Defence Institute of Advanced Technology (DU)

M.Sc. Food Technology

Department of Applied Chemistry

(In association with DFRL, Mysore)

PROGRAMME STRUCTURE

Semester I					
S. No	**Course Code**	**Course**	**L**	**T/P**	**Credit**
1	ACFT 501	Food Chemistry	3	1	4
2	ACFT 502	Food Microbiology	3	1	4
3	ACFT 503	Food and Nutrition	3	1	4
4	ACFT 504	Principles of food processing and preservation	3	1	4
5	RM501	Research Methodology	3	1	4
Semester II					
1	ACFT 505	Food Analysis & Sensory Evaluation	3	1	4
2	ACFT 506	Technology of Fermented Foods	3	1	4
3	ACFT 507	Food Standards and Safety Management	3	1	4
4	ACFT 508	Technology of Milk & Dairy Products	3	1	4
5	On Job Training (OJT)/Internship (at DFRL) (120 hours)		3	1	4
Semester III					
1	ACFT 509	Fundamentals of Food Engineering	3	1	4
2	ACFT 510	Technology of Fruits, Vegetables and Plantation Crops	3	1	4
3	ACFT 511	Technology of Cereals, Pulses and Oil Seeds	3	1	4
4	ACFT 512	Technology of Meat, Poultry & Fish Processing	3	1	4
5	ACFT 513	Food Packaging Technology	3	1	4
6	RP541	Minor Project/Project I			2
5	Elective I		3	1	4
Semester IV					
1	RP542	Major Project/Project II			16
Credits		**Total**			**82**

(Semester I & II will be conducted at DIAT, Pune and semester III & IV will be conducted at DFRL Mysore)

Elective I

S. No.	Course Code	Course
1	ACFT-515	Advanced Food Technology
2	-	Online courses from NPTEL, MOOC
3	-	Open elective from other dept

SEMISTER I

Course Code	Course Name	L – T – P	**Credits**
ACFT 501	**FOOD CHEMISTRY**	**3-0-1**	**4**

Course Objectives:

- To develop understanding about chemical/biochemical reactions that influence food quality with emphasis on food processing industrial applications
- Teach the properties of different food components and how interactions among these components modulate the specific quality attributes of food systems.
- Acquaint the students with the principles that underlay the biochemical/enzymatic techniques used in food proximate and quality/safety analysis.

Course Contents

Unit-1. General Introduction & scope: Fundamentals of Chemistry, Physico-chemical and functional properties of various food constituents and importance

Unit-2. Water: Physical and chemical properties of Water and Ice, water activity, Dispersed systems and surface phenomena.

Unit-3. Carbohydrates-Classification, structure, sources, Physico-chemical, functional properties of sugars and polysaccharides in foods& their applications.

Unit-4. Proteins and amino acids: Classification, structure, sources, physico-chemical, functional properties of proteins & amino acids. Enzymes (classification, mode of action, kinetics, assay techniques, isolation and purification and applications). Denaturation of proteins. Principles for separation methods. Protein concentrates and isolates. Processing induced physical and chemical changes in Proteins.

Unit-5. Lipids: Classification, structure, sources, physico-chemical, functional properties of lipids. Rancidity, Fatty acids- saturated, mono unsaturated and poly-unsaturated. Chemistry of fats and oil and their role. Modifications of lipids.

Unit-6. Vitamins and Minerals: Classifications, biological importance and functions, dietary sources, deficiency diseases, recommended dietary allowance.

Unit-7. Fundamentals of Nanotechnology: Basic concepts and applications of nanotechnology in food technology

Practical

1. Principles and working of common instruments.
2. Analysis of water with respect to pH, TDS/TSS, hardness, chlorine, etc.
3. Estimation of moisture and ash
4. Estimation of proteins by various methods

5. Estimation of reducing and non-reducing sugars, starch
6. Estimation of crude and dietary fibres
7. Estimation of minerals and vitamins
8. Analysis of lipids-saponification value, acid value and iodine value.

Course Outcomes

After completing this course, the students will be able to:

CO1: Demonstrate and apply knowledge of the core competencies in food chemistry and analysis.

CO2: Understand the chemistry involved in the properties and reactions of various foods and its components.

CO3: Understand and effectively apply the principles behind analytical techniques associated with food

Text Books

1. Fennema, O.R.2007. Food Chemistry. Marcel Dekker, CRC Press, New York.

References Books

1. Meyer, L.H. 2002. Food Chemistry. CBS publishers and Distributors, New Delhi.
2. Potter, N.N. and Hotchkiss, J.H. (2006), Food Sciences, Fifth edition, CBS publishers and Distributors, New Delhi.
3. Belitz, H.D., Grosch, Werner, Schieberle, Peter 2009. Food Chemistry. Springer Verlag.
4. Salunkhe, O.K. and Kadam, S.S. Eds. 1999. Handbook of World Legumes: Nutritional Chemistry, Processing Technology and.Utilization. Volume I to III. CRC Press, Florida.
5. Salunkhe, D.K. Chavan, J.K., Adsule, R.N. Kadam, S.S. 1992. World Oilseeds: Chemistry, Technology and Utilization, Van Nostrand Reinhold, New York.

Course Code	Course Name	L – T – P	**Credits**
502	**FOOD MICROBIOLOGY**	**3-0-1**	**4**

Course Objectives:

- In-depth knowledge to students on different aspects of microbial growth and associated spoilage in foods.
- Become conversant in basic methods in microbiology and applying appropriate methods to identify microorganisms (media-based).
- Demonstrate practical skills in microscopy and their handling techniques and staining procedures.

