4. Potentiometry: principle, various electrodes; electrometric measurements of pH, buffers
- 5. Refractometry & Polarimetry techniques
- 6. Microbial Analysis of Foods:

ELISA, other rapid analysis techniques Demonstration of PCR technique as a tool for identification and characterization of microorganism.

#### 7. Measurement of colour:

Colour and appearance (gloss and translucence) monitoring through visual colorimeter, tristimulus colorimeters and reflectance spectrophotometer, CIE, Hunter and Munsel systems for three dimensional expression of colour

- 8. Texture Measurement of foods using Texture Analyser
- 9. DTA, DSA of foods
- 10. Sensory Analysis of Foods

#### ECONOMICS FUNDAMENTALS UNIT I

Nature of Indian Economy – Role of Agricultures Sector, Industrial Sector and Services Sector in the development of Indian Economy. National Income of India, Methods of its measurement – Growth of National Income, per capita income.

**ECONOMICS AND TRADE IN FOOD** 

#### UNIT II **INFRASTRUCTURE**

Energy, Transportation, Storage, Communication, Health, Education, Importance of Cooperation, Role of Small and Medium Enterprises (SMEs), CLUSTER and Industrial Park concept, Self Help Groups (SHG).

#### UNIT III ECONOMICS REFORMS

Liberalization, Privatizations, Disinvestment, Globalization, Importance of Export, Export Documentation, Inflation, Foreign exchange reserves.

#### UNIT IV IMPORTANCE OF MODERN TECHNOLOGY

Modern technology and its evaluation, Importance of Marketability and Feasibility, Definition of Trade and Business, Importance of Scale of Production, Capacity, Concept of productivity.

#### UNIT V QUALITY MANAGEMENT

Total Quality Management, conventional methods, Agmark - certification of Food (Agro) Products Role and Function of Reserve Bank of India in Food Processing Sector, pricing policy fundamentals.

#### **TOTAL: 45 PERIODS**

#### **TEXTBOOKS**

- 1. Francis Cherumolian "International Trade and Export Management".
- 2. Gupta, K.R. "International Economics".
- 3. Sultan Chand, "Indian Economy".
- 4. Mote Paul and Gupta, "Managerial Economics", Tata McGraw Hill, 2000.
- 5. "General Economics for Common Proficiency Test" Institute of Chartered Accountants of India.
- 6. Mortimore, Sara and Carol Wallace "HACCP" (Food Industry Briefing Series) Blackwell Science, 2001.

#### REFERENCES

- 1. Narang, G.B.S. and Kumar, V., "Production and Costing" Khanna Publishers, 1998.
- 2. "Introduction to Process Economics", 2<sup>nd</sup> Edition, John Wiley, 1983.
- 3. "Plant Design and Economics" for Chemical Engineers, 5<sup>th</sup> Edition, McGraw Hill, 2002.
- 4. "The Hindu Survey of Indian Industries", Published Annually.

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#### CEREAL AND PULSE TECHNOLOGY

#### **MAJOR CEREALS** UNIT I

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; wheat based baked products - Bread, Biscuit, Cakes, Eextruded products, Pizza, Chapattis, malting and malt products; 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, Traditional Indian Products- Puffed Rice, flaked rice, Idli/Dosa/vada mixes and other savouries; Traditional and Fermented cereal products

#### UNIT II **OTHER CEREALS**

Corn- Wet and dry milling, Corn Products – Corn flakes, Corn starch, its derivatives syrup, germ oil, preparation of extruded products; canned corn products, puffed product, Barleypearling and malting of barley. Oats- Milling, Oat Products – Steel cut, rolled oats, quick cooking

#### UNIT III MILLETS

Sorghum, Pearl Millet, Finger millet, Foxtail millet, Kodo Millet - Basic agricultural aspects, structure and composition; storage, insect control; processing - pearling, Milling, Malting, Malt based foods, flaked and fermented products; Traditional and Nutritional products based on finger millet.

#### UNIT IV SUGARS

Honey- Composition and Quality aspects; Sugars- Manufacture of table sugar, High Fructose corn syrup and Glucose syrup; Jaggery - sources, manufacture, uses in traditional food products. Physical & chemical changes associated with heating of sugar.

#### UNIT V PULSES AND LEGUMES

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

#### TOTAL: 45 HOURS

#### TEXT BOOKS

- 1. Potter, Norman, N. "Food Science", 5<sup>th</sup> Edition, CBS, 1996.
- 2. Vaclavik, V.A. and Christian, E. W. "Essentials of Food Science", 2<sup>nd</sup> Edition, Springer, 2003
- 3. Hamm, Wolf and Hamilton, R,J. "Edible Oil Processing", Blackwell / Ane Books, 2004.
- 4. Rajah, Kanes K. "Fats in Food Technology", Blackwell / Ane Books, 2004.
- 5. Morris, Peter C and Bryce, J.H. "Cereal Biotechnology", CRC / Wood Head, 2000.

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#### FD 9153 SENSORY ATTRIBUTES OF FOODS

#### UNIT I SENSORY PERCEPTION

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

#### SENSORY CHARACTERISTICS OF FOODS UNIT II

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

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 falvours and tastes; Data handling, analysis and presentation.

#### UNIT IV CONSUMER TESTING

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

#### UNIT V SUBJECTIVE & OBJECTIVE METHODS OF EVALUATION

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

#### **TOTAL: 45 PERIODS**

### **TEXT BOOKS**

- 1. Marshall, David W. "Food Choice : And the Consumer", Balckie Academic & Professional / Chapman & Hall, 1995.
- 2. Vaclavik, V.A. and E. W. Christian "Essentials of Food Science". 2<sup>nd</sup> Edition. Springer. 2005.
- 3. Fisher, Carolyn and T.R. Scott "Food Flavours: Biology and Chemistry", The Royal Society of Chemistry, 1997.
- 4. Potter, Norman N, and J.H. Hotchkiss "Food Science", 5th Edition, CBS Publishers, 1996.

#### REFERENCES

- 1. Ashurst, P.R. "Food Flavourings", 3<sup>rd</sup> Edition, Aspen Publications, 1999.
- 2. Reineccius, Gary "Flavour chemistry and Technology", 2<sup>nd</sup> Edition, Taylor & Francis, 2006.
- 3. Otles, Semih "Methods of Analysis of Food Components and Additives", CRC / Taylor & Francis. 2005.
- 4. Hester, R. E. and R. N. Harrison "Food Safety and Food Quality" (Issues in Environmental Science and Technology) Royal Society of Chemistry, 2001.
- 5. Sensory & Consumer Research in Food Product Design & Development, Moskowitz, Beckley and Resurreccion, Wiley-Blackwell 2006
- 6. Guidelines for Sensory Analysis in Food Product Development and Quality Control: Carpenter, Lyon & Hasdell, Springer 2000.

