Department of Chemical Engineering and Technology
BIT Mesra, Ranchi.

Proposed New Programmes From 2014 July Session

M.Sc. Food Technology (4 Semesters)

Eligibility Criteria:

B.Sc. with Physics, Chemistry, Mathematics or equivalent
B.Sc. Food science and technology, Food Processing and Technology, B.Sc. Agriculture, Home Science and Nutrition, B.Sc. Biotechnology, B.Sc Dairy Science and Technology

Marks: 55% for General, 50% for SC/ST candidates
Total No. of Seats : 15

M.Sc. Food Technology, BIT Mesra, Ranchi.

SEMESTER - I					
Course Code	Course Title	L	T	P	C
SAF 1001	Advanced Food Microbiology	3	0	0	3
SAF 1003	Advanced Food Chemistry and Nutrition	3	0	0	3
SAF 1005	Advanced Food Engineering	3	0	0	3
SAF 1007	Advanced Food Processing	3	0	0	3
SAF 1002	Food Chemistry & Quality Control Lab I	0	0	6	4
SAF 1004	Advanced Food Engineering Laboratory	0	0	3	2
SAF 1006	Advanced Food Microbiology Lab	0	0	3	2
	Total				**20**

SEMESTER - II					
Course Code	Course Title	L	T	P	C
SAF 2001	Cereal Pulses and Oilseeds Technology	3	0	0	3
SAF 2003	Novel Food Processing and Packaging	3	1	0	4
SAF 2005	Food Laws Standard and Regulation	3	0	0	3
SAF 2007	Food Storage and Transportation	3	0	0	3
	Elective I	3	0	0	3
SAF 2002	Food Chemistry & Quality Control Lab II	0	0	3	2
SAF 2004	Advanced food Processing Lab I	0	0	3	2
	Total				**20**

ELECTIVE I [3-0-0, Credit 3]			
SAF 2009	Post Harvest technology and Cold Chain Management	SAF 2019	Oils and Fats Technology
SAF 2011	Beverage and snack food technology	SAF 2021	Food Biotechnology
SAF 2013	Renewable Energy for Food Processing	SAF 2023	Agrochemicals and residues in food
SAF 2015	Food Science and technology, [Compulsory for Non food background lateral entry students]	SAF 2025	Food Toxicology
SAF 2017	Nutraceuticals & Health Foods	SAF 2027	Food Microstructure and Texture

SEMESTER –III					
Course Code	Course Title	L	T	P	C
SAF 3001	Food Business Management	3	0	0	3
SAF 3003	Automation in Food Processing Industry	3	1	0	4
SAF 3005	Food Product Development and sensory evaluation	3	0	0	3
SAF 3007	Animal Product Technology	3	0	0	3
	Elective II	3	0	0	3
SAF 3004	Advanced food Processing Laboratory II	0	0	6	4
	Total				**20**

ELECTIVE-II [3-0-0, Credit 3]			
SAF 3009	Phytochemicals and Herbal Medicines	SAF 3019	Computer Applications in Food Industry
SAF 3011	Flavour Chemistry and Technology	SAF 3021	Food Supply Chain Management
SAF 3013	Grain Storage Technology	SAF 3023	Food Plant and Equipment Design
SAF 3015	Enzymes in Food Processing	SAF 3025	Plantation Crops, Spices, & condiment Technology
SAF 3017	Statistical Quality Control	SAF 3027	Bakery and Confectionary

SEMESTER –IV					
Course Code	Course Title	L	T	P	C
SAF 4002	Entrepreneurship Business Plan	0	0	3	2
SAF 4004	Project				18
	Total				**20**

TOTAL Credits - 80

\

SAF1001 – Advanced Food Microbiology

Module I : Growth and survival of microorganisms in foods; spoilage organisms of milk, fruits, vegetables, grains and oilseeds, meat and poultry; [6]

Module II: Physical and chemical methods to control microorganisms. [6]

Module III: Biochemical changes caused by microorganisms; Microbes in food fermentation, putrefaction, lipolysis; Antagonism and synergism in microorganisms; [6]

Module IV: Food poisoning and food borne infections; Microbial toxins. [6]

Module V: Food hygiene and sanitation: Contamination during handling and processing and its control; indicator organisms; Rapid methods in detection of microorganisms.[6]

Module VI: Food Fermentations; Traditional fermented foods of India and other Asian countries; Probiotics and prebiotics; Fermented foods based on milk, meat and vegetables; Fermented beverages.

Module VII: Preparation and maintenance of cultures, media, reference standard; sterilization techniques; disposal of used cultures and media Detection and detection techniques of microorganism in foods: culture, microscopic examinations, physical, chemical and immunological methods of microbial detection. Bio-burden.

Suggested Readings

1. Banawart GJ. 1989. *Basic Food Microbiology*. 2nd Ed. AVI Publ.
2. Frazier J & Westhoff DC. 1988. *Food Microbiology*. 4th Ed. McGraw Hill.
3. Garbutt J. 1997. *Essentials of Food Microbiology*. Arnold Heinemann.
4. Jay JM, Loessner MJ & Golden DA. 2005. *Modern Food Microbiology*. 7thEd. Springer.
5. Ray B. 2004. *Fundamentals of Food Microbiology*.3rd Ed. CRC.
6. Robinson RK. (Ed.). 1983. *Dairy Microbiology*. Applied Science.
7. Steinkraus KS. 1996. *Handbook of Indigenous Fermented Foods*. MarcelDekker.

SAF1003– Advanced Food Chemistry and Nutrition

ModuleI : Definition and importance; major food constituents and their physicochemical properties; role of water in food.

Module II: Carbohydrates, proteins and lipids: classification, physical, chemical, nutritional, and functional properties and their structural correlations; auto-oxidation of lipids and rancidity.

Module III: Properties of minerals, vitamins, pigments, anti-oxidants, flavor components, allergens, toxins and anti-nutritional factors in foods;

Module IV: Interaction of constituents in food systems; Changes during storage and processing; Browning reactions in foods.

Module V: Food groups and their typical composition; essential nutrients- sources, functions, deficiency diseases; requirements and recommended dietary allowances; Digestion, absorption, transport and metabolism of nutrients in human system; protein quality evaluation.

Module VI: Factors affecting bio-availability of nutrients example, nutrient interactions, food components like anti-nutrients etc. Principles of meal planning. Ways to increase nutritional quality of food such as enrichment, fortification, fermentation and mutual supplementation

Module VII: Best cooking and processing procedures to reduce cooking losses of nutrients. The nutrition transition in India –Malnutrition-concurrent under and over nutrition. Common nutritional deficiencies such as PEM, iron, vitamin A, iodine, calcium and vitamin D, zinc etc. Emerging common degenerated disorders.

Books

1. Bamji MS, Rao NA & Reddy V. 2003. *Textbook of Human Nutrition*. Oxford & IBH.
2. Belitz HD.1999. *Food Chemistry*. Springer Verlag.
3. DeMan JM. 1976. *Principles of Food Chemistry*. AVI.
4. Fennema OR.1996. *Food Chemistry*. Marcel Dekker.
5. Meyer LH. 1987. *Food Chemistry*. CBS.
6. Swaminathan M. 1974. *Essentials of Foods and Nutrition*. Vol. II. Ganesh & Co.

SAF 1005- ADVANCED FOOD ENGINEERING

Module I: Fluid flow in food processing-Newtonian and Non-Newtonian fluids. Measurement of viscosity – Capillary viscometer, rotational viscometer, Fluid moving machinery, Fluid flow measurement, Mixing of liquids

Module II: Application of Heat Transfer in Food Processing - Head transfer by conduction convection and radiation. Steady state and Unsteady state Heat transfer. Heat exchangers. Microwave heating. Food freezing – freezing systems,

Module III: Psychrometry principles of drying. Types of Dryers - Tray, tunnel, Puff, Fluidized ben Spray Freeze drying .etc. Evaporation – Boiling point elevation. Types of evaporation.

Module IV: Mass Transfer. Diffusion process, Unsteady state Mass transfer. Distillation. Membrane separation, Electro-dialysis, Reverse Osmosis, Ultra filtration- Principles and types of systems

Module VI: Supplemental Processes, Filtration, dry and wet methods of solid separation , particle size analysis, screening processes, Sedimentation, Mixing of pastes

Module VII: Extrusion processes for foods- principles of extrusion, Extrusion systems – cold extrusion, extrusion cooking, single and twin screw extruders.

Books:

1. Introduction to Food Engineering,, R. Paul Singh, Dennis R. Heldman, Academic Press, 2009
2. Fundamentals of food process engineering / Toledo, Romeo T. : Aspen Publication, 1999

SAF1007-ADVANCED FOOD PROCESSING

Module I : Scope of food processing; historical developments; principles of food processing and preservation

Module II: Processing and preservation by heat – blanching, pasteurization, sterilization and UHT processing, canning, extrusion cooking, dielectric heating, microwave heating, baking, roasting and frying, etc.

Module III: Processing and preservation by low-temperature- refrigeration, freezing, CA, MA, and dehydro-freezing.

Module IV: Processing and preservation by drying, concentration and evaporation-types of dryers and their suitability for different food products; ultra- filtration, reverse osmosis.

Module V: Processing and preservation by non-thermal methods, irradiation, high pressure, pulsed electric field, hurdle technology.

Module VI: Use and application of enzymes and microorganisms in processing and preservation of foods; food fermentations, pickling, smoking etc;

Module VII : Food additives: definition, types and functions, permissible limits and safety aspects.