Course Contents

Unit-1. Introduction to Microbiology: Historical developments, food microbiology and it's scope, structure, growth & nutrition and reproduction of bacteria, yeast, fungi, algae and viruses- A brief account.

Unit-2. Factors affecting the growth of microorganisms in food - Intrinsic and extrinsic parameters that affect microbial growth. Cultivation of microorganisms.

Unit-3. Microbial spoilage of foods: Different types of spoilage and their control for various foods.

Unit-4. Microorganisms and public health - Food poisoning, types and importance food poisoning. Bacterial agents of food borne illness; non-bacterial agents of food borne illness - poisonous algae, fungi and food borne viruses - A brief account.

Unit-5. Physical and chemical factors influencing the destruction of microorganisms including thermal death time, Z, F and D values. Principles of food preservation; control of water activity.

Unit-6. Determination of microorganisms and their products in food: Sampling plan, sample collection, transport and storage, sample preparation for analysis. Microscopic and culture dependent methods.

Unit-7. Food hygiene and sanitation: Contamination during handling and processing and its control; indicator organisms; Rapid methods in detection of microorganisms.

Practical:

1. Principles and working of common instruments including microscopy.
2. Preparation of nutrient media, sterilization and inoculation techniques
3. Staining techniques–Monochrome staining, negative staining, gram staining, acid fast staining, spore staining, capsule staining and motility of bacteria.
4. Pure culture techniques: isolation of pure cultures from spoiled food
5. Growth characteristics: Methods for determination of microbial numbers– direct and plate count; Generation time.
6. Microbiological quality evaluation of processed food products: a) Water; b) Milk and milk products. c) Fruits and vegetables. d) Egg, meat and fish products; e) canned/ retort processed food and other commonly consumed processed and street foods.
7. **Pathogenic microorganisms**: Different methods for isolation of pathogenic bacteria and fungi from contaminated foods.

Course Outcomes

After completing this course, the students will be able to:

CO1: Gain knowledge about various types of food contamination and spoilage by microorganisms to address food safety problems and solution in global perspectives.

CO2: Learn basic microbiological techniques to isolate, characterize the microbes morphologically and compare their characteristics and behavior.

CO3: Evaluate the microbiological quality of foods by qualitative and quantitative microbiological analyses.

CO4: Apply the principles of food microbiology to evaluate food related cases in daily application

Text Books

1. Bibek Ray (1996) Fundamental Food Microbiology, CRC Press.
2. James M.J. (2000) Modern Food Microbiology, 5th Edition, CBS Publishers.
3. Prescott LM Harley JP and Klein DA (2006). Microbiology (7th edition) McGraw Hill, Newyork.

Reference Books

1. Barnart, G.J. (1997) Basic Food Microbiology, CBS Publishers.
2. Adam M.R. & Moss, M.O. (1995) Food Microbiology, New Age International P. ltd.
3. Waits MJ. 2001. Industrial Microbiology. Blackwell Science.
4. Ward OP. 1989. Fermentation Biotechnology. Prentice Hall.

Garbutt J. 1997. Essentials of Food Microbiology. Arnold Heinemann.

Course Code	Course Name	L – T – P	**Credits**
ACFT 503	**FOOD AND NUTRITION**	**3-0-1**	**4**

Course Objectives:

- To gain a thorough knowledge of Food & Nutrition which would equip the student to face the modern day challenges in Food & Nutrition.
- Systematic subject skills & practical skill within various disciplines of food, health, nutrition, therapeutic nutrition and dietery counselling.
- Developing diet planning skills for healthy and diseased individuals in society for better health management and prevention of diseases

Course Contents

Unit-1. Introduction to Nutrition: Nutritive value of food, recommended dietary allowance, interrelationship between nutrients, nutritional aspects of carbohydrates, lipids,

proteins, vitamins, minerals, fibre, water and electrolyte balance, digestion and absorption of food, energy value of foods, and energy requirements for various conditions, nutrition of infants, children's, adolescents, mother and geriatric nutrition, high altitude nutrition. Military nutrition.

Unit-2. Nutritional Requirements & Disease Control: Therapeutic nutrition & formulation of special dietary foods; Relation of food and diseases; Deficiencies of essential nutrients; Assessment of nutritional status & RDA; Effect of processing on nutrients; Functional foods with attributes to control cardiovascular diseases, cancer, obesity, ageing etc.,

Unit-3. Nutrition of dietary fibres. Biological value of proteins. Energy value of foods. Techniques of diet and health surveys. Formulation of diets and food products for specific needs.

Unit-4. Introduction to nutraceuticals: definitions, synonymous terms, basis of claims for a compounds as a nutraceutical, regulatory issues for nutraceuticals.

Unit-5. Anti-nutritional factors & toxins: Types, chemistry, properties of anti-nutritional factors & toxins (natural toxins, pesticides and antibiotic).

Course Outcomes

After completing this course, the students will be able to:

CO1: Understand the concept of nutritional imbalances and its relationship with chronic diseases prevailing among different age groups.

CO2: The course gives an opportunity to willing students to establish an enterprise of their own in health & food sectors.