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#### FD 9154 FOOD LAWS AND REGULATORY ISSUES

# 3003

#### UNIT I HISTORICAL PERSPECTIVES INCLUDING NECESSITY OF FOOD LAWS

Establishment of US Pure Food Law in early 1900s and of Food & Drug Administration to enforce safety of food products; Urbanisation of population and necessity of processed and preserved foods and the necessity of ensuring quality of food to prevent adulteration.

#### UNIT II FOOD QUALITY, SAFETY & TESTING

Quality of Foods and Quality Standards like BIS; Agmark and other optional standards; the difference between mandatory and optional standards; enforcement of optional standards; Food Safety Systems: Quality systems standards including ISO; Auditing; Good Manufacturing Practice and HACCP

Various ways of testing the safety of foods; Detection of harmful chemicals and microbes in foods; Testing of ingredients and additives; using animals for evaluating safety; Clinical studies. Responsibility of agriculture, food industry & food supply sector;

Standards of Weights & Measures and some provisions under these regarding food products such as requirements of labelling and giving information therein, size of packages etc. Important Issues of GM Foods, Fortification, Nutrition Information on Label, Pesticide Residues, Organic Foods, Safety of Additives, Processes etc. affecting consumers and industry.

#### UNIT III FOOD LAWS & IMPLEMENTING AGENCIES-NATIONAL

Prevention of Food Adulteration Act 1954 & Rules 1955 established in India to enforce safety and purity of food products; Various aspects of defining adulteration, taking samples of food for analysis by public analyst, prosecution for adulteration and punishment; Standards of various food products; FPO; Infant Milk Substitute Act; Laws relating to vegetable oils; Use of permitted additives like colours, preservatives, emulsifiers, stabilisers, antioxidants etc.

Food Safety & Standards Act 2006 and the provisions therein; Integrated Food Law - Multi departmental - multilevel to single window control system, consumer protection Act

#### UNIT IV INTERNATIONAL SCENARIO IN FOOD REGULATION

USFDA, EFSA, UK, Canada, A & NZ, Japan, Malaysia, Singapore; Consumer Movements; Intellectual Property Rights and Trade Marks: Protection of investment and efforts in research and development by patenting: Criteria of patentability: National and international patent; Terms of patents; Copyright.

#### UNIT V INTERNATIONAL AGENCIES IN FOOD REGULATION

Food Codex Alimentarius: The necessity of harmonised Food Standards for international trade; various aspects and relation with domestic laws; Codex Nodal agency, FAO, WHO, WTO, Consumer protection forums.

### TEXT BOOKS

- 1. Mehta, Rajesh and J. George "Food Safety Regulations, Concerns and Trade : The Developing Country Perspective", Macmillan, 2005.
- 2. "The Prevention of Food Adulteration Act, 1954", Commercial Law Publishers (India) Pvt. Ltd.,

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TOTAL: 45 PERIODS

#### REFERENCES

- 1. Rees, Naomi and David Watson "International Standards for Food Safety", Aspen Publication, 2000.
- 2. Newslow, D.L. "The ISO 9000 Quality System: Applications in Food and Technology", John Wiley & Sons, 2001.
- 3. Hubbard, Merton R. "Statistical Quality Control for the Food Industry", 3rd Edition, Springer, 2003.

#### LTPC FD 9155 ENZYMES IN FOOD TECHNOLOGY

#### UNIT I FOOD ENZYMES - TYPES AND SOURCES

History of use of enzymes to process traditional foods use of microbes- yoghurt, cheese, wine, vinegar, beer, kefir, miso; Types- proteases, Glucosidases, Lipases, Others such as cellulases, pectinases, lactase, glucose oxidase; traditional sources- extracts of plants and animals; industrial use of microbes and GMOs for enzyme production- Development and impact of biotechnology on food industry; microbial rennet, recombinant chymosin.

#### ENZYMES FOR DAIRY PRODUCT PROCESSING UNIT II

Microencapsulated and immobilised enzymes-their application in accelerated ripening of cheese; production of protein hydrolysates modification physiologically active bio-peptides/ nutraceuticals, whey protein and other by-products,

#### **ENZYMES FOR CARBOHYDRATES & LIPIDS** UNIT III

Starch, High Fructose corn syrup, functional oligosaccharides, tagatose; modification of acyl glycerols, trans-free fats, coco butter substitutes; enzymes used for processing vegetables and fruits.

#### **ENZYMES FOR TEXTURE MODIFICATION** UNIT IV

Use of cross-linking enzymes for baked and pasta products, meat & fish processing & dairy products, protein based fat replacements.

#### UNIT V ENZYMES FOR PRODUCTION OF FLAVOURS

Production of Mono-sodium glutamate, aspartame; vanilla extraction, enzymatically modified cheeses (EMC) their utilization in various food formulations; polymers from sucrose, sucrose esters.

#### TOTAL: 45 PERIODS

#### **TEXT BOOKS**

- 1. Rastall, Robert "Novel Enzyme Technology for Food Applications", CRC / Woodhead Publications, 2007.
- 2. Schmidl, Mary K. and Theodore P. Labuza "Essentials of Functional Foods", Aspen Publications, 2000.
- 3. Sofos, John N. "Improving the Safety of Fresh Meat", CRC / Woodhead, 2005.
- 4. Feineccins, Gary "Flavor Chemistry and Technology "Taylor & Francis, 2005.

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#### REFERENCES

- 1. Vaclavik, V.A. and E.W. Christian "Essentials of Food Science", 2<sup>nd</sup> Edition, Springer, 2005.
- Potter, Norman N, and J.H. Hotchkiss "Food Science", 5<sup>th</sup> Edition, CBS Publishers, 1996.
- 3. Kapoor, Ajay "Diary Science and Technology", Vishvabharathi Publication, 2005.

# FD 9121 ADVANCED FOOD CHEMISTRY AND MICROBIOLOGY L T P C 3 0 0 3

#### UNIT I FOOD LIPIDS, ANTIOXIDANTS

Chemistry of oils and fats, free radical chemistry, reactive oxygen, photosensitized oxidation, metal catalysed reactions, Antioxidants: chemistry and mechanisms of action, techniques of evaluation of antioxidant activity, uses.

#### UNIT II FOOD PROTEINS AND ENZYMES; STARCH, HYDROCOLLOIDS AND GUMS 9

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.

#### UNIT III WATER RELATIONS IN FOOD

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.