Books

1. Arsdel WB, Copley MJ & Morgan AI. 1973. *Food Dehydration*. 2nd Ed. Vols.I, II. AVI Publ.
2. Desrosier NW & James N.1977. *Technology of Food Preservation*. 4th Ed. AVI.Publ.
3. Fellows PJ. 2005. *Food Processing Technology: Principle and Practice*. 2nd Ed. CRC.
4. Jelen P. 1985. *Introduction to Food Processing*. Prentice Hall.
5. Potter NN & Hotchkiss 1997. *Food Science*. 5th Ed. CBS.
6. Potty VH & Mulky MJ. 1993. *Food Processing*. Oxford & IBH.
7. Ramaswamy H & Marcotte M. 2006. *Food Processing: Principles and Applications*.Taylor & Francis.

SAF 2001- CEREALS PULSES AND OIL SEED TECHNOLOGY

Module I : Status, production and major growing areas of cereals, in India and world, Structure and chemical composition of cereals, pulses and oilseeds, Nutrition and anti-nutritional factors.

Module II: Wheat Processing: Wheat classification, wheat grain structure quality and milling Functionality of wheat flour components and bakery ingredients.

Rice Processing: Classification, paddy Processing and treatment for quality improvement, Milling and sorting.

Module III: By product utilization e.g. Bran: Novel product development – Instant Rice, puffed products etc.

Module IV: Coarse Cereals Products: Maize, sorghum, pearl millet and small millets processing and value addition.

Pulses: Pretreatment of pulses for milling, milling of major pulses. Methods to improve recovery.

Module V: Oil seeds Processing: Groundnut, Mustard, Soybean, Sunflower, Safflower, Sesame and other oil bearing materials Special Topics: Processing &Utilization of Soya bean for value added products, Sources; chemical composition; physical and chemical characteristics; functional and nutritional importance of dietary oils and fats. Post-harvest handling storage and processing of oil seeds for directs use and consumption.

Module VI: Extraction of oil by mechanical expelling and solvent extraction and obtaining de-oiled cakes suitable for edible purposes. Processing of other plant sources of edible oils and fats like coconut, cottonseed, rice bran, maze germ, etc.

Refining: Clarification, degumming, neutralization (alkali refining), bleaching, deodorization techniques / processes. Blending of oils.

Processing of refined oils: Hydrogenation, fractionation, winterization, inter-esterification etc .for obtaining tailor-made fats and oils

Module VII: Innovative products from cereals, pulses and oilseeds. Extrusion technology for cereals

Books:

1. Cereal Technology by Kent, CBS
2. Wheat Chemistry and Technology by Y. Pomeranz
3. Post Harvest Technology of Cereals byChakraborty AC, CRC Press.
4. Cereals and Cejreal Processing: Chemistry andTechnology DAV Dendy and BJ Dobrazczyk
5. Chemistry and Technology of Cereal Food and Feedby S A Matz3

SAF 2003- NOVEL FOOD PROCESSING AND PACKAGING

Module I : Membrane technology: Introduction to pressure activated membrane processes: micro- filtration, UF, NF and RO and their industrial application. Supercritical fluid extraction: Concept, property of near critical fluids NCF and extraction methods.
Module II: Microwave and radio frequency processing: Definition, Advantages, mechanism of heat generation, application in food processing: microwave blanching, sterilization and finish drying. Hurdle technology: Types of preservation techniques and their principles, concept of hurdle technology and its application. Freeze Drying
Module III: High Pressure processing: Concept, equipments for HPP treatment, mechanism of microbial inactivation and its application in food processing. Ultrasonic processing: Properties of ultrasonic, application of ultrasonic as processing techniques.
Module IV: Newer techniques in food processing: Application of technologies of high intensity light, pulse electric field, ohmic heating, IR heating, inductive heating and pulsed X-rays in food processing and preservation. Nanotechnology: Principles and applications in foods.
Module V: Objectives and importance of extrusion in food product development; Components and functions of an extruder; Classification of extruder; Advantages and disadvantages of different types of extrusion; Change of functional properties of food components during extrusion; Pre and post extrusion treatments; Use of extruder as bioreactor; Manufacturing process of extruded products; Application of extrusion technologies in food industries.
Module VI: Packaging material and their selection – paper, polymers, metallic glass. Types of packaging. Current use of novel packaging techniques, Oxygen, ethylene and other scavengers, Oxygen scavenging technology, Ethylene scavenging technology, Carbon dioxide and other scavengers, Antimicrobial food packaging: Constructing an antimicrobial packaging system,
Module VII: Novel MAP applications for fresh-prepared produce, Novel MAP gases, Testing novel MAP applications, Applying high O_2 MAP.

Suggested Readings

1. Barbosa-Canovas 2002. *Novel Food Processing Technologies*. CRC.
2. Dutta AK & Anantheswaran RC.1999. *Hand Book of MicrowaveTechnology for Food Applications*.
3. Frame ND. (Ed.). 1994. *The Technology of Extrusion Cooking*. Blackie
4. Gould GW. 2000. *New Methods of Food Preservation*. CRC.
5. Shi J. (Ed.). 2006. *Functional Food Ingredients and Nutraceuticals:Processing Technologies*. CRC.

SAF 2005 - FOOD LAWS, STANDARDS AND REGULATIONS

Module-I: Introduction, concept of food safety and standards, food safety strategies. Food hazards and contaminations - biological (bacteria, viruses and parasites), chemical (toxic constituents / hazardous materials) pesticides residues / environmental pollution / chemicals) and physical factors. Preventive food safety systems -monitoring of safety, wholesomeness and nutritional quality of food.

Module – II: Prevention and control of microbiological and chemical hazards. Food safety aspects of novel methods of food processing such as PEF, high pressure processing, thermal and non thermal processing, irradiation of foods.

Module – III: Indian and Food Regulatory Regime (Existing and new), PFA Act and Rules, Food Safety and Quality Requirements, Additives, Contaminants and Pesticide Residue. Food Safety and Standards Act, 2006, Essential Commodities Act, 1955, Global Scenario, Codex Alimentarius, WHO/FAO Expert Bodies (JECFA/JEMRA/JMPR) WHO/FAO Expert Bodies (JECFA/ JEMRA/JMPR).Food safety inspection services (FSIS) and their utilization.

Module IV: Introduction to OIE & IPPC, Other International Food Standards (e.g. European Commission, USFDA etc). WTO: Introduction to WTO Agreements: SPS and TBT Agreement, Export & Import Laws and Regulations, Export (Quality Control and Inspection) Act, 1963.

Module V: Customs Act and Import Control Regulations, Other Voluntary and mandatory product specific regulations, Other Voluntary National Food Standards: BIS Other product specific standards; AGMARK. Nutritional Labeling, Health claims.

Module VI: Risk assessment studies: Risk management, risk characterization and communication.

Module VII: Voluntary Quality Standards and Certification GMP, GHP, HACCP, GAP, Good Animal Husbandry Practices, Good Aquaculture Practices
ISO 9000, ISO 22000, ISO 14000, ISO 17025, PAS 22000, FSSC 22000, BRC, BRCIOP, IFS, SQF 1000, SQF 2000. Role of NABL, CFLS.

Books:

1. Singal RS (1997). Handbook of indices of food quality and authenticity. Woodhead Publ. Cambridge, UK.
2. Shapton DA (1994). Principles and practices of safe processing of foods. Butterworth Publication, London. Winton AL (1999)Techniques of food analysis, Allied Science Publications NewDelhi.
3. Pomeranze Y (2004). Food analysis - Theory and Practice CBS Publications, New Delhi.
4. Jacob MB (1999). The chemical analysis of foods and food products. CBS Publ. New Delhi

SAF 2007 -FOOD STORAGE AND TRANSPORTATION

Module I : Food science and the transport of food : Composition of food, Chemical reactions in foods, Physical changes in foods: crystallization phenomena, Microbiology and food transportation.

Characteristics of bacterial growth - the use of modeling, Controlled and modified atmosphere transportation, Taints, Transport of animals.

Logistics of food transport: Importance of logistics, The food industry, Key logistics trends and supply chain relationships in the food industry. Food transport case studies.

Land transport of food: principal elements and current practice: Brief history, The transport medium-decision making parameters, The supply chain, In-transit refrigeration, Refrigeration developments, Beyond refrigeration, Loading vehicles and containers, Selecting transport.

Module II: Transport of food stuffs by sea: Cooling of cargo in transit, Conventional refrigerated ships, Containerships, Need for refrigeration.

Air transport of perishables: Cargo space, Unit load, devices: containers and pallets, Temperature regulation within the cargo, Expendable refrigerants: dry ice and water ice, Carton design, Temperature protection, Documentation, temperature monitoring Recommendations.

Transport of fruit and vegetables: Post-harvest behavior of fruit and vegetables, Pre-cooling and the cold chain, Product requirements during transport, Storage temperature management.

Transport of oils and fats: Quality problems arising in transport, Transport at sea, Transport on land.

Transport of dairy product: Main dairy product types, Packaging, Manufacture and storage, Product deterioration, Land transport, Shipping, Air freight. Insurance,

Module III: Hygiene in food transport: Basic hygiene requirements, Shipping container loading, Inspection of incoming carriers, Quality systems in food transportation, Quality and safety in food transportation, History of quality management in food transportation, Standards for quality systems, Benefits of implementing a quality management system, Clauses of ISO9002,HACCP: A food safety management system.