CO3: Evaluate the quality of food based on the theoretical knowledge of Food and Nutrition

Text Books

1. Bamji MS, Krishnaswamy K and Brahmam GNV (Eds) (2009). Textbook of Human Nutrition, 3rd edition. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi

Reference Books

1. Salukhe, O. K. And Kadam, S. S. Eds. 1999. Handbook of world Legumes: Nutritional chemistry, Processing Technology and Utilization Volume I to III. CRC Press
2. Brigelius-Flohe, J and Joost H. G. 2006, Nutritional Genomics; Impact on health and Disease. Wiley VCH.
3. Focus on Nutrition Research, Tony P. Starks, Nova Science, 2006

Course Code	Course Name	L – T – P	**Credits**
ACFT 504	**PRINCIPLES OF FOOD PROCESSING AND PRESERVATION**	3-0-1	**4**

Course Objectives:

- To impart knowledge on the causes of food spoilage and methods of processing and preserving food
- To identify & select processing equipment and preservation methods appropriate for specific foods
- To describe the effects of preservation methods on the quality of food

Unit-1. Introduction: Definition and scope of Food Science and Technology, historical development of food processing and preservation, general principles of food preservation, unit operations, effect of various food processing operations on nutrients, packaging materials used for foods.

Unit-2. Preservation by heating: Principles of the method, Types of microorganisms, bacterial load, sterilization and commercial sterility, thermal resistance of the microorganisms and enzymes. Canning and bottling, ultra-high temperature processes, determination of thermal process time.

Unit-3. Refrigeration and freezing preservation: Refrigeration, refrigerated storage of various foods, freezing of foods, influence of freezing and freezing rate of the quality of food products, methods of freezing, storage and thawing of frozen foods.

Unit-4. Drying and dehydrations: Water activity and its effect on the keeping quality, sorption isotherms. Factors affecting drying, methods of drying, type of driers, intermediate moisture foods.

Unit- 5. Newer methods of food preservation: Introduction, newer thermal and non-thermal methods, irradiations, principles, applications in food processing.

Unit-6. Chemical preservation: Preservation of foods using sugar, salt, chemicals, smoking

Practical

1. Preparation of syrups and brine solutions
2. Determination of TSS, pH, acidity
3. Demonstration of food processing equipment
4. Calculation of dehydration and rehydration ratio
5. Calculation of water activity and moisture content

Course Outcomes

After completing this course, the students will be able to:

CO1: Recognise and interpret the role of engineering, chemistry, microbiology and other disciplines and their interdependence in processing and preservation of foods

CO2: Describe and explain basic principles of several food processing and preservation methods including thermal processing, freezing, dehydration, fermentation, high pressure processing and irradiation.

CO2: Describe and apply the principles of operation, and the key process parameters for microbial safety and quality of food products.

Text Books

1. Potter, N. N. and Hotchkiss, J. H. 1995. Food Science, Springer Science, Fifth Edition

Reference Books

1. Bawa AS, Raju PS, Chauhan OP. 2013. Food Science. New India Publishing Agency, New Delhi, India.
2. Chauhan OP. 2022. Advances in Food Chemistry - Food Components, Processing and Preservation. Springer, Singapore.
3. Chauhan, O.P. 2019. Non-thermal Processing of Foods. CRC Press. USA.
4. Fellows, P. and Ellis H. 1990. Food Processing Technology: Principles and Practice, New York.
5. Jelen, P. 1985. Introduction to Food Processing. Prentice Hall, Reston Virginia, USA.

SEMISTER II

Course Code	Course Name	L – T – P	**Credits**
ACFT 505	**FOOD ANALYSIS & SENSORY EVALUATION**	3-0-1	**4**

Course Objectives:

- Introduction to Sensory Evaluation – The role of sensory evaluation in the food industry, food flavors and taints and off flavors.
- Holistic approaches to understand colour, flavor, texture profiles of food products: Fruits/ vegetables/ confectionary/ baked goods.
- Sensory Test Methods–Steps to conducting a sensory study; Discrimination Tests; Descriptive Analysis Tests; Consumer Tests

Unit-1. Food Component Analysis: Proximate composition includes protein, fat, moisture ash etc. Analysis of minerals & vitamins & nutritional component, pesticide analysis. Use of Analytical Techniques in Food Science; Basics, Principles and Applications of UV – Vis Spectrophotometer, Gas Chromatography (GC), High Pressure Liquid Chromatography (HPLC), LCMS, GCMS, Atomic Absorption Spectroscopy (AAS), ICPMS, MALDI-TOF, Fourier Transform Infrared Spectroscopy (FTIR), Differential Scanning Calorimetry (DSC) and Thermo Gravimetric Analysis (TGA). Microwave and IR techniques.

Unit-2. Introduction to quality attributes of food: Appearance, flavour, textural factors and additional quality factors. Chemical dimensions of basic tastes- sweet, salt, sour, bitter and umami

Unit-3. Gustation & Taste perception: Structure and physiology of taste organs- tongue, papillae, taste buds, salivary glands. Mechanism of taste perception Factors affecting taste quality& evaluation methods foe sensory analysis, Estimation of colour of food by visual /instrumental means.

Unit-4. Principles and working of common instruments.

Practical

1. Analysis of minerals by using Atomic Absorption Spectroscopy (AAS)/ICP
2. Fatty acid analysis by using GC
3. Determination of vitamins by chromatography
4. Taste evaluation
5. Evaluation of Taste thresholds
6. Taste evaluation by overall acceptability (OAA)

Course Outcomes

After completing this course, the students will be able to:

CO1: Acquire knowledge about sensory attributes, facilities for sensory evaluation sensory evaluation methods of food.