#### UNIT IV ANALYTICAL CHEMISTRY

Introduction to Chemical instrumentation; basic components of analytical instruments, optical detectors (photomultipliers, monochromators, etc.,), electrical detectors (pH – electrodes, etc), miscellaneous detectors; Atomic and molecular emission, absorption and fluorescence spectroscopy, Basic principles of analytical instrumentation used in Food quality, Quality control of food and containers, migration of metals and compounds from container into food; Case studies.

#### UNIT V FOOD MICROBIOLOGY

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; 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 micro-organisms, deterioration of various types of food products; Food poisoning and microbial toxins, microbial food fermentation, standards for different foods; Food borne intoxicants and mycotoxins; Microbial growth in food: intrinsic, extrinsic and implicit factors; Microbial interactions; Use of antimicrobial chemicals- organic acids, sugars, sodium chloride, nitrites, phosphates, sulphites, Benzoates, Sorbates / Propionates naturally occurring antimicrobials; Physical methods- Low and high temperatures, drying, radiation and high

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pressure; Tolerance of microbes to chemical and physical methods in various foods; Effects of enzymes and other proteins; Combination systems. Adaptation phenomena and stress phenomena; Effect of injury on growth or survival; Commercial available databases. Microbes of importance in food fermentations, - Homo & hetero-fermentative bacteria, yeasts & fungi; Lactic acid bacteria fermentation and starter cultures, Alcoholic fermentations -Yeast fermentations; Fungal fermentations. Microbes associated with typical food fermentations- yoghurt, cheese, fermented milks, breads, idli, soy products, fermented vegetables and meats.

#### **TOTAL: 45 PERIODS**

#### TEXT BOOKS

- 1. Damodaran, Srinivasan, Kirk L. Parkin and O.R. Fennema "Fennema's Food Chemistry" 4<sup>th</sup> Edition, CRC / Taylor & Francis, 2008.
- 2. Belitz, H.D., W. Grosch and P. Schieberle "Food Chemistry", 3rd Edition, Springer. 2004.

#### REFERENCE

1. Walstra, Pieter "Physical Chemistry of Foods", Marcel Dekker, 2003.

#### FD 9122 FERMENTATION TECHNOLOGY LTPC

# 3003

#### FERMENTATION PATHWAYS FOR INDUSTRIAL PRODUCTS UNIT I 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.

#### UNITI II **MEDIA FOR FERMENTATION**

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.

#### **DIFFERENT TYPES OF FERMENTERS** UNIT III

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.

#### DOWNSTREAM PROCESSING UNIT IV

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.

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#### UNIT V FERMENTATIVE PRODUCTION

### a) Foods

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) Industrial chemicals

Fermentative Production of Organic acids like (Citric Acid, Lactic Acid), Amino Acids (Glutamic acid, Lysine), Antibiotics (Erythromycin, Penicillin), Polysaccharides (Dextran, Xanthan) etc.; steroids transformation and industrial enzyme production by microorganisms; process descriptions and key controls for optimal production.

#### TOTAL: 45 HOURS

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### TEXT BOOKS

- 1. Joshi, V.K. and Ashok Pandey "Biotechnology: Food Fermentation, Microbiology, Biochemistry and Technology", Vol. I & vol. II Educational Publisher, 1999.
- 2. Peppler, H.J. and D. Perlman "Microbial Technology : Fermentation Technology", 2<sup>nd</sup> Edition, Vol. II Academic Press / Elsevier, 2004.
- 3. Potter, Norman N, and J.H. Hotchkiss "Food Science", 5<sup>th</sup> Edition, CBS Publishers, 1996.
- 4. Stanbury, P.F., A. Whitaker and S.J. Hall "Principles of Fermentation Technology", 2<sup>nd</sup> 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", 2<sup>nd</sup> Edition, Standard Publishers, 2005.
- 3. El-Mansi, E.M.T. et al "Fermentation Microbiology and Biotechnology" 2<sup>nd</sup> Edition,CRC / Taylor & Francis, 2007.

#### FD 9123 FOOD PROCESS ENGINEERING

LTPC 3003

# UNIT I ASEPTIC TECHNOLOGY

Application of HTST and UHT in improvement in quality of milk, fruit juices and other liquid food products; Effectiveness of high and ultra-high temperature on deactivation of microorganisms and its relationship with destruction of nutrients; Design of heat transfer systems used for continuous thermal processing; Details of shell & tube, plate and spiral heat exchangers; Aseptic transfer of sterile food; Design aspects of equipment and packaging materials requirement; Different products and processes using aseptic technology.

Retort Pouch Processing: Flexible films available for high temperature processing; technology and engineering aspects differing with canning operations; heat penetration data; process time calculation; evaluation of thermal process and lethality; different products made by this process.

# UNIT II DRYING & THERMAL PROCESSING

Recent developments in drying including spray drying, freeze drying, foam mat drying and other newer drying processes; newer methods of concentration and evaporation; freeze concentration design aspects; membrane filtration for recovery of low concentration products; applications of ultra-filtration and reverse osmosis.

Use of electric current for thermal processing of foods; relationship of conductance and heating of foods; Ohmic heating: principle & applications.

### UNIT III HIGH PRESSURE & PULSE ELECTRIC FIELD PROCESSING 12

Application of High Pressure Processing to preserve fruit, vegetable products and sea foods; mechanism of destruction of various spoilage and pathogenic microbes by high pressure; Equipment design for high pressure processing.

Pulsed electric field processing: description/ mechanism and factors affecting microbial inactivation effects on food components, present status and future scope for food applications.

### UNIT IV RADIATION PROCESSING

Generation of irradiation by different techniques including gamma rays and electron acceleration; Safety and effect of radiation doses; Radiation processing of cereals & grains, meat, fish & poultry products, spices & herbs etc. Control of ripening of fruits by irradiation; Infra-red heating: interaction of infra-red (IR) radiation with penetration properties, equipment; dairy and food application, advantages and disadvantages of IR heating.

### UNIT V OTHER METHODS

### a) Concept of Hurdle Technology

Application of different processing techniques like chemicals, radiation, thermal, low temperature etc. in combination; advantages of hurdle technology in processing fruits, vegetables, meats etc. and effects on sensory properties

**b)** Controlled/Modified Atmosphere Packaging (CAP/MAP) for preserving fruits, vegetables, cheese, meat etc.; barrier properties of packaging material and their applications in CAP/MAP; packaging systems available; Active Packaging.