Legislation and food transport: Legislation-food, Legislation-transport

Module IV: Distribution of chilled and frozen foods : Loading disciplines, Overnight standing and noise difficulties, Thermographs and temperature monitoring equipment, Temperature measurement, Calibration, Refrigerated vehicles, Foodstuffs carried, Transport refrigeration requirements, Refrigeration methods, Insulation, Pre-cooling the product, Design and specification,

Module V: Stored Product Quality : Open Dating and Temperature Monitoring. Quality Management during Storage and Distribution. Freezing Preservation of Fresh Foods: Quality Aspects. Quality Changes During Distribution of Deep Frozen and Chilled Foods : Distribution Chain Situation and Modeling Considerations. Technologies to Extend the Refrigerated Shelf-Life of Fresh Fruits and Vegetables. Ambient Storage. Toxicological Implications of Post-Processing In-Storage or Shipped Foods. Consumer Attitudes and Perceptions.

Facilities for the Cold Chain: Freezing Methods and Equipment, Cold Store Design and Maintenance, Transportation of Frozen Foods, Retail Display Equipment and Management, Household Refrigerators and Freezers, Monitoring and Control of the Cold Chain.

Module VI: Food Transport: Controlled Atmosphere: The Biology of Controlled Atmospheres, Techniques in Controlled Atmosphere Storage, Modified Atmosphere Packaging. Food Storage, Handling & Transportation: Bulk storage system: Metallic bins,

silos, intermediate bulk containers - fabrication, types, functional properties, its application, impact of storage condition on quality of food products, cold storage of fresh produce.

Module VII: Handling and transportation: Mechanical handling system, palletisation, containerization, ULD, different mode of transportation-its advantages and disadvantages, cool chain of food products, requirement of marking on transport packages.

Testing of package durability and compatibility for physical distribution. Modes of transportation.

Refrigerated storage: Factors of importance in refrigerated storage. Food storage requirement Cold storages and frozen storage for food products and vapour barriers for cold stores. Refrigerated warehouse, refrigerated trucks, trailers and containers. Railways refrigerated cars, marine refrigeration, and refrigeration in air transport

Books:

1. Fruits and Vegetables. A.K Thompson. Blackwell publishing

S. Ranganna, Hand Book of Analysis and Quality Control for Fruits and Vegetable Products, Tata McGraw Hill, 2002.

2. S. Ranganna, Hand Book of Canning and Accepting Packaging, Tata McGraw Hill, 2000.

3. L. Somogyi, Processing Fruits: Science and Technology, Vol I : Biology Principles and Applications, Woodhead Publishing,1996.

4. L. Somogyi, D.M. Barette and Y.H. Hui, Processing Fruits: Science and Technology, Vol II: Major Processed Products, Woodhead Publishing, 1996.

5. Y. H. Hui, S. Ghazala, D.M. Graham, K.D. Murrell and W.K.Nip, Handbook of Vegetable Preservation and Processing, Marcel Dekker,2003.

SAF2009- SAF2027-- Elective I

SAF 3001- Food Business Management

Module I: introduction to Business Organisation, Overview of Basic Management Functions & Executive Functions.
Module II: Human Resource Management: Manpower Planning, Recruitment, Selection & Training manpower for Food Businesses.
Consumer Behavior: Food Consumption Behavior, Marketing research for Food Market, Secondary data sources for Food Market and Food Industry
Module III: International trade; Basics, classical theory, theory of absolute advantage. theory of comparative, modern theory, free trade- protectionism, methods of protection, quotas, bounties, exchange control, devaluation, commercial treaties, terms of trade, balance of payments, EXIM policy, foreign exchange, mechanics of foreign exchange, GATT, WTO, role of WTO, International Trade in agriculture.
Module IV: World trade agreements related with food business, export trends and prospects of food products in India.
Module V: World consumption of food; patterns and types of food consumption across the globe. Ethnic food habits of different regions. Govt. institutions related to International ad trade; APEDA, Tea board, spice board, wine board, MOFPI etc.
Module VI: Management of export import organization, registration, documentation, export import logistics, case studies. Export and import policies relevant to horticultural sector.
Module VII: Entrepreneurship Development: Assessing overall business environment in the Indian economy, Concept of Entrepreneurship, entrepreneurial and managerial characteristics; motivation and entrepreneurship development; importance of planning, Budgeting monitoring, evaluation and follow up; managing competition.
Entrepreneurship Development Programs (EDP). SWOT analysis; Generation, incubation and commercialization of ideas and innovations. Government schemes and incentives for promotion of entrepreneurship. Government policy on small and Medium Enterprises (SMEs)/ Small Scale industries (SSls). Venture capital, contract farming and joint ventures. public-private partnership (PPP). Over view of Food Process Industry. Characteristics of Indian Food Processing Industry. Social Responsibility of Food Processing Business.

Books:

1. Principles of Agri Business Management - D. David and S Erickson 1987. Mc Graw Hill Book Co., New Delhi.
2. Agricultural Marketing in India - Acharya S S and Agarwal N L 1987. Oxford & ISH Publishing Co., New Delhi.
3. Marketing in the International Environment - Cundiff Higler 1993, Prentice Hall of India, New Delhi.
4. GAD implications of Denkel proposals - G S Batra & Narindev kumar (1994) Azmol Publications Pvt., New Delhi.
5. Marketing Management - Phill Kottler 1994 Prentice Hall of India, New Delhi.

SAF 3003- AUTOMATION IN FOOD PROCESSING INDUSTRY

Module I : Measurement system and error analysis, measurement of level, flow, temperature, strain pressure, vacuum, force, torque, power, displacement, vibration, acceleration, pH, colour viscosity, surface tension and composition. Indicating recording instruments, digital displays, transmitting and telemetering devices.

Module II : Introduction to control system- Feedback and feed forward control strategies, block diagrams, Mode of control and generation of control action; P. PI and PID control elements and value positioners, Electronic, pneumatic and hydraulic control systems and their application in farm machinery, food processing industry, aquaculture and their applications milk processing plants.

Module III: Introduction: electronic nose, food quality evaluation, indication variables, Data acquisition, elastography, electronic nose, ultrasonic, Data analysis, intramuscular fat, wavelet, marbled meat, statistical textural feature extraction from, elastography, Sampling, concept and system for data acquisition, image acquisition, ultrasonic B- mode imaging. Data Analysis – Data processing, Dynamic data analysis, Image processing.

Module IV: Modeling system identification, Modeling strategy, linear statistical modeling, ANN Modeling,

Module V : F statistic, null hypothesis Prediction Levenberg-Marquardt algorithm, recurrent neural networks, gradient descent. Control objective function, neuro-fuzzy, membership functions Systems integration assembly language, high-level programming language.

Module VI: System integration, Robotics, Application of robotics and basic components of robotics, Features of II and II generation robots.

Module VII: Bottle Washing Machine Automaton, Bottling Plant Drive System, Demineralization Plant Control System, Labeling Machine Control system, Charger level automation, Reverse Osmosis plant automation, Thermal plant automation, Dehydration and freezing pant automation.

Automation in different units of food processing, preparation of raw food and materials, sorting, grading, size reduction, mixing an agitation, thermal processing, dehydration, packaging, CIP, quality control.

Books:

1. Considine 2001. *Process Control*. AVI Publ.
2. Huang Y & Lacey RE. 2003. *Principles of Robotics*. CRC Press.
3. Huang Y, Whittaker AD & Lacey RE. 2001. *Automation for FoodEngineering*. CRC Press.

SAF 3005- FOOD PRODUCT DEVELOPMENT AND SENSORY EVALUATION

Module I : New Food Products: Definition, Classification, Characterization, Factors shaping new product development- Social concerns, health concerns, impact of technology and market place influence.

Module II : Market Survey, Consumer survey to identify new products in terms of Line Extension Repositioning Existing Products New form/Reformulation. New packaging of existing products Innovative products, Creative Products. Tapping traditional foods and unconventional sources of foods. Minimizing post harvest losses. Identification of concept & product for development, Market research for the concept and selected product, Identification of products, selection of one product and its standardization improving success.

Module III: Bulk preparation of product, Packaging and Labeling of the product, Packaging design, graphics and labeling nutritional evaluation (estimation of relevant parameters), Shelf life testing of the product (testing for appropriate quality parameters- chemical, microbiological and nutrient content, acceptability studies), Product integrity and conformance to standard, Costing the product and determining the sales price, Advertising and test marketing the product, Report preparation.

Module IV: Overview of sensory principles and practices: General consideration in sensory testing, flowcharts of sensory evaluation. Anatomy, physiology and function of various senses.

Module V: Psychological methods Selection and screening of panel: Types of panel (Trained panel, discriminative and communicative panel). Methodology for sensory evaluation: Discriminative test - difference test: paired comparison, Duo-trio, triangle, ranking, Sensitivity Test, Descriptive test - category scaling, ratio scaling, flavor profile analysis, texture profile analysis, quantitative descriptive analysis.

Module VI: Effective Tests: paired performance test, ranking test, rating scale: hedonic rating, food action scale rating. Maintaining suitable environmental conditions: laboratory setup and equipment

Module VII: Sample preparation, Basic statistical concepts for sensory evaluation: Hypothesis testing and sensory inference, variation of T Test, Nonparametric and binomial based, Statistical methods, Chi-square test, analysis of variation, Correlation regression.

Books:

1. Lyon, D.H.; Francombe, M.A.; Hasdell, T.A.;Lawson, K. (eds) (1992): Guidelines for Sensory Analysis in Food Product Development and Quality Control. Chapman and Hall, London.
2. Amerine, M.A.; Pangborn, R.M.; Roessler, E.B.(1965): Principles of Sensory Evaluation. AcademicPress, New York.
3. Kapsalis, J.G. (1987): Objective Methods in Food Quality Assessment. CRC Press, Florida.
4. Martens, M.; Dalen, G.A.; Russwurm, H. (eds)(1987): Flavour Science and Technology. John Wileyand Sons, Chichester.
5. Moskowitz, H.R. (eds) (1987): Food Texture: Instrumental and Sensory Measurement. MarcelDekker Inc. New York.