CO2: Gain knowledge about panel members, their selection, types and tasks, sampling procedure for sensory evaluation, application of consumer tests.

CO3: Learn statistical testing, accuracy and precision of sensory data and correlation between instrumental and sensory measurements**.**

Text Books

1. Ranganna. Analysis of food and vegetables, ICAR, New Delhi

Reference Books

2. Fennema, O.R.2007. Food Chemistry. Marcel Dekker, CRC Press, New York.

3. Sensory Evaluation of Food: Principles and Practices; Harry T. Lawless, Hildegarde Heymann, Springer US, 11-Dec-2013.

Course Code	Course Name	L – T – P	**Credits**
ACFT 506	**TECHNOLOGY OF FERMENTED FOODS**	3-0-1	**4**

Course Objectives:

- To understand the principles of food fermentation technology
- To study the types of starters used in food industry, kinetics and mechanism of microbial growth
- To study the production of various fermented food

Unit-1. Scope and Importance: History and Introduction to fermentation Technology, Types of Fermentation, Fermentor Designs.

Unit-2. Fermentation process: Media formulations, sterilization, Starter cultures and their maintenance. Factors influencing fermentation process. Down-stream process. Immobilization of enzymes. Primary and secondary metabolites

Fermented food products: Lactic acid fermentation. Ethanol fermentation. Vitamin B-12 fermentation. Soya sauce fermentation. Fermented Dairy products. Wine and Beer fermentation. Vinegar fermentation. Bread making by yeast. Indian traditional foods, pickles, fermented vegetables, Mushroom cultivation, Oriental fermented products, Probiotics.

Unit-3. GM foods: Genetically modified microorganisms and foods. Bio-safety, ethics and risk assessment

Unit-4. Volarization of Agri food waste: Bioethanol production, biohydrogen production.

Practical

1. Media preparation and sterilization
2. Fermentation of lactic acid at flask level.
3. Fermentation involving lactic acid bacteria.
4. Identification of simple secondary metabolites such as lactic acid bacteriocins.
5. Fermentation of molasses for ethanol production.

Course Outcomes

After completing this course, the students will be able to:

CO1: Gain knowledge about fermentation technologies used in food industry, learn role of microorganisms in fermentation and to gain skills to control of fermentation processes.

CO2: Evaluate factors that contribute in enhancement of cell and product formation during fermentation process.

CO3: Analyse kinetics of cell and product formation in batch, continuous and fed-batch cultures

Text Books

1. Prescott & Dunn (1992). Industrial Microbiology, 4th Edition. CBS Publishers, New Delhi.

Reference Books

1. Ward, O.P. (1989). Fermentation Biotechnology- Principles, Process and Products. Prentice Hall Publishers, New Jersey.
2. Stansbury, P.F., Whitakar, A and Hall, S.J. (1995). Principles of Fermentation Technology, Pergamen Press, Oxford.
3. Rehm, H.J., Read, G.B., Puhler, A and Stadler (1999). Biotechnology, Vol. 1-8, VCH Publications.
4. Crueger and Crueger (2000) Biotechnology – A Text book of Industrial Microbiology. IInd edition. Panima Publishing company
5. Bains W. 1993. Biotechnology from A to Z. Oxford Univ. Press.
6. Crueger W &Crueger A. 2000. Biotechnology: A Textbook of Industrial Microbiology. Madison, USA.
7. Joshi VK & Pandey A. 2003. Biotechnology Food Fermentation. Vols. I, II.Education Publ.
8. Knorr D. 2002. Food Biotechnology. Marcel Dekker.

Course Code	Course Name	L – T – P	**Credits**
ACFT 507	**FOOD STANDARDS AND SAFETY MANAGEMENT**	3-0-1	**4**

Course Objectives:

- To develop qualified and competent human resource in the field of the food safety and quality management for regulators, industry, academic/research institutions, certifying and accreditation bodies, food trade, food testing and training
- To delve in depth on various aspects of food safety and quality management i.e. food standards, harmonization with global benchmarks, quality management systems, food analysis, instrumentation, risk analysis /management, traceability and auditing to transform the food ecosystem
- To nurture a positive and disciplined food safety culture among the professionals.

Course Contents

Unit-1. Importance and functions of food safety and quality control: Concept and meaning of food quality and food Safety, food adulteration, food hazards.

Unit-2. Food laws and regulations – International and National scenario & law, standards and governing bodies dealing with inspection, certification, traceability and authentication such as Codex Alimentarious Commission, USFDA, FSSAI, Voluntary national standards (BIS and AGMARK). Domestic regulations and Food Safety and Standards Act, 2006

Unit-3. Principles of Food safety and quality management- Total Quality Management, Risk analysis (risk management, risk assessment and risk communication), History, structure, principles, HACCP applications, HACCP based SOPs, Other food safety practices (GMP/GHP; GLP, GAP sanitary and hygienic practices)

Unit-4. Food Safety and Quality Management Systems-Quality Management system (ISO-9001), food safety management system (ISO 22000:2005 and ISO 22000:2018). Quality manuals, documentation and audits, case studies of food safety and Quality management. Quality assurance and quality control, sampling procedures and plans, specification of raw materials and finished products, labelling issues, export import policy; laboratory quality procedures and assessment of laboratory performance. CASE STUDIES

Course Outcomes

Upon completion of this course, the student will be able to understand t

CO1: The principles and methods of Quality Control and Assurance in foods.