# TOTAL: 45 PERIODS

#### TEXT BOOKS

- 1. Gopala Rao, Chandra, "Essential of Food Process Engineering", BS Publications, 2006.
- 2. Majumdar, Arun S. "Dehydration of Products of Biological Origin", Oxford & IBH Publication, 2004.
- 3. Das, H. "Food Processing Operations Analysis", Asian Books, 2005.
- 4. Smith, P.G. "Introduction to Food Process Engineering" Springer, 2005.
- 5. Rao, M.A., S.S.H. Rizvi and A.K. Datta "Engineering Properties of Rood", 3<sup>rd</sup> Edition, Taylor & Francis, 2005.

### REFERENCE BOOKS

- 1. Fellows, P.J. "food Processing Technology : Principles and Practice", Wood head Publishing, 1997.
- 2. Aguilera, J.M. "Microstructural Principles of Food Processing and Engineering", 2<sup>nd</sup> Edition, Aspen, 1999.
- 3. Toledo, R.M. "Fundamentals of Food Process Engineering", 3<sup>rd</sup> Edition, Springer, 2007.

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FD 9124

# FOOD PROCESSING AND QUALITY CONTROL LAB

- 1. Determination of absorbed oil content in fried foods.
- 2. Monitoring the primary and secondary oxidative rancidity in oils.
- 3. Determination of thermal load during retort processing of food products.
- 4. Determination of browning and colour measurement in foods.
- 5. Preparation pickled vegetables, fruit jams, and bakery products; soups and gravies and their chemical analysis
- 6. Determination of thermal conductivity of food products.
- 7. Determination of film heat transfer co-efficient during processing of foods.
- 8. Studies on parallel flow heat exchanger and on counter flow heat exchange.
- 9. Canning of vegetables & fruits fruit juices, squashes, syrups and ready-to-serve beverages.
- 10. Drying of fruits and vegetables, quality control of processed products.
- 11. Spray drying of liquid foods
- 12. Freezing of foods.
- 13. Testing of packaging materials for quality assurance- establishment of moisture sorption isotherm; determination of gas transmission rates of packaging film; determination of water vapour permeability of packages.
- 14. Shelf life calculation for moisture sensitive and oxygen sensitive foods.
- 15. Estimation of shelf life of seasonal fresh vegetables & fruits.
- 16. Packaging of cereal & cereal products, Palm products & fermented foods.
- 17. Vacuum packaging of food products.
- 18. Packaging of food products using retort pouch technology.

#### **TOTAL : 90 PERIODS**

#### FD 9125 FERMENTATION TECHNOLOGY LAB

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#### AIM

To enable the students to understand the design, scale up and operation of equipment in handling of food based enzymes and cultivation of microbes relevant to food industry on industrial scale.

#### OBJECTIVE

- 1. To sterilize the bioreactor
- 2. To operate the bioreactor
- 3. To design experiments to evaluate the performance of the bioreactor
- 4. To develop enzyme immobilized processes.

#### **Equipment needed**

Bioreactor Centrifuge Microfiltration unit Homogeniser

#### Experiments

- 1. Enzyme kinetics, effect of pH and Temperature
- 2. Enzyme immobilization gel entrapment, cross linking
- 3. Batch sterilization design
- 4. Estimation of kla dynamic gassing method,
- 5. Estimation of kla sulphite oxidation method
- 6. Estimation of overall heat transfer coefficient
- 7. Batch cultivation
- 8. Fed batch cultivation
- 9. Cell separation by Centrifugation and microfiltration
- 10. Cell disruption by homogenization
- 11. Protein precipitation and aqueous two phase extraction

#### REFERENCES

#### TOTAL : 90 PERIODS

- 1. Bailey, J.E. and Ollis, D.F. "Biochemical Engineering Fundamentals" 2<sup>nd</sup> Edition, McGraw Hill, 1988.
- 2. Lee, James M. "Biochemical Engineering", PHI, U.S.A.
- 3. Stanbury, P.F. et al. "Principles of Fermentation Technology", 2<sup>nd</sup> Edition, Butterworth Heinemann / Elsevier, 1995.
- 4. El-Mansi, E.M.T. et al., "Fermentation Microbiology and Biotechnology", 2<sup>nd</sup> Edition, CRC / Taylor & Francis, 2007.
- Peppler, H.J. and D. Perlman "Microbial Technology" (vol. I Microbial Processes and Vol. II Fermentation Technology)" 2<sup>nd</sup> Edition, Academic Press / Elsevier, 2004.

# BT 9123 IMMUNOTECHNOLOGY L T P C

#### UNIT I INTRODUCTION

Cells of the immune system and their development; primary and secondary lymphoid organs; humoral immune response; cell mediated immune responses; complement.

#### UNIT II ANTIBODIES

Monoclonal antibodies and their use in diagnostics; ELISA; Agglutination tests; Antigen diction assay; Plaque Forming Cell Assay.

#### UNITI III CELLULAR IMMUNOLOGY

PBMC separation from the blood; identification of lymphocytes based on CD markers; FACS; Lymphoproliferation assay; Mixed lymphocyte reaction; Cr51 release assay; macrophage cultures; cytokine bioassays – IL2, gamma IFN, TNF alpha; HLA typing.

#### UNIT IV VACCINE TECHNOLOGY

Basic principles of vaccine development; protein based vaccines; DNA vaccines; Plant based Vaccines; recombinant antigens as vaccines; reverse vaccinology.

#### UNIT V DEVELOPMENT OF IMMUNOTHERAPEUTICS

Engineered antibodies; catalytic antibodies; idiotypic antibodies; combinatorial libraries for antibody isolation.

#### TOTAL: 45 PERIODS

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### TEXT BOOKS

- 1. Male, David, Jonathan Brostoff, David B Roth and Ivan Roitt, "Immunology", 7<sup>th</sup> Edition, Mosby / Elsevier, 2006
- 2. Kindt, T. J., R.A.Goldsby and B.A. Osborne, "Kuby Immunology", 6<sup>th</sup> Edition, W.H. Freeman, 2007.
- 3. Weir, D.M. and J. Stewart "Immunology" 8<sup>th</sup> Edition, Churchill Livingstone, 2000.
- 4. Lydyard, P.M. "Instant Notes in Immunology", Viva Books, 2000.
- 5. Abbas, A.K., A.H. Lichtman and Shiv Pillai "Cellular and Molecular Immunology", 6<sup>th</sup> Edition, Saunders / Elsevier, 2007.
- 6. Davis, J.M. "Basic Cell Culture : A Practical Approach", IRL Press, 1994.
- 7. Master, J.R.W. "Animal Cell Culture", 3<sup>rd</sup> Edition, Oxford University Press, 2000.
- 8. Glick, B.R. and J.J. Pasternak, "Molecular Biotechnology : Principles and Applications of Recombinant DNA", 3<sup>rd</sup> Edition, ASM Press.