SAF 3007- ANIMAL PRODUCT TECHNOLOGY

Module I : Sources of meat and meat products in India, its importance in national economy. Chemical composition and microscopic structure of meat. Effect of feed, breed and management on meat production and quality. Slaughtering of animals and poultry, inspection and grading of meat.

Module II : Factors affecting post-mortem changes, properties and shelf life of meat. Meat quality evaluation. Mechanical deboning, meat tenderization. Aging, pickling and smoking of meat. Meat plant sanitation and safety, Byproduct utilization.

Module – III: Poultry: classification, composition, preservation methods and processing. Structure, composition, nutritive value and functional properties of eggs and its preservation by different methods. Processing of egg products. Factor affecting egg quality and measures of egg quality

Module – IV: Types of fish, composition, structure, post-mortem changes in fish. Handling of fresh water fish. Canning, smoking, freezing and dehydration of fish. Preparation of fish products, fish sausage and home makings. Fish products - production of fish meal, fish protein concentrate, fish liver oil and fish sauce and other important byproducts; Quality control of processed fish; Fish processing industries in India

Module – V: Milk Processing Milk Processing flow sheet – Filtration / clarification, Storage of milk, Standardization – simple problems in standardization, Homogenization, Pasteurization – Types of pasteurization process. Equipments used in each process - Cream separating centrifuges, Pasteurizers (Heat Exchangers), Homogenizers, Bottle and pouch fillers, Milk Chillers, Plant piping, Pumps.

Module – VI: Manufacture of Dairy Products Manufacture of Cream, Butter, Ghee, Milk powder, Cheese – Types and Defects in cheese Quality aspects of these products. Equipments used for manufacture of each product like Butter churn, ghee boiler, Spray and Drum Dryers, Product in sanitizing equipment etc.

Module – VII: Manufacture of Ice Cream and other Dairy Products - Manufacture of Ice cream – Chemistry and technology – Microbiology of ice cream – Quality aspects. Manufacture of paneer, Toned Milk, Sweetened Condensed milk, Khoa.

Fermented dairy products: Fermented products – Yoghurt, Curd, acidophilus milk, butter milk. Dairy plant sanitization – Cleaning in place – bottle and can washing, cleaning of tankers and silos – Detergents and sanitizers used.

Energy use in Dairy plant - sources and cost of energy, Control of energy losses and Energy conservation. Quality control of milk and milk products; Milk plant hygiene and sanitation

Text Books:

1. Lawrie, R.A. 1975. Meat Science, 2nd Ed. Pergamon Press, Oxford UK.
2. Vijaya Khader, 2001, "A Textbook of Food Science and Technology", ICAR, New Delhi
3. Modern Dairy Products, Lampert LH; 1970, Chemical Publishing Company.

References:

1. Developments in Dairy Chemistry – Vol 1 & 2; Fox PF; Applied Science Pub Ltd.
3. Milk & Milk Processing; Herrington BL; 1948, McGraw-Hill Book Company.
4. Portsmouth, J.I. 1979, Commercial Rabbit Meat Production. 2nd Ed. Saiga Survey, England

SAF3009- SAF3027-- Electives-II

Electives-I

SAF 2009-POST HARVEST TECHNOLOGY & COLD CHAIN MANAGEMENT

Module – I: Importance& scope of post harvest management of fruits and vegetables in Indian economy. Morphology, structure and composition of fruits and vegetables; maturity indices and standards for selected fruits and vegetables; methods of maturity determinations.

Module - II : Harvesting and handling of important fruits and vegetables, Harvesting tools and their design aspects ;Field heat of fruits and vegetables and primary processing for sorting and grading at farm and cluster level; factors affecting post harvest losses; Standards and specification for fresh fruits and vegetables.

Module –III : Post harvest physiological and biochemical changes in fruits and vegetables; ripening of climacteric and non-climacteric fruits; regulations, methods; Storage practices :CA and MA, hypobaric storage, pre-cooling and cold storage, Zero energy cool chamber; Commodity pretreatments- chemicals, wax coating, prepackaging, VHT and irradiation.

Module - IV: Physiology post harvest disorders – chilling injury and disease; prevention of post harvest diseases and infestation; Handling and packaging of fruits and vegetables; Post Harvest handling system for fruits and vegetables of regional importance citrus, mango, banana, pomegranate, tomato, papaya and carrot etc., packaging house operations; principles of transport and commercial transport operations.

Module –V: Fundamentals of Freezing: Glass transition in frozen foods and biomaterials, Microbiology of frozen food, thermo physical properties of frozen food, freezing loads and freezing time calculations, innovations in freezing process. Facilities for the cold chain: Freezing methods and equipment, cold storage design and maintenance, transportation of frozen foods, retail display equipment and management, house hold refrigerators and freezers, monitoring and control of cold chain.

Module - VI: Quality and safety of frozen foods: Quality and safety of frozen meat and meat products, quality and safety of frozen poultry and poultry products. Quality and safety of frozen fish, shell fish and related products, Quality and safety of frozen vegetables, Quality and safety of frozen fruits, Quality and safety of frozen dairy products, Quality and safety of frozen ready mea Quality and safety of frozen bakery products, Quality and safety of frozen eggs and egg products.

Unit –VII: Monitoring and measuring techniques for quality and safety: Chemical measurements, sensory analysis of frozen foods, food borne illnesses and detection of pathogenic microorganisms, shelf life prediction of frozen foods. Packaging of frozen foods.

Text books:

1. Lal, G., Siddappa, G. and Tondon G.L.: Preservation of Fruits and Vegetables, Indian Council of Agricultural Research, New Delhi. (1986).
2. Vijaya Khader, "Textbook of Food Science and Technology", ICAR, New Delhi (2001).
3. S Cohen and J Roussel, Strategic Supply Chain Management : The five disciplines for top performance, McGraw-Hill Co, (2004).

Reference books:

1. N Lewis, The Cold Chain, Hamish Hamilton (1988).

SAF 2011-BEVERAGE & SNACK FOOD TECHNOLOGY

Module I : Juice Processing: Present status of juice processing in India & Abroad. Types of beverages and their importance ; status of beverage industry in India; Manufacturing technology for juice- based beverages; synthetic beverages; technology of still, carbonated, low calorie and dry beverages; isotonic and sports drinks. Recent advances in juice processing technology. Fruits & its processing: Harvesting and pre-processing consideration, Post harvest processing, washing, skin removal, cutting and trimming, blanching, canning, freezing & dehydration of fruits, Fruit Processing: Freezing, blanching, ascorbic acid dip, SO_2 dip, sugar syrup preservation, salt preservation, vacuum dehydration, concentration and drying, Application of membrane technology in processing of juices, Juice Processing: Orange juice, Grape fruit juice, Lemon & Lime juice, Pine apple juice, Apple juice, Mango juice.

Module II : Fruits Beverages & other processing: Fruit Beverage, Orange squash, Grape fruit squash, Lemon squash, Orange squash, Pine apple squash, Syrups, Rose, Sandal, pine apple, orange, mulberry & apple, Carbonated beverage, Lemon, lime, pine apple, Fruit juice concentrate, Tamarind Juice Concentrate and Fermented Beverages, Miscellaneous, fruit juices, tropical fruit beverages, Nectars, pulpy juices, tropic blends, Beverages- Classification, Scope, Manufacture of carbonated non alcoholic beverages.

Module III: Equipments & tools for juice extraction: Equipments for fruit juices, Washing equipment, sorting equipment, extraction equipment, Halving &burring machine, Roller type Press, Crusher for grape berries, Pulping equipment, Straining & screening, filtration equipment, De-aerator & flash Pasteurizer.

Module IV: Role of various ingredients of soft drinks, carbonation of soft drinks. Specialty beverages based on tea coffee, cocoa, spices, plant extracts, herbs, nuts, dairy and imitation dairy –based beverages. Alcoholic beverages- type, manufacture and quality evaluation; the role of yeast in beer and other alcoholic beverages, ale type beer, lager type beer technology of brewing process, equipment used for brewing and distillation, wine and related beverages, distilled spirits.'

Unit -V

Packaged drinking water- definition, types, manufacture and quality evaluation and raw and processed water, methods of water treatment, BIS quality standards of bottled water; mineral water, natural spring water, flavoured water, carbonated water.

Unit-VI

Technology for snacks based on:

Grain: whole grains – roasted, toasted, puffed, popped, and flakes, coated grains- salted, spiced and sweetened.

Flour : – batter and dough products; savory and farsons; formulated chips and wafers, papads, instant premixes of traditional Indian snack foods.

Fruit and vegetable based snacks: Chips, wafers; Technology for coated nuts- salted, spiced and sweetened chikkis.

Module VII: Extruded snack foods: Formulated and processing technology, colouring, flavouring and packaging. Equipments for frying, baking and drying, toasting, roasting and flaking, popping, blending, coating, chipping .

Text books:

1. Extrusion of Food, Vol 2; Harper JM; 1981, CRC Press
2. Bakery Technology & Engineering; Matz SA; 1960; AVI Pub.
3. Desrosier NW & JamesN. 2004. *The Technology of Food Preservation*. 4thEd. CBS.