CO2: Understand the principles of HACCP in different food processing, identify hazards and critical control points of different existing production processes

CO3: Compare different quality systems and assess their usefulness for the food manufacturer and food handler

Text Books

1. Food Safety and standards Act 2006, Rules 2011, Regulations, 2011, 10th Edition, ILBCO India, Indian Law Book Company, 2013

Reference Books

1. The training manual for Food Safety Regulators. Vol.II- Food Safety regulations and food safety management. (2011) Food safety and Standards Authority of India. New Delhi.
2. HACCP: A practical approach, Mortimre, S., and Wallace, C., (2005) 2nd Ed, Aspen.
3. American Society for Quality by Surak, J.G., and Wilson, S. (2007), 2nd Ed., Quality Press
4. FSSAI, FSIS, EU and FAO website for updates

Course Code	Course Name	L – T – P	**Credits**
ACFT 508	**TECHNOLOGY OF MILK AND DAIRY PRODUCTS**	3-0-1	**4**

Course Objectives:

- To acquaint students about the processes involved in the processing of raw milk with constructional details, operation and maintenance of dairy equipments.
- To impart a comprehensive knowledge on chemical and microbiological quality of milk for production of health beneficial foods.
- To impart skills in the application of biological, chemical, biochemical, physical and engineering sciences in processing and preservation of milk and milk products.

Unit-1. Introduction: Present status of milk & milk products in India and Abroad; market milk- Composition of milk of various species, quality evaluation and testing of milk, procurement, transportation and processing of market milk, standardization, toning of milk, homogenization, pasteurization, sterilization, storage, transportation and distribution of milk. Cleaning & sanitization of dairy equipment's. Special milks such as flavoured, sterilized, recombined & reconstituted toned & double toned. Judging and grading of milk and its products.

Unit-2. Condensed milk- Definition, methods of manufacture, evaluation of condensed & evaporated milk; dried milk- Definition, methods of manufacture of skim & whole milk powder, instantization, physiochemical properties, evaluation, defects in dried milk powder.

Unit-3. Cream- Definition, classification, composition, cream separation, sampling, neutralization, sterilization, pasteurization & cooling of cream, evaluation, defects in cream; Butter- Definition, composition, classification, methods of manufacture, theories of churning, evaluation, defects in butter.

Unit-4. Ice cream- Definition, composition and standards, nutritive value, classification, methods of manufacture, evaluation, defects in ice cream, and technology aspects of softy manufacture.

Unit-5. Cheese: Definition, composition, classification, methods of manufacture, cheddar, Gouda, cottage and processed cheese, evaluation, defects in cheese.

Unit-6. Indigenous milk products - Present status, method of manufacture of milk products.

Unit-7. Milk product processing- cream, butter oil, cheese, cheese spread, condensed milk, evaporated milk, whole and skimmed milk powder, ice cream, khoa, channa, paneer, fermented milk products. Yoghurt, dahishrikhand and similar products. Drying Theories,

Dried milk: Definition and composition, production by drum drying and air spray system; defects; dried milk products–butter-milk powder, whey powder, cream powder, infant milk food. Drying Equipments: Spray Drier, Drum Drier.Novel emerging milk processing techniques. Quality Control in Milk Processing: Tests for evaluation of quality of milk and adulteration.

Practical

1. Study on basics of reception of milk at the plant; platform test of milk, physico-chemical, microbiological and sensory analysis of milk and milk products
2. Estimation of fat by Gerbers' method and SNF in milk;
3. Homogenization of milk.
4. Preparation of curd/lassi.
5. Operation of LTLT & HTST Pasteurization;
6. Spray drying of milk.
7. Preparation of special milks;
8. Cream separation.
9. Standardization of milk from cow and buffalo using Pearson's Method.
10. Preparation and evaluation of table butter, ice cream, cheese and indigenous milk product such as *khoa, chhana, paneer, ghee, rosogolla, gulabjamun, shrikhand, lassi, burfi*
11. Determination of adulterants in milk-by-milk testing kit.

Course Outcomes

After completing this course, the students will be able to:

CO1: Understand the physicochemical properties of milk and various technologies and techniques involved from collection to distribution of milk.

CO2: Understand the technology of fermented milk products and manufacturing techniques, storage, marketing and defects of cheese and butter.

CO3: Understand the technology of frozen milk products technology of evaporated and dried milk technology of condensed milk and their defects and control.

CO4: Understand the technology of dairy by product and their utilization, technology of indigenous milk product and process of manufacturing.

Text Books

1. Walstra P. (Ed.). 2006. *Dairy Science and Technology*. 2nd Ed. Taylor & Francis.

Reference Books

1. Aneja RP, Mathur BN, Chandan RC & Banerjee AK. 2002. *Technology of Indian Milk Products*. Dairy India Publ.

2. Walstra P. 1999. Dairy Technology. Marcel Dekker.

3. Dey S.1994. Outlines of Dairy Technology. Oxford Univ. Press, New Delhi.
4. Rathore NS et al. 2008. Fundamentals of Dairy Technology - Theory & Practices. Himanshu Sharma, H, Pandey H, Singh C. 2009. Dairy Science and Technology and Food and Dairy Engineering. CBS Publishers.
2. Spreer E. 1998. Milk and Dairy Product Technology. Marcel Dekker, New York.