#### REFERENCES

- 1. Harris, W.J. and Cunningham, C. "Antibody Therapeutics". Springer, 1995
- 2. Wawrzyuczak, E.J. "Antibody Therapy". BIOS Scientific Publication, 1995.
- 3. Borrebaeuk, Carl A.K. "Antibody Engineering". 2<sup>nd</sup> Edition, Oxford University Press1995.
- 4. Shepherd, P. and Dean, C. "Monoclonal Antibodies". Oxford University Press, 2000.
- 5. Rastogi, S.C. "Immunodiagnostics : Principles and Practice". New Age International, 1996.

#### FD 9156 ENVIRONMENTAL ISSUES IN FOOD INDUSTRY

#### UNIT I ENVIRONMENT AND POLLUTION

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

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

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

#### LTPC 3003 9

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2. Hester, R.E. and R.M. Harrison "Food Safety and Food Quality", (Issues in Environmental Science and Technology) RSC, 2001.

#### LTPC FD 9157 FOOD PRODUCT DESIGN AND DEVELOPMENT

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#### FOOD NEEDS & CONSUMER PREFERENCE UNIT I

Market survey and its importance in; designing a guestionnaire to find consumer needs for a product or a concept; advantages of processed foods in urbanised Modern Society; Why people buy processed foods. Developing a Product to Meet the Requirements

#### UNIT II **DESIGNING NEW PRODUCTS**

New Food Product Development (NPD) process and activities, NPD success factors, new product design, food innovation case studies, market-oriented NPD methodologies. organisation for successful NPD; Recipe Development; use of traditional recipe and modification; recent developments in food ingredients/additives flavourings, colourings, emulsifiers, stabilizer and sweeteners; involvement of consumers, chefs and recipe experts; selection of materials/ingredients for specific purposes; modifications for production on large scale, cost effectiveness, nutritional needs or uniqueness; use of novel food ingredients and novel processing technologies.

#### **STANDARDIZATION & LARGE SCALE PRODUCTION** UNIT III

Process design, equipment needed and Design; establishing process parameters for optimum quality; Sensory Evaluation; Lab requirements; different techniques and tests; statistical analysis: application in product development and comparison of market samples: stages of the integration of market and sensory analysis.

#### UNIT IV **STORAGE & DISPOSAL OF WASTE**

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.

#### UTILIZATION OF WASTE UNIT V

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.

### TEXT BOOKS

### 1. Potter, Norman N. and J.H. Hotchkiss "Food Science", 5<sup>th</sup> Edition, CBS, 1996.

- 2. Moorthy, C.K. "Principles and Practices of Contamination Control and Clean rooms", Pharma Book Syndicate, 2003.
- 3. Roday, S. "Hygiene and Sanitation in Food Industry", Tata McGraw Hill Publishing, 1999.

#### REFERENCES

# 1. Wilson, C.L. "Microbial Food Contamination", 2<sup>nd</sup> Edition, CRC, 2008.

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**TOTAL: 45 PERIODS** 

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### UNIT IV QUALITY, SAFETY & REGULATORY ASPECTS

Product Stability; evaluation of shelf life; changes in sensory attributes and effects of environmental conditions; accelerated shelf life determination; developing packaging systems for maximum stability and cost effectiveness; interaction of package with food; Regulatory Aspects; whether standard product and conformation to standards; Approval for Proprietary Product.

### UNIT V ADVERTISEMENT, MARKETING & CASE STUDIES

Product performance testing; market positioning, Marketing: developing test market strategies; various tools and methodologies to evaluate consumer attitudes, preferences and market acceptance factors; Case Studies of some successes and failures- Factors that influence NPD success, innovation case studies to highlight best practice in terms of the integration of technological and marketing approaches to NPD; food choice models and new product trends.

### TOTAL: 45 PERIODS

### TEXT BOOKS

- 1. Gupta, Rahul "Food Retailing: Emerging Trends", ICFAI University, Press, 2005.
- 2. Phani Madhav, T. "Food Industry and Health Concerns: Trends and Cases", ICFAI University Press, 2005.
- 3. Chakraborty, Amrita "Food Processing: Opportunities and Challenges", ICFAIUniversity Press, 2006.

### REFERENCES

- 1. Brody, Aarn L. and John B. Lord "Developing new Food Products for a Changing Marketplace", 2<sup>nd</sup> Edition, CRC / Taylor & Francis, 2008.
- 2. Food product development: Maximising success: M Earle, R Earle, and A Anderson, Woodhead Publ., 2001
- 3. New Food Product Development: From Concept to Marketplace, GW Fuller, CRC 2004
- 4. Sensory & Consumer Research in Food Product Design & Development, Moskowitz, Beckley and Resurreccion, Wiley-Blackwell 2006
- 5. Guidelines for Sensory Analysis in Food Product Development and Quality Control: Carpenter, Lyon & Hasdell, Springer 2000.
- 6. Developing New Food Products for a Changing Marketplace: Brody & Lord, CRC 2007

# BT9162METABOLIC PROCESS AND ENGINEERINGL T P C

# UNIT I REVIEW OF CELLULAR METABOLISM

An Overview of Cellular Metabolism, Transport Processes, Fuelling reactions: glycolysis, Fermentative pathways, Biosynthetic reactions, polymerization, Cellular energetics.

### UNIT II MATERIAL BALANCE AND DATA CONSISTENCY

Comprehensive models of cellular reactions; stoichiometry of cellular reactions, reaction rates, dynamic mass balance, yield coefficients and linear rate equations, analysis of over determined systems – identification of gross measurement errors.

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#### theorems, Determination of flux control coefficients, MCA of linear pathways, branched pathways, theory of large deviations.

METABOLIC CONTROL ANALYSIS

#### ANALYSIS OF METABOLIC NETWORKS UNIT V

Control of flux distribution at a single branch point, grouping of reactions, case studies, extension of control analysis to intermetabolite, optimization of flux amplification, consistency tests and experimental validation.

#### TEXT BOOKS

UNIT IV

- 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.

#### 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. Rhodes, P.M. and P.F. Stanbury "Applied Microbial Physiology " A Practical Approach". IRL Press. 1997.
- 4. Caldwell, D.R. "Microbial Physiology & Metabolism". Wm. C. Brown, 1995.
- 5. Rehm, H.J. and G. Reed, "Biotechnology : Products of Primary Metabolism Vol.6 and Biotechnology: Products of Secondary Metabolism Vol.7, VCH / Wiley, 1997.