4. Lal G, Siddappa GS & Tandon GL. 1998. *Preservation of Fruits andVegetables*. ICAR.
5. Nelson PE & Tressler DK.1980. *Fruit & Vegetable Juice ProcessingTechnology*. Vol. III. AVI Publ.
6. Potter NN.1978. *Food Science*. 3rd Ed. AVI Publ

SAF 2013-RENEWABLE ENERGY FOR FOOD PROCESSING

Module I: Energy for Food Processing: Concerns of the current millennium, Renewable Energy Utilization, desirability, feasibility and the niches. Integrated Renewable Energy Sources for Process heat availability.
Module II: Solar energy resources, solar thermal and solar photovoltaic technology for Electricity and process heat, Solar cell technologies for decentralized energy generation.
Module III: Elements of passive solar architectural and solar active system for refrigeration and cooling, Solar Cooker Solar drying of fruits and vegetables, Hybrid solar dryer for industrial applications, solar furnaces and concentrators.
Module IV: Overview of wind energy developments, wind turbine technology & its utilization for process heat and electricity generation.
Module V: Bio energy resource, Briquetting and incineration. Incinerator design.
Module VI: Biomass conversion sources viz Gasification systems for process heat, biogas for electricity and other industrial energy, ethanol fermentation, liquid fuel from biomass (process, chemistry and technologies), complete combustion technology, improved cook stoves &furnace technology.
Module VII: Energy Audit of Food Processing Industries.

Suggested Readings

1. Hordeski MF. 2004. Dictionary of Energy Technologies. CRC Press.
2. Kreith F & Goswami D. 2007.Handbook of Energy Efficiency and Renewable Energy.CRC Press.
3. NIIR Board. 2001. Modern Technology of Agro Processing & Agricultural Waste Products.National Institute of Industrial Research Publ.
4. Rathore NS & Panwar NL. 2007. Renewable Energy for Sustainable Development. New India Publ. Agency.
5. Teri 1993. Rays of Hope: Renewable Energy for Sustainable Development.Tata Energy Research Institute, New Delhi.

SAF 2015-FOOD SCIENCE AND TECHNOLOGY

Module I : Microbiology and its significance; Brief history of microbiology; Prokaryotes and Eukaryotes morphology; structure and function of microbial cells and their components; mode of reproduction in microorganisms. Major groups of microorganisms: Role of bacteria, fungi and viruses in foods; Growth cycles, growth patterns;

Module II: Physical and chemical factors affecting growth and destruction of microbes- aerobes and anaerobes, psychrophiles, psychrotrophs, mesophiles, thermoduric, thermophiles, halophiles osmophiles and spore formers.

Module III: Introduction to food chemistry; Definition, Proximate composition of foods; Functions of various food constituents in brief. Carbohydrates: Definition, classification, structure of monosaccharides, disaccharides, oligosaccharides polysaccharides (starch, glycogen, cellulose, hemi-cellulose, lignins, pectins, gums and mucilages);

Module IV: Lipids: Definition, classification, structures, physical and chemical properties of lipids and fatty acids, Proteins: Amino-acids - definitions, classification, essential and non-essential amino-acids, structures and properties; peptides - peptide bonds and some important peptides;

Vitamins: structures and functions in brief. Minerals: Occurrence and functions in brief. Enzymes - general characteristics, enzymes in food processing.

Module V: Concepts and trends in food legislation. International and federal standards: Codex alimentations, ISO series,

Quality factors: appearance, texture and flavor, Appearance factors – size and shape, colour , consistency. Textural Factors – measuring texture, texture changes. Flavour Factors – influence of colour and texture on flavor.

Module VI: Food – related hazards – biological, chemical and physical hazards, trace chemicals. Microbiological considerations in food safety.

Prevention of Food Adulteration Act-1954.Food safety and Standards Act-2006.Food Safety and Management Systems- FSMS-22000.

Module VII : International Food, Standards and Codex Alimentarius, HACCP and ISO 9000 series ,FPO, Agmark ,BIS,FAO, WTO. History and evaluation of IPR; Patent rights/protection and procedure; Infringement or violation; Remedies against infringement; Indian Patent Act 1970

Books:

1.Black, JG. 2005. *Microbiology: Principles and Explorations*.
2. John Wiley Frobischer M. 1968. *Fundamentals of Microbiology*.
3. Hans G. 1986. *General Microbiology*. Cambridge Univ. Press.
4. Fennema, OR. Food Chemistry, McGraw Hill.
5. Belitz, HD and Grosch, W (1987), Food Chemistry, Springer Verlag.
6. Meyer LH (1960), Food Chemistry, AVI, New York.
7.Santaniello, Evenson, Ziberman, Carlson – Agriculture and Intellectual Property Rights, Univ. Press, 1998
8. S. K. Chakraborty : Values and Ethics in Organization, OUP
9. A. N. Tripathi : Human Values, New Age International

SAF 2017-NUTRACEUTICALS & HEALTH FOODS

Module I: Introduction to Nutraceuticals: definitions, synonymous terms, basis of claims for a compound as a nutraceutical, regulatory issues for Nutraceuticals including CODEX.

Module II : Concept of angiogenesis and the role of Nutraceuticals/functional foods; Nutraceuticals for cardiovascular diseases, cancer, diabetes, cholesterol management, obesity, joint pain, immune enhancement, age-related macular degeneration, endurance performance and mood disorders – compounds and their mechanisms of action, dosage levels, contraindications if any etc.

Module III: Manufacturing aspects of selected Nutraceuticals such as lycopene, isoflavonoids, prebiotics and probiotics, glucosamine, phytosterols etc.; formulation of functional foods containing Nutraceuticals – stability and analytical issues, labeling issues.

Module IV: Clinical testing of Nutraceuticals and health foods; interactions of prescription drugs and nutraceuticals; adverse effects and toxicity of nutraceuticals; nutrigenomics – an introduction and its relation to nutraceuticals.

Module V: Value addition in food products using secondary metabolites of therapeutic importance- alkaloids, steroids ,isoflavones etc.

Module VI: Nutraceuticals preservation. Evaluation and standardization.

Module VII: Toxicity in food products. Stability and evaluation of toxicity.

Suggested Readings

1. Brigelius-Flohé, J & Joost *HG. 2006. Nutritional* Genomics: Impact on Health and Disease. Wiley VCH.
2. Cupp J & Tracy TS. 2003. *Dietary Supplements: Toxicology and Clinical Pharmacology*. Humana Press.
3. Gibson GR & William CM. 2000. *Functional Foods - Concept to Product*
4. Goldberg I. 1994. *Functional Foods: Designer Foods, Pharma Foods*.
5. Losso JN. 2007. *Angi-angiogenic Functional and Medicinal Foods*. CRCPress.
6. Manson P.2001. Dietary Supplements. 2nd Ed. Pharmaceutical Press.
7. Campbell JE & Summers JL. 2004. *Dietary Supplement Labeling Compliance*.
8. Neeser JR & German BJ. 2004. *Bioprocesses and Biotechnology for Nutraceuticals.* Chapman & Hall.
9. Robert EC. 2006. *Handbook of Nutraceuticals and Functional Foods*. 2ndEd. Wildman.
10. Shi J.(Ed) 2006. *Functional Food Ingredients and Nutraceuticals: Processing echnologies*.. CRC.
11. Webb GP. 2006. *Dietary Supplements and Functional Foods*. Blackwell Publ.

SAF 2019- OILS AND FATS TECHNOLOGY

Module –I : Sources and Biological significance of lipids, classification, occurrence, chemical and physical characteristics of lipids: Triglycerides and phospholipids; emulsions and emulsifiers; Inter-esterifications. Industrial fats and oils, shortenings, salad oils, margarine, non-caloric fats; standard and quality control, packaging and storage of fats and fatty foods. Changes during processing and storage of oils and fats, polymorphism, rancidity and reversion.

Module -II: Post-harvest handling storage and processing of oil seeds for direct use and consumption. Extraction of oil by mechanical expelling and solvent extraction and obtaining deoiled cakes suitable for edible purposes. Processing of other plant sources of edible oils and fats like coconut, cottonseed, rice bran, maze germ, etc.

Module –III: Refining: distillation for separation of oil and solvent, design concept for solvent extraction system for oil bearing material, physical and chemical refining of oils, hydrogenation. Clarification, degumming, neutralization (alkali refining), bleaching, deodorization techniques / processes. Blending of oils.

Module – IV : Processing of refined oils: Hydrogenation, fractionation, winterization, inter-esterifications etc. for obtaining tailor-made fats and oils. Special uses of fat for several foods, like chocolate, bread, biscuit, mayonnaise, salad, frying, etc. Non conventional edible oils, oil seed cakes and meal utilization:

Module—V: Production of butter oil, lard, tallow, Margarine, Cocoa butter equivalents, shortenings, low fat spreads, peanut butter etc. Speciality fats and designer lipids for nutrition and dietetics, especially by biotechnology.

Module VI: By-products of oils and fats processing industries, manufacturing techniques for glycerin, soaps, detergents, polishes and paints. Oleoresins and essential oils-its physical and chemical characteristics, extraction methodology and down-stream processing, application, storage, packaging and analysis of oleoresin and essential oils;

Module VII: Toxicity and safety of Fats and oils

Books:

1. Bailey's Industrial Oil & Fat Products, 4th ed.John Wiley & Sons.
2. The Industrial Chemistry of Facts & Waxes 3rd. by Balliere,Tindall& Cox.
3. Handling & Storage of Oilseeds, Oils, Fats& Meal by Paterson, HBW.
4. Modern Technology in the Oils & Fats industry by S.C. Singhal,OTA (I).