SEMISTER III

Course Code	Course Name	L – T – P	**Credits**
ACFT 509	**FUNDAMENTALS OF FOOD ENGINEERING**	3-0-1	**4**

Course Objectives:

- To acquaint the students about basics of cost-effective design, production, and commercialization of sustainable, safe, nutritious, and high-quality foods
- To understand the concept of development of food systems, machinery, and instrumentation.
- To understand the concept of rheological and thermal properties of foods on measuring the various engineering properties of food products

Course Contents

Unit-1. Fundamental Concepts and Definitions: Introduction to food engineering, Dimensions and units, thermodynamic systems (closed, open and isolated), intensive and extensive properties, equilibrium state, density, specific volume, specific weight, specific heat, enthalpy, entropy, pressure, temperature scales.

Material Balances: Principles, process flow diagrams, total mass balance, component mass balance, material balance problems involved in dilution, concentration and dehydration; heat balance calculations.

Energy Balances: Principles, energy terms, specific heat of solids and liquids, properties of saturated and superheated steam, heat balances.

Unit-2. Heat Transfer

Conduction: Fourier's law, thermal conductivity, resistances in series, heat flow through cylinder.

Convection : Natural convection and force convection, film coefficient, overall heat transfer coefficients, dimensionless numbers – pandtl number and nusselt and heat transfer from

condensing vapours to boiling liquids, heat exchange equipment applied to food insustries – jacketed pans, heaters, coolers – tubular heat exchangers, scrapped surface heat exchangers and plate heat exchangers.

Radiation: Stefan-Boltzmann constants. Black bodies. Irradiation of foods. Radiation units and doses for foods, safe limits, irradiation mechanism and survival curve, irradiation of packaging materials.

Thermal process calculations : Commercially sterile concept, concept of D, F and Z values, reference F value; effect of temperature on thermal inactivation of micro-organisms, thermal process calculation for canned foods; calculation of processing time in continuous flow systems.

Evaporation: Properties of liquid, heat and mass balance, single and multiple effect evaporation, steam economy, heat recovery, efficiency, process calculations, equipment, accessories and systems. Application of evaporators in food industries.

Unit-3. Mechanical operations :

Mixing kneading, and blending: solid mixing, liquid mixing, classification of equipment and application. Homogenisation.

Size separation: filtration theory, constant rate and constant pressure filtration. Classification of filtration equipment – plate and frame filter press, rotary vacuum filters, leaf filters, centrifugal filters and air filters. Sedimentation – sedimentation of solids in liquid and solids in gas – stokes law, centrifulgal separation – equipment and theory.

Size reduction and classification : Slicing, dicing, crushing and grinding – laws governing crushing and grinding – classification of equipment and applications. Sieve analysis, standard sieves – types of equipment, vibrating screen, tromels, oscillating, vibrating and planetary equipment.

Extrusion Cooking: Theory and applications, extrusion cookers and cold extrusion, single and twin screw extruders, design considerations.

Unit-4.

Distillation : Vapour-liquid relationships, Raoult's law, Henery's law,boiling point diagram, classification of distillation – batch distillation, steam distillation, vacuum distillation and rectification and their application to food industries.

Drying : Theory and Mechanism of drying, moisture and drying rate curves, free moisture content, critical moisture content, equilibrium moisture content, constant and falling rate periods, spray, drum, bin, cabinet, tunnel, vacuum shelf dryer, through flow dryer, fluidized bed dryers, batch and continuous operational, osmotic dehydration, freeze drying and their respective applications in food industries.

Chilling, refrigeration and freezing: Shelf life extension requirements for various products, theories, characteristics curve, cooling rate calculations. Chilling and freezing equipment, cryogenics. Freezing – technological principles of freezing operations, freezing systems – direct contact and indirect contact system; influence of freezing rate on food system; freezing time calculations.

Crystallization: Solubility, nucleation, super saturation, heat of crystallization, type of crystallization, equipment and applications

Practicals

- Mechanical drawing
- Refrigeration plant
- Boiler house
- Pilot plant
- Electrical laboratory
- Instrumentation
- Pumps and Flow meters
- Mass and energy balance
- Determination of water activity
- Heat treatment : pasteurization and sterilization
- Thermal Process calculations
- Canning operations
- Dehydration of fruits and vegetables – drying rate curves
- Numerical Problem based on Mass balance
- Size determination
- Mixing, kneading, blending
- Extrusion products
- Filtration and centrifugation
- Freezing curve
- Filtration and centrifugation
- Freezing curve

Course Outcomes

After completing this course, the students will be able to:

CO1: Employ a systematic problem-solving method for addressing engineering questions, including making and testing assumptions, calculate mass and energy balances in the context of food processing equipment

CO2: Describe the different modes of heat and momentum transfer and explain the effects

of each on a food process of interest to the student

CO3: Select appropriate mathematical models for a given situation and use them to calculate food processing parameters such as sterilization time, heating/cooling rate, or flow rate.

Text Books

1. R.P. Singh and D.R. Heldman, 'Introduction to Food Engineering', Academic Press, INC, London.
2. J.G. Brennan, J.R. Butters, N.D. Cowell and A.E.V. Liley, 'Food Engineering Operations', Elsevier, New York, U.S.A.