#### FRUIT AND VEGETABLE TECHNOLOGY FD 9158

#### UNIT I PRE-PROCESSING

Fresh fruits and vegetables – Handling, grading, cleaning, pretreatments, transportation, pre cooling, chilling, modified atmosphere packaging, Controlled atmosphere storage, packaging, transportation, quality assurance.

#### UNIT II FREEZING OF FRUITS AND VEGETABLES

Different freezing methods and equipments, problems associated with specific fruits and vegetables;

#### DEHYDRATION OF FRUITS AND VEGETABLES UNIT III

Dehydration – different methods of drying including sun, tray, cabinet, drum, spray, vacuum, tunnel, spray, low temperature drying process, process calculations

#### UNIT III METABOLIC FLUX ANALYSIS

Theory, overdetermined systems, underdetermined systems, linear programming, sensitivity analysis, methods for the experimental determination of metabolic fluxes by isotope labeling, applications of metabolic flux analysis.

Fundamental of Metabolic Control Analysis, control coefficients and the summation

#### TOTAL: 45 PERIODS

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osmotic dehydration and other modern methods, choice of suitable methods, preserving the colour, flavour and nutrient content of the products

# UNIT IV CANNING, JUICES & CONCENTRATES

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 operations in canning blanching, exhausting, processing conditions. Fruit Juice / pulp/ Nectar/Drinks, concentrates – General and specific processing, different packing including aseptic; Vegetable Purees/pastes - processing of Tomato and tomato products

### UNIT V FRUIT AND VEGETABLE PRODUCTS & STANDARDS

Ready to eat vegetable products, Jams/Marmalades, Squashes/cordials, Ketchup/sauces, Chutneys, Fruit Bar, Soup powders, Candied Fruits, Natural colors, Fruit and Vegetable Fibres - specific processing, different packing including aseptic, Product specifications and standards; food regulations with respect to fruit and vegetable products.

### TOTAL: 45 PERIODS

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### TEXT BOOKS

- 1. Indira Gopalan and Mohanram, M. "Fruits" NIN, 1996.
- 2. Valpuesta, Victoriano "Fruit and Vegetable Biotechnology" CRC / Wood Head Publishing, 2002.
- 3. Arthey, David and Ashwat P.R. "Fruit Processing : Nutrition, Products, and Quality Management", 2<sup>nd</sup> Edition, Springer, 2005.
- 4. Majumdar, A.S. "Dehydration of Products of Biological Origin", Oxfords IBH, 2004.
- 5. Alzamora, S.M., Tapia, M.S. and Lopez Malo, A. "Minimally Processed Fruits and Vegetables: Fundamental Aspects and Applications", Springer, 2005.

### REFERENCES

- 1. Potter, Norman N. and J.H. Hotchkiss "Food science", 5<sup>th</sup> Edition, CBS, 1996.
- Vaclavik, V.A. and E.W. Christian "Essentials of Food Science", 2<sup>nd</sup> Edition, Springer, 2005.
- 3. Salunkhe, D.K. and Kadam, S.S. "Handbook of Fruit Science and Technology : Production, Composition, Storage, and Processing", Marcel Dekker, 2005.
- 4. "Agro Food Processing : Technology Vision 2020 Fruits & Vegetables Current Status and Vision", TIFAC, 1996.

# FD9159 FOOD PLANT EQUIPMENTS L

### UNIT I MILLING AND EXTRUSION EQUIPMENTS

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

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

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systems: Solid bowl and disc bowl centrifuges; cyclone separator and self cleaning centrifuge.

### UNIT III MIXING, BLENDING & FILLING EQUIPMENTS

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

Autoclaves - types, operation; Different drying systems - Spray, Fluidized bed, tunnel; evaporators; pasteurizers, steamer, roaster ovens, kettles, baking & confectionery equipments

Freezing equipments - Plate, Tunnel, blast, IQF, Liquid nitrogen, Heat exchangers - Tubular and Plate; Refrigerated transport and transportation in insulated containers,

### UNIT V HYGIENIC DESIGN ASPECTS

REFERENCES

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

- 1. Lopez Gomez, A. and Barbosa Canovas, G.V. "Food Plant Design", Taylor & Francis, 2005.
- 2. Smith, P.G. "Introduction to Food Process Engineering", Springer, 2005.
- 3. Rao, M.A. S.S.H. Rizvi and A.K. Datta, "Engineering Properties of Food", 3<sup>rd</sup> Edition, Taylor & Francis, 2005.
- 4. "Food and Bio Process Engineering" Anamaya Publishers, 2005.

# FD 9160 BIOREACTOR DESIGN L T P C 3 0 0 3

# UNIT I BIOLOGICAL SYSTEMS AND ORGANISM SELECTION

Bacteria, Yeast, Fungi's – Effect of culture characteristics microbe on Bioreactor design and operation of plant and annual cells in bioreactor application.

### UNIT II STIOCHIOMETRY AND MEDIUM DESIGN

Formulation and optimization of media mass and energy balance, relationship between reactant, product formation and heat evolution. Microbial process, plant cell processes, maintain cell process maintenance of stock,

# UNIT III FUNDAMENTALS OF BIOREACTOR DESIGN

Stoichiometry, kinetics of cell population growth, product formation and substrate utilization - Mass Transfer and Heat in Bioreactor, Shear in Bioreactor, Bioreactor operation modes – Batch operation, Fed batch operation, continuous operation - other operation scale up – consequences of changing scale–up of operation, scale-up methods used - Thermodynamics, Microkinetics, transport scale-up methods, fundamental method, semi

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fundamental method; rules of thumb, dimension analysis, regime analysis, similarity principle.

### UNIT IV TYPES OF BIOREACTORS

CFSTR, Strived tank Type of Bioreactor, Pneumatically agitated Bioreactor, Membrane reactor, immobilized microbial Bioreactor, immobilized annual cell Bioreactor, Plant cell Bioreactor, Photobioreactors, plug flow reactors.

### UNIT V BIOREACTOR SUPPORT SYSTEMS

Sterilization and containment – presterilization of equipment, Bioreactor system supplies, sterilization of Feed stocks. Water – process water quality, pretreatment maintenance of sterile operation and production, operating condition, Sanitization of water systems containment design and cooling water, Steam – plant steam, clean system, steam connption, An e gases: process air, cylinder gases, sizing for process Air and cylinder gas requirements.

### **TOTAL : 45 PERIODS**

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### TEXT BOOKS

- 1. Gilbert.J and Seuyava.H.Z (Eds) "Bioreactive Compounds in Foods" Blackwell Publishing. 2008.
- 2. Hurst. W.F. (Ed.,) "Methods of Analysis for Fund Foods and Nutraceuticals" 2<sup>nd</sup> Edition, CRC Press, 2008.
- 3. Shi. J (Ed) "Functional Food Ingredients and Nutraceuticals Processing Technologies", CRC Press, 2008.