SAF 2021-FOOD BIOTECHNOLOGY

Module I : Basic principles of Gene cloning, Food safety and biotechnology- Impact of Biotechnology on microbial testing of foods, New challenges, Immunological methods, DNA based methods in food authentication, Real time PCR based methods. Biological role of DNA in cell metabolism, Molecular genetics i.e. fundamentals of molecular biology with special reference to chemistry and biology and DNA, (Primary secondary and tertiary) structures. Genetic recombination mechanisms and technique used for improvement in microbial strains. Recombinant-DNA technology (plasmids and cloning),
Expression of foreign genes, Promoters (Enzyme),

Module II : Transgenic Plants - Current status, methods, prospects, risks and regulation.
Transgenic Animals - Methods and applications, ethical issues.

Module III: Control Of Micro-Organisms – Bacteriocins of Lactic acid bacteria, applications of bacteriocins in food systems. Aflatoxins –production, control and reduction using molecular strategies, antagonistic microbes. Biomass production by using various micro organisms.

Module IV: Protein Engineering In Food Technology – Methods, objectives, limitations and applications of protein engineering (e.g. Glucoseisomerase, Lactobacillus â-galactosidase and peptide antibiotic nisin).

Module V : Biotechnology And Food Ingredients – Biogums, fats, oils, fatty acids and oilseed crops, fat substitutes, citric, fumaric and malic acids, Bioflavors and biocolors,

Module VI: Traditional fermented foods, Soya based oriental fermented foods. Applications of genetically control mechanism in industrial fermentation process, (Induction, manipulation and recombination).

Module VII: Cell and tissue culture, Continuous cultures, Secondary metabolites
synthesis. Transducers And Biosensors In Food - Principle, types and applications in food processing.

Books:
1. Lee, B.H. (1996). Fundamentals of Food Biotechnology,VCH Publishers.
2. Tombs, M.P. (1991). Biotechnology in FoodIndustry, Open University Press, Milton Keynes.
3. V. K . Joshiand Ashok Pandey (1999) . Biotechnology- Food fermentation, Volume 1&2Educational publishers and Distributors.
4. Schwartzberg, A & Rao (1990). Biotechnology &Food Process Engineering, Marcel Dekker, INC,New York

SAF 2023-AGROCHEMICALS AND RESIDUES IN FOOD

Module I : Agrochemicals in Agriculture including growth regulators – purpose, classification and methods of dispensing them, characteristics, and estimations
Module II : Agrichemicals – Pesticide, Insecticides, Attractants and Repellent, Fumigants, Nematocides, Miticides, rodenticides, Fungicides, Analysis of Residues in foods.

Module -III : Agrochemical residues – Pesticides, fungicides, herbicides, permitted levels and toxicity details, methods to remove these residues.

Module – IV : Fumigants other chemicals used in grain/spices storage – purpose, chemicals used and toxicity, Ripening agents- types, uses, effects and residue evaluation.[6]

Module - V : Veterinary drugs including antibiotics and hormones- purpose of use, classification, residue levels and its associated hazards and toxicity.

Module - VI : Uptake of agrochemicals from soil, water, environment, packaging by plant foods,

Module –VII: Concept of organic farming and systems.

.

Books:

1. GT (Ed) 1999. Pesticide Chemistry and Bioscience. Woodhead
2. Felix D'Mello JP (Ed) 1991. Toxic Substances in Crop Plants.Woodhead
3. Watson DH (Ed) 2001. Food Chemical Safety Vol I Woodhead
4. Watson DH (Ed) 2004.Pesticide, Veterinary and other residues in Foods. CRC Press

SAF 2025-FOOD TOXICOLOGY

Module -I : Definition scope and general principles of food toxicology; manifestation of toxic effects; classification of food toxicants; factors affecting toxicity of compounds; methods used in safety evaluation-risk assessments. [4]

Module - II : Toxicants and allergens in foods derived from plants, animals, marine, algae & mushroom; Microbial toxins; Food Poisoning; Food borne infections and disease. [6]

Module-III : Derived Food toxicants- Processing & Packaging; Toxicants generated during food processing such as nitrosamines, acryl amide, benzene, dioxins and furans; persistent organic pollutants. [4]

Module -IV : Toxicology & food additives; Toxicological aspects of nutrient supplements; Chemicals from processing such as fumigants, chlorinated solvents, autoxidation products, carcinogens in smoked foods and pyrolysis, agrochemicals; heavy metals; intentional and unintentional additives [8]

Module -V :.Food borne disease agents among the major microbial groups: bacteria, algae, viruses, protozoa and worms. Spores and food processing micro- organisms. Food toxicants; Bacteriotoxins (botulinm and other bacterial exotoxins). Mycotoxins (Aflatoxins, trichothecenes, ochratoxins)their production, properties and regulation .(4)

Module -VI : Toxicants formed in processed foods(food mutagens, carcinogens); Toxicants formed in processed foods. Hazardous chemical compounds arising from processing and storage of foods. Heating and chemical changes to Frying food. Conservation , Radiation and Microwave energy. Polycyclic aromatic hydrocarbons.(4)

Module -VII: Environmental Toxicants (heavy metals. Pesticides, industrial contaminants): Dose effect relationship. Toxicity testing. Health effects of nitrates, nitrites and N- nitroso compounds. Heavy metals and other toxic elements (lead, mercury, cadmium and others) Radionuclide. Diphenyls, dioxins and pentachlorophenol. (4)

Books:

1. Branen AL, Davidson PM & Salminon S. 1990. *Food Additives*. Marcel Dekker.
2. Concon JM.1988. *Food Toxicology - Principles & Concepts*. Marcel Dekker.
3. Hathcock JN. (Ed.). 1982. *Nutritional Toxicology.* Vol. I. Academic Press.
4. Rechcigl M Jr. 1983. (Ed.). *Handbook of Naturally Occurring Food Toxicants*. CRC Press.
5. Shabbir S. 2007. *Food Borne Diseases*. Humana Press.
6. Steven T. 1989. *Food Toxicology: A Perspective on Relative Risks*.
7. Tweedy BG.1991. *Pesticide Residues and Food Safety*. Royal Society of Chemistry.

SAF 2027-FOOD MICROSTRUCTURE AND TEXTURE

Module - I: Examining food microstructures: history of food microstructure studies, light microscopy, transmission electron microscopy, scanning electron microscopy, other instrumentation and techniques, image analysis: image acquisition, image processing, measurement analysis. [7]

Module - II: Fundamentals of structuring: polymer, colloid, and materials science; food polymers, polymer solutions, phase transitions, colloids and surface chemistry,

Module III: Mechanical and rheological properties, rheology of foods, mechanical properties of food solids, food structure in the mouth and beyond. [7]

Module - IV: Micro-structural components and food assemblies, water and ice, proteins, lipids, carbohydrates, cells and cell membranes, structural aspects of animal tissue, structural aspects of plant tissue. [5]

Module V : Food structuring: traditional food structuring and texture improvement, approaches to food structuring, extrusion and spinning, structuring fat products, structure and stability, gels, gelation mechanisms, mixed gels, the microstructure of gels, structure-property relations in gels.[5]

Module – VI: Food microstructure and quality: measurement of texture, structural aspects of food texture, quality and structure. [4]

Module – VII : Microstructure and mass transfer: solid-liquid extraction; fundamental aspects of extraction, extraction process, extraction of food materials, modifying microstructure, modeling the extraction process, simultaneous heat and mass transfer: dehydration basic concepts, drying process, osmotic dehydration, influence of drying on structural properties, frying of foods, the micro-structural approach**:** structure-property relationships, micro structural approach. [7]

Books

1. Aguilera JM. 2001. Micro Structure: Principles of Food Processing Engineering.
2. Barbosa-Cánovas GV. 2000. Dehydration of Foods. Chapman & Hall.
3. Bechtel DB. 1983. New Frontiers in Food Microstructure. American Association of Cereal Chemists.
4. Glasbey CA. 2004. Image Analysis for Biological Sciences.
5. Hartel RW. 1988. Principles of Food Processing.
6. Moskowitz 1999. Food Texture. AVI Publ.
7. Russ JC. (Ed.). Journal of Computer-Assisted Microscopy.

ELECTIVE- II

SAF 3009-PHYTOCHEMICALS AND HERBAL MEDICINES

Module -I: Crude Drugs - Crude Drugs- Scope and Importance, Classification (Taxonomical, Morphological, Chemical, Pharmacological); Cultivation, Collection & processing of Crude Drugs.
Module -II: Medicinal and Aromatic Plants Cultivation and utilization of medicinal & Aromatic Plants in India. Genetics as applied to Medicinal Herbs.
Module -III: Analysis of Phytochemicals Methods of Drug evaluation (Morphological, Microscopic, Physical and Chemical).Preliminary screening, Assay of Drugs- Biological evaluation / assays, Microbiological methods.
Module IV: Chemical Methods of Analysis and analysis and detection of adulterants: Chemical estimation, spectrophotometry & Fluorescence analysis. Drug adulteration – Types of adulterants.
Module -V: Types of Phytochemicals - Carbohydrates and derived products; Glycosides- extraction methods (Digitals, Aloe, Dioscorea); Tannins (Hydrolysable & Condensed types); Volatile Oils – Extraction methods(Clove, Mentha).
Module VI: Alkaloids- extraction methods (Taxus, Papver, Cinchona); Flavonoids – Extraction Methods,
Resins- extraction Methods.
Module VII: Application of Phytochemicals Application of phytochemicals in industry and healthcare; Biocides, Biofungicides, Biopesticides. Evaluation of pesticides residues and aflatoxins.

Books:

1. Pharmacognacy, C K Kokate, A P Purohit, S P Gokhale (1996), Nirali Prakashan, 4th edition.
2. Natural Products in medicine: A Biosynthetic Approach (1997), Wiley.

SAF 3011-FLAVOUR CHEMISTRY AND TECHNOLOGY

Module – I : Food flavor and its importance to consumers and food processors. Flavor and nutrition. Sources, extraction, delivery systems, and analyses (chemical, instrumental, and sensory) off flavors and flavorings in foods.

