

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	T	P	C
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 (for Science stream graduates)	3	0	0	3
3.	FD 9113	Basic Food Chemistry and Microbiology (for Engineering stream graduates)	3	0	0	3
4.	FD 9114	Principles of Food Processing & Preservation (for Graduates without Food background)	3	0	0	3
5.	FD 9115	Food and Ingredient Functionality (for Graduates with Food background)	3	0	0	3
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				
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	T	P	C
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	T	P	C
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	T	P	C
PRACTICAL						
1.	FD 9141	Project work – Phase II	0	0	24	12
TOTAL CREDITS			9	0	24	12

LIST OF ELECTIVES**SEMESTER I**

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
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. NO	COURSE CODE	COURSE TITLE	L	T	P	C
1.	BT 9123	Immunotechnology	3	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	3	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. NO	COURSE CODE	COURSE TITLE	L	T	P	C
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.	FD9164	New Process Principles and Production Systems for Food	3	0	0	3
6.	FD9165	Animal Product Technology	3	0	0	3

UNIT III MICROBIAL NUTRITION, GROWTH AND METABOLISM 6

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 9

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 9

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

TEXT BOOKS

1. Vaclavik, V.A. and E.W. Christian "Essential of Food Science", 2nd Edition, Springer, 2005.
2. Belitz, H.D., W. Grosch and P. Schieberle "Food Chemistry", 3rd Rev. Edition, Springer, 2003.
3. Jay, J.M. "Modern Food Microbiology", 4th Edition, CBS, 2003.
4. Adams, M.R. and M.O. Moss "Food Microbiology", 2nd 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)**

**L T P C
3 0 0 3**

UNIT I PRINCIPLES OF FRESH FOOD STORAGE 9

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 12

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 6

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 9

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 9

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", 4th 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", 2nd Edition, Springer, 2003.
5. Potter, Norman N. "Food Science" 5th 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.

REFERENCES

1. Fellows, P. J. "Food Processing Technology: Principles and Practices", Wood Head Publishing, 1997.
2. "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", 2nd 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)

**L T P C
3 0 0 3**

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.

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

TEXT BOOK

1. Vaclavik, V.A. and E. W .Christian “Essential of Food Science”, 2nd 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
		3 0 0 3
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

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”, 2nd Edition- Tata McGraw-Hill,

- UNIT I SOLUTION OF EQUATIONS, INTERPOLATION 9**
 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 9**
 Finite Difference Solutions for the second order ordinary differential equations - Their applications in heat equations – two dimensional Laplace equations.
- UNIT IV C – PROGRAMMING 9**
 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.
- UNIT V FILE HANDLING, PROGRAMS FOR NUMERICAL METHODS 9**
 Structure, Unions, File management in C, Developing C programs for numerical methods; Developing Matlab Programs for numerical methods.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Grewal, B.S., “Numerical Methods in Engineering & Science”, 40th Edition, Khanna Publishers, 2007.
2. Sastry, S.S., “Introductory Methods of Numerical Analysis”, 3rd Edition, Prentice - Hall of India.
3. Balaguruswamy, E., “Programming in ANSIC”, 3rd 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”, 2nd 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](http://www.mathworks.com/moler/chapters.html)

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

1. 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, isoelectric focussing
3. 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

TOTAL: 90 PERIODS

- UNIT I ECONOMICS FUNDAMENTALS 9**
Nature of Indian Economy – Role of Agriculture 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.
- UNIT II INFRASTRUCTURE 9**
Energy, Transportation, Storage, Communication, Health, Education, Importance of Co-operation, Role of Small and Medium Enterprises (SMEs), CLUSTER and Industrial Park concept, Self Help Groups (SHG).
- UNIT III ECONOMICS REFORMS 9**
Liberalization, Privatizations, Disinvestment, Globalization, Importance of Export, Export Documentation, Inflation, Foreign exchange reserves.
- UNIT IV IMPORTANCE OF MODERN TECHNOLOGY 9**
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 9**
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", 2nd Edition, John Wiley, 1983.
3. "Plant Design and Economics" for Chemical Engineers, 5th Edition, McGraw Hill, 2002.
4. "The Hindu Survey of Indian Industries", Published Annually.

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; 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	6
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, Barley-pearling and malting of barley. Oats- Milling, Oat Products – Steel cut, rolled oats, quick cooking		
UNIT III	MILLETS	9
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	6
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	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		

TOTAL: 45 HOURS**TEXT BOOKS**

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

UNIT I SENSORY PERCEPTION**6**

The perceptions of taste, smell and oral texture of foods; anatomy of the chemical senses- olfaction and taste; chemesthesis. 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 flavours 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 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", 2nd 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", 3rd Edition, Aspen Publications, 1999.
2. Reineccius, Gary "Flavour chemistry and Technology", 2nd Edition, Taylor & Francis, 2006.
3. Otlés, 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.

UNIT I HISTORICAL PERSPECTIVES INCLUDING NECESSITY OF FOOD LAWS 6

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 12

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 9

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 9

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 9

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.

TOTAL: 45 PERIODS**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.,

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.

FD 9155

ENZYMES IN FOOD TECHNOLOGY

L T P C

3 0 0 3

UNIT I FOOD ENZYMES -TYPES AND SOURCES

9

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.

UNIT II ENZYMES FOR DAIRY PRODUCT PROCESSING

9

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,

UNIT III ENZYMES FOR CARBOHYDRATES & LIPIDS

9

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.

UNIT IV ENZYMES FOR TEXTURE MODIFICATION

9

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

9

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.