Reference Books

1. R.L. Earle, 'Unit Operations in Food Processing', Pergamon Press Oxford, U.K.
2. R.T. Toledo, 'Fundamentals of Food Process Engineering', CBS Publishers, New Delhi, India.
3. J.C. Batty and S.L. Folkman, 'Food Engineering Fundamentals', John Wiley and Sons, New York, U.S.A.
4. J.C. Harper, 'Elements of Food Engineering', AVI, Westport, U.S.A.
5. Harper, J.C. (1976) Elements of Food Engg., AVI Publ. Co., Westport, Connecticut.
6. Brennan, J.Buffers, J.R., Cowell N.D., Lilly, A.E.V. (1976). Food Engg. Operations, 2nd Ed., Elsevier, New York.
7. Lewis, M.J. (1987). Physical Properties of Foods & Foods Processing Systems, Ellis Horwood, England.
8. Fellows, P.J. (2015). Food processing technology. Elsevier India.
9. Berk, Zeri. (2009). Food process engineering and technology. Elsevier India.
10. Smith, P.G. 'Introduction to Food Process Engineering' Springer, 2005.
11. Gopala Rao, Chandra, 'Essential of Food Process Engineering', BS Publications.

Course Code	Course Name	L – T – P	**Credits**
ACFT 510	**TECHNOLOGY OF FRUITS, VEGETABLES & PLANTATION CROPS**	3-0-1	**4**

Course Objectives:

- To impart basic knowledge about the importance and management of tropical and dry land fruits grown in India.
- Understanding the principles of biodiversity and strategies in germplasm conservation of fruit crops.
- To disseminate the knowledge on recent developments and innovations in different science and engineering domains of post-harvest management and processing of fruits, vegetables, spices, and plantation crop products.

Unit-1. Introduction to fruits and vegetables

Importance of fruits and vegetables; structure, classification and general composition of fruits and vegetables, Indian and global scenario on production and processing of fruits and vegetables

Unit-2. Postharvest handling and storage of fresh fruits and vegetables

Post harvest changes in fruits and vegetables, climacteric rise, horticultural maturity, physiological maturity, physiological changes during ripening and storage of fruits and vegetables, factors affecting postharvest losses. Fresh fruits and vegetables handling, sorting, grading, phytosanitation, cooling, packaging, quality assurance, chilling injury. Principles of storage, types of storage, low temperature storage, modified atmosphere and controlled atmosphere storages, hypobaric storage.

Unit 3: Processing of fruits and vegetables

Freezing of fruits and vegetables, methods, freezing injury. Dehydration of fruits and vegetables, dehydration methods, physical and chemical changes during drying. Canning of fruits and vegetables, syrups and brines for canning, types of cans, manufacturing of cans, lacquering, mechanical defects, spoilage in canned foods. Fruit juices, beverages and concentrates, squashes,cordials, carbonated beverages, fruit juice powders. Fermented fruits and vegetables products. Jams, jellies, marmalades, preserves and candied products, role of pectin, theory of jelly formation, strength of pectin. Chutneys, sauces, pickles and tomato products.

Unit 4: Fruits and vegetables by-product and their utilization

By-products of fruits and vegetables industry; peel, pomace, oil, pectin, alcohol, enzyme, etc. and their utilization.

Unit 5: Plantation crops

Importance of plantation crops, chemical composition, processing of tea, coffee, cocoa, chicory. Spices, production, processing.

Practicals:

1. Equipment for fruits and vegetable processing and plant layout
2. Preparation of fruit juices, squashes, syrups and ready-to-serve beverages
3. Preparation of jams, jellies, marmalades, preserves and candies
4. Preparation of pickles and chutneys
5. Preparation of tomato products
6. Canning of fruits and vegetables
7. Examination of canned fruits and vegetables
8. Estimation of caffeine in tea and coffee
9. Estimation of pectin
10. Estimation of browning enzymes, PPO and POD
11. Determination of salt content

Course Outcomes

After completing this course, the students will be able to:

CO1: Understand the fundamental components of production technology of plantation crops like fruits, vegetables and spices.

CO2: To know various processing steps involved in plantation crop processing

CO3: To acquaint with the basics of post harvest management of perishables and durable crops

Text Books

1. Ranganna S. (1986). Handbook of analysis and quality control for fruits and vegetable products. Tata Mc Graw-Hill publishing company limited.

Reference Books

1. Girdharilal., Siddappaa, G.S and Tandon, G.L. (1998). Preservation of fruits & vegetables. ICAR,New Delhi.
2. Thompson, A.K., (2003). Fruits and vegetables; Harvesting, handling and storage. Blackwell Publishing.
3. Srivastava, R.P. and Kumar, S. (2006). Fruits and Vegetables Preservation- Principles and Practices.3rd Ed. International Book Distributing Co
4. Wills, R. B. H. (1996). Postharvest: An Introduction to the Physiology and Handling of fruit and vegetables.

Course Code	Course Name	L – T – P	**Credits**
ACFT 511	**TECHNOLOGY OF CEREALS, PULSES AND OIL SEEDS**	3-0-1	**4**

Course Objectives:

- To acquaint the students with production, consumption trends, structure, composition, quality evaluation, and processing technologies for product development and value addition of various cereals, pulses and oilseeds.
- To develop knowhow of proper handling technologies of cereals, pulses and oil seeds to reduce post harvest losses.
- Innovative bakery product development

General introduction and production and utilization trends; Structure and composition of common cereals, pulses and oilseeds. Postharvest storage of grains.