Module II: Sensory perception of flavor: Senses of taste and smell, tasting versus sniffing, astringency, pungency, interaction of senses in flavor perception; taste, odor, and acceptance of flavor stimuli.

Module III: Chemistry of substances responsible for taste and flavor-taste sensations, flavour enhancers, flavour potentiators or modifiers. Methodology of sensory evaluation and determination of threshold levels as specified by BIS.

Module IV: Flavoring constituents of various foods like meat, fish, milk, vegetables, fruits, fats & oils ,spices & herbs, cereals and pulses. Flavor changes during processing, preservation, packaging, and storage of foods. Roles as sulfur compounds, fatty acids, amino acids, terpenoids, lactic acid-ethanol in food flavors. Process and reaction flavors/volatiles in foods.

Module V: Spices and herbs as food flavorings: Processing of basil, mint, saffron, cloves, tamarind, ginger, cardamom, chilies, pepper etc. for essential oils, extracts and oleoresins as the case maybe.

Module VI: Determination of hygroscopic nature and shelf life/acceptance of foods. Natural, Nature identical and Synthetic flavors: Definitions, chemical composition/constituents, extraction and preparation of flavors, Stability and utility of flavor preparations.

Module VII: Methods used in flavor evaluation. BIS Specifications/PFA restrictions for use of certain constituents in flavoring materials.

Books:

1. Food Chemistry by Fennema, Marcel Dekker.
2. Spices & Flavor Technology by Pruthi, J.s.
3. Ashurst PR. 1994. *Food Flavorings*. 2nd Ed. Blackie.
4. Burdock GA. 2004. *Fenaroli's Handbook of Flavor Ingredients*.5th Ed.CRC Press.
5. Deibler D & Delwiche J. 2004. *Handbook of Flavor, Characterization:*
6. *Sensory Analysis, Chemistry and Physiology*. Marcel Dekker.
7. Heath HB & Reineccius G.1986. *Flavor Chemistry and Technology*. AVI Publ.
8. Taylor A. 2002. *Food Flavour Technology*. Sheffield Academic Press.

SAF 3013-GRAIN STORAGE TECHNOLOGY

Module I : Physico-chemical and thermal properties of grains - grain dimensions, bulk density, true density, porosity, coefficient of friction, angle of repose, thermal conductivity and aerodynamic properties. Psychrometry: humidity, % relative humidity, humid heat, deterioration index, wet bulb temperature, use of psychrometric charts.
Module II : Grain drying - moisture content, equilibrium moisture content; free and bound water, rate of drying, constant and falling rate of drying rate; factors affecting rate of drying process, types of dryers used for drying of grains.
Module III: Grain storage – principles, moisture movement during bulk storage of grains, pressure distribution in storage bins, methods of aeration, various theories,
Module IV: Physical, chemical, microbiological and sensory changes occurring during storage, Grain storage structures - location and material selection for storage building, Types - traditional, modern; temporary and permanent storage structures; design considerations.
Module V: Insects and pests – types, extent of losses during storage, causes and control measures, Insecticides- principles, scope of application in warehouses; requirements, group of active ingredients, choice, toxicity, resistance, application techniques,
Module VI: Fumigants - chemicals, areas of application, choice, toxicity, application rates, exposure time and resistance. Rodenticides -Types and effectiveness and limitations, important moulds and bacteria involved in spoilage of grains; effect on physico- chemical and sensory quality of grains; Mycotoxins
Module VII: Air tight, controlled atmosphere and modified atmospheric storage; differences, principles, optimization of storage gas composition, rate of supply, control systems for oxygen and carbon dioxide- their effect on microbes and limitations.

Books

1. AACC. 2004. *Storage of Cereal Grains and their Products*.
2. Chakraverty & De *Post Harvest Technology of Cereals, Pulse and Oilseeds*. IBH Publ.
3. Mahajan & Goswami. 2005. *Food and Process Engineering*.
4. Ojha TP & Michael AM. 2006. *Principles of Agricultural Engineering*. Jain Brothers.

SAF 3015- ENZYMES IN FOOD PROCESSING

Module - I: Enzymes–classification, properties, characterization, kinetics and immobilization;

Module – II: fermentative production of enzymes (amylases, proteases, cellulases, pectinases, xylanases, lipases) used in food industry and their downstream processing.

Module -III : Enzymes for production of protein hydrolysates and bioactive peptides, maltodextrins and corn syrup solids (liquefaction, saccharification, dextrinization, isomerization for production of high-fructose-corn-syrup), fructose and fructo-oligosaccharides.

Module - IV : Enzymes as processing aids: Role of enzymes in cheese making and whey processing; fruit juices (cell wall degrading enzymes for liquefaction, clarification, peeling, debittering, decolourization of very dark coloured juices such as anthocyanases); **Module – V:**Role of enzymes in baking (fungal α-amylase for bread making; maltogenic α-amylases for anti-staling; xylanses and pentosanases as dough conditioners; lipases or dough conditioning; oxidases as replacers of chemical oxidants; synergistic effect of enzymes); meat and meat processing (meat tenderization); egg processing.
Module – IV: Enzyme processing for flavors (enzyme-aided extraction of plant materials for production of flavors, production of flavour enhancers such as nucleotides; flavors from hydrolyzed vegetable/animal protein);
Module – VII: enzymatic approach to tailor- made fats.

Books:

1. Flickinger MC & Drew SW. 1999. *Encyclopedia of Bioprocess Technology*. A Wiley-Inter Science Publ.
2. Kruger JE *et al*. 1987. *Enzymes and their Role in Cereal Technology*. American Association of Cereal Chemists Inc.
3. Nagodawithana T & Reed G. 1993. *Enzymes in Food Processing*. Academic Press.
4. Tucker GA & Woods LFJ. 1991. *Enzymes in Food Processing*, Springer.S
5. Whitehurst R & Law B. 2002. *Enzymes in Food Technology*. Blackwell Publ.

SAF 3017- STATISTICAL QUALITY CONTROL

Module I

Measures of central tendency- Average, Mean, Mode, Median, Standard Deviation, Measures of dispersion coefficient of variation skewness, standard error of mean. Simple correlation and regression, Multiple-regression, Multiple & partial– correlation/variability- range, variance, standard deviation, standard error.

Module II

Theory of Probability: equally likely, mutually exclusive events, definition of probability, addition & Multiplication theorems of probability & problems on theorems of probability & problems based on them. Normal & Binomial Distributions.

Module III

Testing of Hypothesis: Concepts of Hypothesis, Degrees of freedom, Level of significance, Type I & Type II errors. Chi square 2 (X ,), Student - t test, F- tests definition, applications & problems based on these tests). SND test when population's SD is known and SD is unknown Analysis of variance (ANOVA) techniques, Definitions and assumptions, One way classification, two way classification with more than one Observation per cell.

Module IV

Designs of experiment, principles of experimental design, randomized block design (R.B.D), Latin square design (L.S.D.), missing plot technique in R.B.D. and L.S.D., critical difference (C.D.), split plot design. Factorial experiment 2 x 2 x 3 and 3 x 2, factorial design (Yates method of analysis) 2 x 3 & 2x 4 factorials, Durcan's multiple range test, Newman's kuel test.

Module V

Sampling techniques, simple random sampling, stratified random sampling and Systematic sampling. Data Management Analysis: Data Analysis- Coding of data Parametric and non-parametric tests Use of statistical tools.

Module VI

Quantitative analysis, descriptive statistics, inferential statistics : Uses and limitations Statistics : Uses and limitations Summation sign and its properties Summation sign and its properties. Grouped data-frequency distribution, histogram, frequency polygons, percentiles, quartiles, tertiles, ogive.

Module VII

Tabulation and Organization of data frequency distributions, cumulative frequency distribution, contingency tables Graphical presentation of data- histogram, frequency polygon, ogive, stem and leaf plot, box and whiskers plot, Graphs for nominal and ordinal data- pie diagram, bar graphs of different types, graphs for relation between two variables, line diagram.

Books:

1. Statistical Methods for Biological Workers-Pillai and Sinha HC 1968. Ram Prasad and Sons, Agra.
2. Statistical Methods – Snedecor GW and Cochran W 1968. Oxford & IBM Publishing Cop. New Delhi
3. Hand Book of Agricultural Statistics – Chandel SRS 1972. Anchal Prakashan Mandir, Kanpur.
4. Statistics for Agricultural Sciences – Nageshwara Rao G 1983. Oxford & IBH Publishing Co., New Delhi.
5. Statistical Procedure of Agricultural Research – Gomez K A and Gomez AA 1995. John Wiley & Sons, New York and Singapore.

SAF 3019-COMPUTER APPLICATIONS IN FOOD INDUSTRY

Module I: Fundamentals of Computer including Devices and Internet Overview of operating Systems:- Windows, LINUXlMS-Office, MS-Excel, MS-PPT, MS-SQL

Module II : Introduction to Programming: Concepts of Algorithm ,Flow Chart, Pseudo code. Features of Programming Language: Character Set, Identifiers, Keywords, DataTypes, Variables, Declarations, And Operators &Expressions; Assignment, Input / Output statements; Flow Control; Conditionals and Branching: Iteration:
Module III: Functions, Function Types, Scope Rule; Recursion: Arrays, Pointers, Structures. (A programming Language C shall be used as a basis language. The same languageis to be used for the laboratory).
Module IV : Computer Applications: Use of computers for preparing and presenting documents, spreadsheets. Appropriate statistical and other relevant packages, Internet. Use of Library documentation and scientific literature searching, Use of internet in Food Industry++,
Module V : MATLAB Programming Introduction to MATLAB, MATLAB Basics, Branching Statement and Program Design, Loops, User-Defined Functions, Complex Data, Character Data, and Additional Plot Types, Spares Arrays and S t r u c t u r e s , I n p u t / O u t p u t F a c t i o n s ,Handle Graphics, Graphical User Interfaces, Use of word processing software for creating report, Familiarization with software related to food industry,
Module VI : Role of Computer in Optimization: Introduction to operation Research; A Computer Oriented Algorithmic approach; Queuing systems and waiting models; PERT, CPS and CPM.
Module VII: Food Process Modeling and Simulation; CAD and CAM in Food Industry: instrumentation, process Control, inventory Control, Automation, Robotics,Expert system and artificial intelligence.