### REFERENCES

- 1. Asenjo, J.A. "Bioreactor System Design" Marcel Dekker Inc, 1995.
- 2. "Operation Modes of Bioreactor BIOTOL Series", Butterworth Heineunam, 2004.
- 3. "Bioreactor Design and Product Yield BIOTOL Series", Butterworth Heineunam, 2005.
- 4. Johnson. A.T. "Biological Process Engineering" John-Willey and Sons Inc., 1999.
- 5. Schugerl.K and Bellgardt, K.H (Eds.,) "Bioreaction Engineering Modeling and Control", Springer, 2000.

#### FD 9161 BIO-THERMAL PROCESS ENGINEERING L

#### UNIT I INTRODUCTION

Biochemical engineering: kinetics of substrate utilization; product yield and biomass production in cell cultures;

### UNIT II MASS AND HEAT TRANSFER

Gas liquid mass transfer in microbial systems; design and analysis of fermentation vessels; residence time distribution; introduction to thermal processing; sterilisation classification; UHT systems and recent advances;

#### UNIT III MICROBES AND THERMAL PROCESSING

Factors affecting spoilage of different types of food products and design of thermal process; aseptic packaging systems and conditions; survivor curve; thermal death curve;

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arrheneous curve; techniques for determination of heat resistance of microorganisms; analysis of thermal resistance data;

#### UNIT IV OTHER ASPECTS OF PROCESSING

Processing in containers; process time; lethality; general formula for evaluation of heating and cooling process; broken heating curve; design of batch and continuous sterilisation cycles in vat; inter-relationship between batch and continuous reactors; design calculations.

### UNIT V SHELF LIFE AND PACKAGING

Application of HTST and UHT; Design of heat transfer systems used for continuous thermal processing; Aseptic transfer of sterile food; Different products and processes using aseptic technology; Retort Pouch Processing: Flexible films available for high temperature processing; technology and engineering aspects differing with canning operations; heat penetration data; process time calculation; evaluation of thermal process and lethality; different products made by this process.

### TEXT BOOKS

- 1. Gopala Rao, Chandra, "Essential of Food Process Engineering", BS Publications, 2006.
- 2. Majumdar, Arun S. "Dehydration of Products of Biological Origin", Oxford & IBH Publication, 2004.
- 3. Das, H. "Food Processing Operations Analysis", Asian Books, 2005.
- 4. Smith, P.G. "Introduction to Food Process Engineering" Springer, 2005.
- 5. Rao, M.A., S.S.H. Rizvi and A.K. Datta "Engineering Properties of Rood", 3<sup>rd</sup> Edition, Taylor & Francis, 2005.

#### REFERENCES

- 1. Fellows, P.J. "food Processing Technology : Principles and Practice", Wood head Publishing, 1997.
- 2. Aguilera, J.M. "Microstructural Principles of Food Processing and Engineering", 2<sup>nd</sup> Edition, Aspen, 1999.
- 3. Toledo, R.M. "Fundamentals of Food Process Engineering", 3<sup>rd</sup> Edition, Springer, 2007.

# FD 9162 QUALITY ASSURANCE AND SAFETY IN FOOD PROCESSING L T P C 3 0 0 3

#### UNIT I QUALITY ASSURANCE IN THE FOOD INDUSTRY

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**TOTAL: 45 PERIODS** 

Objectives, importance and functions of quality control; Concept of quality assurance and quality control in relation to food industry; role of international organisations such as ISO; IDF; CAC; AOAC; WTO, Food regulations, grades and standards, Concept of Codex Almentarious/HACCP/USFDA/ISO 9000 series etc.. and national organisations like BIS; CCFS; PFA and Agmark; (MMPO) and APEDA (Agricultural and Processed Foods Export Development Authority, guidelines for setting up quality control laboratory; Food adulteration and food safety; Food laws and standards, function and roles of USFDA, USDA and EPA; Food Safety and Standards Act India 2006; Prevention of Food Adulteration Act, India, 1954; Responsibilities of the Food service operator, consumer protection, food audit; IPR and patents

### UNIT II SAMPLING AND STATISTICAL QUALITY CONTROL

Quality and specification of raw materials and finished products; statistical quality control including use of control charts and sampling procedures; Sensory evaluation-introduction, panel screening, selection methods; selection and training of sensory panel; Sensory and instrumental analysis in quality control; Hedonic rating of food; Identification and ranking of food product attributes, interaction and thresholds; Sensory and instrumental methods for measuring food attributes.

#### UNIT III ASSESSMENT OF FOOD SAFETY

Food related hazards – Chemical hazards, physical hazards, microbiological hazards and their considerations in food safety. Safety limits of Food additives; Risk assessment and risk benefit Indices of human exposure, acute toxicity, mutagencity and carcinogenicity, reproductive and developmental toxicity, neurotoxicity and behavioural effect, immunotoxicity

### UNIT IV FOOD SAFETY MANAGEMENT SYSTEMS

Food safety and quality management systems- Physical, chemical and Microbial hazards and their control in food industry; Good laboratory practice (GLP); Quality systems standards including ISO; - ISO 9000; total quality management (TQM); hazard analysis of critical control points (HACCP); good manufacturing practices (GMP); Good Manufacturing Practice and HACCP; Surveillance networks, Consumer and food service operator education; GM Foods, safety and labeling; International Food Standards ISO 9000 and related standards; Impact of food safety on global trade.

#### UNIT V FOOD SAFETY AND QUALITY IN PROCESSING

Building and equipment design; microbiological quality of water, air; Safety in food procurement, storage, handling and manufacture; Food safety in retail food businesses; international food service operators, institutional food service operators; application of the principals of modern hygiene; Food handlers, habits, clothes, illness; Training & Education for safe methods of handling food; cleaning and sanitisation of processing plants; principles of cleaning and sterilization ; sterilization & disinfection- different methods used-detergents, heat, chemicals; selecting and installing equipment; Cleaning of equipment and premises. Safety limits of sanitizers; pest control; management and disposal of waste.

#### **TOTAL : 45 PERIODS**

#### REFERENCES

- 1. Entis, Phyllis, "Food Safety: Old Habits, New Perspectives", ASM, Blackwell Publishing, Washington, 2007.
- 2. Mortimone, Sara and Wallace, Carot, "HACCP" (Food Industry Briefing Series), Blackwell Science, Oxford, UK, 2007.
- 3. Schmidt, Ronald H. and Rodrick, G.E. "Food Safety Handbook", Wiley Interscience, UK, 2005.
- 4. Mehta, Rajesh and George, J. "Food Safety Regulations Concerns and Trade" : The Developing Country Perspective", Macmillan, New Delhi, 2005
- 5. Paster, Tara "The HACCP: Food Safety Training Manual", John Wiley, Oxford, 2006.