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” 4th 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

**L T P C
3 0 0 3**

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.

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

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 k_{la} – dynamic gassing method,
5. Estimation of k_{la} – 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

TOTAL : 90 PERIODS

REFERENCES

1. Bailey, J.E. and Ollis, D.F. “Biochemical Engineering Fundamentals” 2nd Edition, McGraw – Hill, 1988.
2. Lee, James M. “Biochemical Engineering”, PHI, U.S.A.
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 D. Perlman “ Microbial Technology” (vol. I Microbial Processes and Vol. II Fermentation Technology)” 2nd Edition, Academic Press / Elsevier, 2004.

BT 9123

IMMUNOTECHNOLOGY

L T P C

3 0 0 3

UNIT I INTRODUCTION

9

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

UNIT II ANTIBODIES

9

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

UNIT III CELLULAR IMMUNOLOGY

9

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

9

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

UNIT V DEVELOPMENT OF IMMUNOTHERAPEUTICS

9

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

TOTAL: 45 PERIODS

TEXT BOOKS

1. Male, David, Jonathan Brostoff, David B Roth and Ivan Roitt, "Immunology", 7th Edition, Mosby / Elsevier, 2006
2. Kindt, T. J., R.A.Goldsby and B.A. Osborne, "Kuby Immunology", 6th Edition, W.H. Freeman, 2007.
3. Weir, D.M. and J. Stewart "Immunology" 8th 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", 6th 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", 3rd Edition, Oxford University Press, 2000.
8. Glick, B.R. and J.J. Pasternak, "Molecular Biotechnology : Principles and Applications of Recombinant DNA", 3rd 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". 2nd Edition, Oxford University Press 1995.
4. Shepherd, P. and Dean, C. "Monoclonal Antibodies". Oxford University Press, 2000.
5. Rastogi, S.C. "Immunodiagnosics : Principles and Practice". New Age International, 1996.

FD 9156

ENVIRONMENTAL ISSUES IN FOOD INDUSTRY

L T P C

3 0 0 3

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

TEXT BOOKS

1. Potter, Norman N. and J.H. Hotchkiss "Food Science", 5th 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", 2nd Edition, CRC, 2008.
2. Hester, R.E. and R.M. Harrison "Food Safety and Food Quality", (Issues in Environmental Science and Technology) RSC, 2001.

**FD 9157 FOOD PRODUCT DESIGN AND DEVELOPMENT L T P C
3 0 0 3**

UNIT I FOOD NEEDS & CONSUMER PREFERENCE 9

Market survey and its importance in; designing a questionnaire 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 9

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.

UNIT III STANDARDIZATION & LARGE SCALE PRODUCTION 9

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 III	METABOLIC FLUX ANALYSIS	9
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.		
UNIT IV	METABOLIC CONTROL ANALYSIS	9
Fundamental of Metabolic Control Analysis, control coefficients and the summation theorems, Determination of flux control coefficients, MCA of linear pathways, branched pathways, theory of large deviations.		
UNIT V	ANALYSIS OF METABOLIC NETWORKS	9
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.		

TOTAL: 45 PERIODS

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.

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.

FD 9158 **FRUIT AND VEGETABLE TECHNOLOGY** **L T P C**

3 0 0 3

UNIT I	PRE-PROCESSING	9
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	6
Different freezing methods and equipments, problems associated with specific fruits and vegetables;		
UNIT III	DEHYDRATION OF FRUITS AND VEGETABLES	9
Dehydration – different methods of drying including sun, tray, cabinet, drum, spray, vacuum, tunnel, spray, low temperature drying process, process calculations		

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 9

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 9

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

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", 2nd Edition, Springer, 2005.
4. Majumdar, A.S. "Dehydration of Products of Biological Origin", Oxford 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", 5th Edition, CBS, 1996.
2. Vaclavik, V.A. and E.W. Christian "Essentials of Food Science", 2nd 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 T P C
3 0 0 3**

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 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 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

REFERENCES

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”, 3rd 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 9

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

UNIT II STIOCHIOMETRY AND MEDIUM DESIGN 9

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 9

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

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

UNIT IV TYPES OF BIOREACTORS 9
CFSTR, Stirred 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 9
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 consumption, Air gases: process air, cylinder gases, sizing for process Air and cylinder gas requirements.

TOTAL : 45 PERIODS

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 Food Foods and Nutraceuticals” 2nd 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 T P C
3 0 0 3**

UNIT I INTRODUCTION 9
Biochemical engineering: kinetics of substrate utilization; product yield and biomass production in cell cultures;

UNIT II MASS AND HEAT TRANSFER 9
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 9
Factors affecting spoilage of different types of food products and design of thermal process; aseptic packaging systems and conditions; survivor curve; thermal death curve;

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

UNIT IV OTHER ASPECTS OF PROCESSING 9

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 9

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.

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 Food", 3rd 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", 2nd Edition, Aspen, 1999.
3. Toledo, R.M. "Fundamentals of Food Process Engineering", 3rd 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 9

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 Alimentarius/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 9

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 9

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, mutagenicity and carcinogenicity, reproductive and developmental toxicity, neurotoxicity and behavioural effect, immunotoxicity

UNIT IV FOOD SAFETY MANAGEMENT SYSTEMS 9

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 9

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.

UNIT I INTRODUCTION TO FOOD PACKAGING 9

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 9

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 9

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; bio-degradable 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 9

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; dairy 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

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” 2nd 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

9

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

9

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

TEXT BOOK

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