Books:
1.Principles and Calculations in Chemical Engineering by Himmelblau, D.M. 6th ed., Prentice- Hall of India.
2. Computer Application in Food Technology by SinghR. P., Academic Press.
3. Solving Problems in Food Engineering by StavrosYanniotis, Springer.
4. Amos Gilat, "Matlab- An Introduction withApplications"
5. Rajaraman, "Fundamentals of Computers", PrenticeHall of India, 3rd Edition..
6. Gillette BE. Introduction to Operation Research (A Computer OrientedAlgorithmic Approach).
7.Groover MP& Zimmers EW. *CAD/CAM: Computer Aided Design andManufacturing.PrenticeHall.*

SAF 3021-FOOD SUPPLY CHAIN MANAGEMENT

Module I : Building blocks of supply chain network, performance measures, decisions in supply world and models. Supply chain inventory management, economic order quantity models, recorder point models, multi echelon inventory systems.
Module II: Use of stochastic models and combinatorial optimization in SC planning, layout, capacity planning, inventory optimization, dynamic routing and scheduling.

Module III: Internet technologies and electronic commerce in SCM related to ERP, Qprocurement, e-logistics, internet auctions, e-market, electronic, business process optimization.
Module IV: Cold chain -Introduction, scope and importance of cold chain in food processing industry and retail chain, components of cold chain and integration.

Module V: Products going in cold chain, their temperature and humidity requirements ,packaging needs and their compatibility in cold chain.

Module VI: Stages and points of control in cold storages and structures, functions in cold storages, pallet layout and stacking options, flexibility storage systems cold chain transportation in land and export, retail & supermarket cold chain and display systems.
Module VI: Temperature recording devices used during transport, documentation and traceability, Risk management problem diagnosis, cost benefit studies for type of transport, loading and unloading, storage duration.

Books:

1. *1.Systems*. Prentice Hall.Chopra S & Meindel P. 2002. *Supply Chain Management:*
    a. *Strategy, Planning and Operation*. Prentice Hall.
2. Handfield RB & Nochols EL.1999. *Introduction to Supply Chain Management*. Prentice Hall.
3. Hopp WJ & Spearman ML. 1996. *Factory Physics: Foundations of Manufacturing Management*. McGraw Hill.
4. Levi DS, Kaminsky P & Levi ES. 2000. *Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies*. Mc Graw Hill.
5. Shapiro JF. 2001. *Modeling the Supply Chain*. Duxbury Thomson Learning.
6. Tayur S, Ganeshan R & Magazine M.1999. *Quantitative Models for Supply Chain Management*. Kluwer Academic Publ.
7. Viswanadham N. 2000. *Analysis of Manufacturing Enterprises*. Kluwer.
8. 9.Viswanadham N & Narahari Y. 1998. *Performance Modeling of Automated Manufacturing*

SAF 3023-FOOD PLANT AND EQUIPMENT DESIGN

Module I : Physical properties of food materials and energy balance calculations for preliminary estimation of plant capacity and equipment sizes. Preparation of flow sheets for material movement and utility consumption in food plant.

Module II : Materials of construction : welding and machining of stainless steel. Fabrication of equipment.

Module III: Design of storage vessels for liquid food and grains. Pressure vessels design and design of vessel for drum drying.

Module IV: Performance characteristics and selection of fans, blowers, ejector compressors and vacuum pumps.
Design of fluid conveyance system; pipe, sanitary pipe fitting and valves. Performance characteristics and selection of centrifugal and positive displacement sanitary pumps.
Design of CIP system.

Module V: Design of heat echange equipment-plate, scraped surface and extended surface for heating and cooling of gas and liquid.

Module VI: Design of evaporator calandria, vapour separator and condenser,

Module VII: Design considerations for location of food plant. Equipment layout and ventilation in food process plants.

References:

1. D. Q. Kern, Process Heat Transfer,McgrawHill
2. J. H. Perry, Chemical Engineers Handbook, McgrawHill
3.. Howerd F. Rase Piping design for process plant, JohnWilley.
4. Stanley M. Walas Chemical Process Equipments , Butterworth, Heinemann.
5. Coulson and Richardson Chemical Engineering Design Vol-6, Butterworth, Heinemann.

SAF 3025-PLANTATION CROPS, SPICES & CONDIMENT TECHNOLOGY

Module -I : Plantation Crops - Description of various types of Plantation crops, viz., coconut, areca nut, coffee, tea, cocoa etc. Processing and preservation methods. Value-added products shelf-stable products viz., coconut water bottling, desiccated coconut powder, coffee concentrate, instant coffee powder, instant tea powder, cocoa processing.

Module -II : Leafy vegetables - Description of various types of leafy vegetables, viz., hibiscus, curry leaves, coriander leaves, etc. Their composition, nutritive value, health benefits. Preservation methods and packaging techniques.

Module –III : Spices & Condiments - Description of various types of spices and condiments, their composition, functional properties, flavouring agents. Nutritive value of spices and their health benefits. Intermediate Moisture Products – Intermediate Moisture Products viz., ginger paste, ginger – garlic paste, tamarind paste, tamarind concentrate. Their importance in culinary preparations. Flavour retention and packaging methods.

Module -IV : Spice Powders & Curry Powders : Their importance in culinary preparations, their preparation methods, grinding and packaging methods for spice powders like chilli powder, turmeric powder, ginger powder, garlic powder; and Masala Powders for chicken masala, meat masala, biryani masala, chat masala etc. Importance of Cryogenic grinding of spices.

Module V : Spice Oils – Concept and importance of spice oils from spices like and condiments like clove, cardamom, cinnamon etc. Their application in food processing, and extraction methods of spice oils by various techniques, viz., solvent extraction, steam distillation etc.

Module VI: Extraction of Oleoresins – Concept and importance of oleoresins in food processing, processing of spices like chili, turmeric, pepper, ginger etc. for solvent extraction of oleoresins. Oleoresins technology, desolventization methods, regulatory and statutory requirements for oleoresin processing. Extraction of Natural Food Colors - Extraction of Natural Food colors from paprika, turmeric, blue grapes, beet root etc. Their importance in food processing.

Module –**VII :** Herbs – Description of various types of herbs, viz., Basil, Chives, Cilantro, Dill, Coriander, Mint, Oregano, Parsley, Chives, Borage and Avocado leaves, Rose marry, Saga, Tarragon, Thyme, Winter savory and bolbo leaves, Papalo, Pipicha and Safflower. Their nutritive value & health benefits, their processing and Post harvest handling. Packaging methods for processed products.

TEXTBOOKS :

1. Spices & Condiments, J S Pruthi, National Book Trust, New Delhi (2001).
2. Spices : Morphology, History , Chemistry., J W Parry, Chemical Publishing Co., New York (1969).
3. Leafy Spices, V Prakash, CRC Press, Florida (1990).

SAF 3027 -BAKERY & CONFECTIONARY

Module - I: Introduction to baking; Bakery ingredients and their functions; Machines & equipment for batch and continuous processing of bakery products.

Module- II : Bakery and confectionary industry ; raw materials and quality parameters; dough development; methods of dough mixing; dough chemistry; rheological testing of dough-Farinograph, Mixograph, Extensograph, Amylograph/ Rapid Visco Analyzer, Falling number, Hosney's dough stickiness tester and interpretation of the data.

Module- III: Technology for the manufacture of bakery products – bread, biscuits, cakes and the effect of variations in formulation and process parameters on the quality of the finished product; quality consideration and parameters; Staling and losses in baking.

Module - IV: Chocolate Processing Technology, Compound coatings & Candy Bars, Tempering technology, Chocolate hollow figures, Chocolate shells, Enrobing technology, Manufacture of candy bars, Presentation and application of vegetable fats. Production of chocolate mass.

Module- V: Sugar confectionery manufacture, General technical aspects of industrial sugar confectionary manufacture, Manufacture of high boiled sweets- Ingredients, Methods of manufacture- Types- Center- filled, lollipops, coextruded products. Manufacture of gums and jellies- Quality aspects.

Module- VI : Quality characteristics of confectionery ingredients; technology for manufacture of flour , fruit, milk, sugar, chocolate and special confectionery products; colour, flavor and texture of confectionery; standards and regulations ; machineries used in confectionery industry.

Module -VII : Manufacture of Miscellaneous Products, caramel, Toffee and fudge- Liquorices paste and aerated confectionery, Lozenges, sugar panning and Chewing gum, Count lines Quality aspects, fruit confections.

Text Books:

1. Extrusion of Food, Vol 2; Harper JM; 1981, CRC Press.
2. Bakery Technology & Engineering; Matz SA; 1960; AVI Pub.

References:

1. Up to-date Bread Making; Fance WJ & Wrogg BH; 1968, Maclasen & Sons Ltd.
2. Modern Cereal Chemistry; Kent-Jones DW & Amos AJ; 1967, Food Trade Press Ltd.