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# FD 9163 FOOD PACKAGING TECHNOLOGY

## UNIT I INTRODUCTION TO FOOD PACKAGING

Status of current packaging; critical review of the existing knowledge in packaging of products; Packaging –Concepts, definition, Significance, classification; Packaging – Development, Retail / Unit; Causes of food spoilage and deterioration; the function of packaging; package strategy.

#### UNIT II PACKAGING MEDIA & MATERIALS

Primary packaging media –Properties and application Properties, manufacturing and applications of textiles and wood, paper and paperboard, metal, glass, plastics; combined package systems; Identification methods used for plastic food packaging materials; Shaping and manufacturing processes used for the production of moulded plastic food containers; Edible films and coatings used in the food packaging industry; Labels, caps and closures and adhesives, inks and lacquers, cushioning materials, reinforcements.

#### UNIT III PACKAGING SYSTEMS AND METHODS

Vacuum packaging, gas flush packaging, Tamper-evident packaging; aseptic packaging; modified atmosphere packaging (MAP), Controlled atmosphere packaging (CAP) & aseptic & retort pouch technology, box in box; microwave packaging; active packaging; biodegradable packages, edible packages; Use of smart packaging by the food industry; Use of sensor technology within the food packaging industry; Industrial packaging: unitizing, palletizing, containerizing, stacking and materials handling; distribution systems for packaged foods including prevention of shock damage to articles during transportation; Rigid and semi-rigid containers; flexible containers; form-fill-seal systems; Testing & evaluation of packaging media – retail packs & transport packages.

#### UNIT IV PACKAGING FRESH AND PROCESSED FOODS

Packaging requirements for different foods and processing methods- General classification and packaging types, varieties and trends; Protective packaging of foods; packaging of food products sensitive to oxygen, light, moisture; special problems in canned foods; packaging of convenience foods; Packaging of Food products-; fruits and vegetables; packaging requirements of fresh fruits and vegetables; packaging of fruit juices; fats and oils; packaging of spices; packaging of meat and poultry; packaging and transportation of fish and other sea-foods; criteria for selection of proper packaging based on the shelf life desired; diary products; beverage products; cakes and snack foods; different packaging requirements for thermal- processed, dehydrated, frozen, irradiated and other specially processed foods.

#### UNIT V PACKAGING DESIGN & ENVIRONMENTAL ISSUES IN PACKAGING 9

Food marketing and role of packaging- Packaging aesthetic and graphic design; Coding and marking including bar coding; 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**

#### REFERENCES

- 1. Robertson, G.L. Food Packaging: Principles and Practice (2nd ed.), Taylor & Francis 2006
- 2. Ahvenainen, R. (Ed.) Novel Food Packaging Techniques, CRC Press, 2003

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- 3. Han, J.H. (Ed.) Innovations in Food Packaging, Elsevier Academic Press, 2005
- 4. Coles, R., McDowell, D. and Kirwan, M.J. (Eds.) Food Packaging Technology, CRC Press, 2003
- 5. Parry R. T. and Blakistone B. A. Principles & Applications of MAP –Springer, New York, 1999
- 6. Food Packaging Technology Handbook. NIIR Board, National Institute of Industrial Research, 2003.

### FD 9164 NEW PROCESS PRINCIPLES AND PRODUCTION SYSTEMS FOR FOOD

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### UNIT I INTRODUCTION

Importance and need for processes to explore the physical-chemical properties of functional food ingredients and nutraceuticals and optimalization of both the nutritional/physiological functionality of ingredients at the molecular, mesoscopic and macroscopic levels

#### UNIT II EXTRACTION

Different types of methods of extraction for molecules of interest and their optimization; Industrial processes for extraction of desirable and undesirable components from fresh and/or stored products by supercritical fluid (SCF)extraction and other techniques; application of ultrafiltration, reverse osmosis; nanofiltration and microfiltration in food industry.

#### UNIT III FRACTIONATION

Methods used for fractionation and characterization of molecules/groups of compounds such as polyphenols, phytates, saponins, phytoestrogens, fatty acids, volatile and aroma / flavour components - by head-space sampling, extraction, concentration, separation and identification techniques - chromatography with mass spectroscopic techniques, GC-MS, random MS and ESR, NMR, IR and Raman Spectroscopy; Pulse Nuclear Magnetic Resonance (PNMR) spectroscopy, X-ray crystallography and polarising light microscopy, scanning electron microscopy, spectro-polarimetry, circular dichroism and differential scanning calorimetry.

#### UNIT IV SYNTHESIS OF INGREDIENTS

Production of functional ingredients by microbes – oligoscahharides, polyscahharides, biosweeteners, biopreservatives, flavour and colour components; Modification of phytonutrients using enzymes or microbial fermentations to improve bioavailability, enhance water-solubility, slow-release applications, solubility in oil, and effecting hydroxylation/methylation patterns to modulate bioactivity.

# UNIT V BIOPROCESSING TECHNOLOGY FOR NUTRACEUTICALS 9

Pasteurisation & Sterilization with high pressure – ultrahydrostatic pressure treatment, dense carbon-di-oxide treatment, encapsulation of neutraceuticals – materials, mechanical processes and chemical based processes, nanoencapsulation; packaging requirements and practices for functional foods; distillation and dehydration technologies to retain bioactive compounds.

#### TOTAL: 45 PERIODS

#### REFERENCES

- 1. Gilbert .J and Seuyava .H.Z (Eds) "Bioreactive Compounds in Foods" Blackwell Publishing.2008.
- 2. Hurst W.F.(Ed.,)"Methods of Analysis for Fund Food and Nutraceuticals" 2<sup>nd</sup> Edition ,CRC Press,2008.
- 3. Shi .J (Ed) "Functional Food Ingredients and Nutraceuticals proceesing Technologies", CRC Press,2008.

# FD 9165 ANIMAL PRODUCT TECHNOLOGY L T P C 3 0 0 3

#### UNIT I INTRODUCTION

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

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

Structure and composition of meat, carcass chilling, ageing; storage of fresh meat-Modified atmosphere packaging, packaging of retail cuts; Processing and preservationartificial 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

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

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**

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#### TEXT BOOK

1. Sofos, J.N. "Improving and Safety of Fresh Meat" Wood Head Publishing / CRc, 2005.