Unit-1. Wheat. Structure, types and physicochemical characteristics; wheat milling - products and by products; factors affecting quality parameters; physical, chemical and rheological tests on wheat flour; additives used in bakery products; flour improvers and bleaching agents; manufacture of bakery products, pasta products and various processed cereal-based foods. Primary and secondary products from wheat.

Unit-2. Rice. Structure, classification, physicochemical characteristics; cooking quality; rice milling technology; by- products of rice milling and their utilization; Parboiling of rice-technology and effect on quality characteristics; aging of rice - quality changes; processed products based on rice.

Unit-3. Maize. Structure, Classification, chemical properties. Primary and secondary processing products. Application in food and allied industries.

Unit-4. Millets: Structure, Bajra, Jowar and Ragi etc. Types & availability, Post-harvest processing handling and processing of millets and their products.

Unit-5. Bakery: Bakery and confectionary industry; raw materials and quality parameters; dough development; methods of dough mixing; dough chemistry; rheological testing of dough. Technology for the manufacture of bakery products 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; machineries used in bakery industry. Chapati making process and qualities, Staling losses in baked products including chapathi.

Unit-6. Legumes, oilseeds and pulses: composition, anti-nutritional factors, processing and storage; Oil Seeds: production of edible oil, meal, flour and other by-products. Oil

refining & hydrogenation. Different high protein products based on legumes and oilseeds using latest technologies such as extrusion, flaking etc.

Practical:

1. Physical characteristics of grains
2. Texture analysis of grains
3. Oil extraction from oilseed
4. Oil content of oilseeds
5. Free fatty acids, Iodine value
6. Saponification value
7. Peroxide Value
8. Preparation of biscuits
9. Dough rheology
10. Estimation of gluten content, Amylographic studies, Starch damage etc

Course Outcomes

After completing this course, the students will be able to:

CO1: Aware the importance of physico-chemical properties, composition and milling operations for food grains

CO2: Identify the problems associated with milling of grains and their solution

CO3: Know processing food grains into value added products.

Text Books

1. Hoseney RS. 1994. *Principles of Cereal Science and Technology*. 2nd Ed. AACC.
2. Salunkhe DK.1992. *World Oilseeds: Chemistry, Technology and Utilization*. VNR.

Reference Books

1. Chakrabarty MM. 2003. Chemistry and Technology of Oils and Fats. Prentice Hall.
2. Dendy DAV &Dobraszczyk BJ. 2001. Cereal and Cereal Products. Aspen.
3. Kulp K & Ponte GJ. 2000. Handbook of Cereal Science and Technology. 2nd Ed. Marcel Dekker.
4. Lorenz KL.1991. Handbook of Cereal Science and Technology. Marcel Dekker.
5. Marshall WE & Wadsworth JI. 1994. Rice Science and Technology. Marcel Dekker.
6. Mathews RH. 1989. Legumes Chemistry, Technology and Human Nutrition. Marcel Dekker.
7. Dubey SC. 2002. Basic Baking. The Society of Indian Bakers, New Delhi.
8. Francis FJ. 2000. Wiley Encyclopedia of Food Science & Technology. John Wiley & Sons.
9. Manley D. 2000. Technology of Biscuits, Crackers & Cookies. 2nd Ed. CRC Press.
10. Pyler EJ. Bakery Science & Technology. 3rd Ed. Vols. I, II. Sosland Publ.
11. Qarooni J. 1996. Flat Bread Technology. Chapman & Hall.

Course Code	Course Name	L – T – P	**Credits**
ACFT 512	**TECHNOLOGY OF MEAT, POULTRY AND FISH PROCESSING**	3-0-1	**4**

Course Objectives:

- To give knowledge about structure, composition and nutritive value of meat, fish, egg and poultry.
- To develop in-depth knowhow about scientific slaughtering of animals, post mortem changes in them; handling, storage, and transportation of fish, and processing of meat, fish and poultry products.
- To provide insight into the functions and areas of responsibility of meat inspection

Unit-1. Meat: Sources of meat and meat products in India, its importance in national economy. Selection of animals for slaughtering, importance of traceability, ante-mortem inspection, grading and safety protocols. Effect of feed, breed and management on meat production and quality.Chemical composition and muscle structure, post-mortem muscle chemistry; meat colour and flavours; meat microbiology and safety.

Modern abattoirs/ meat plants, typical layout and features, design of Ante-mortem handling facilities; hoisting rail and travelling pulley system; stunning methods; Slaughtering of animals and poultry. Steps in slaughtering and dressing; offal handling and inspection; inedible by-products; operational factors affecting meat quality: Rigor mortis, pH changes, colour changes, effects of processing on meat tenderization; abattoir equipment and utilities. Meat quality evaluation, inspection, grading of meat.Mechanical deboning, Meat plant sanitation and safety, By-product utilization.

Chilling and freezing of carcass and meat/poultry; factors responsible for effective chilling and freezing, importance of cold chain facilities, quality changes during chilling and freezing, cold shortening, ripening, DFD and PSE, Factors affecting post-mortem changes - properties and shelf-life of meat.

Processing of meat – pickling, curing and smoking; thermal and non-thermal processing methods of preservation – retort processing, different dehydration techniques, high pressure processing, hurdle processing and irradiation. Restructured and designed meat products. intermediate moisture and dried meat products; meat plant hygiene – GMP and HACCP; Packaging of meat products.

Unit-2. Poultry: classification, composition, preservation methods and processing. Poultry industry in India, measuring the yields and quality characteristics of poultry products, microbiology of poultry meat, spoilage factors; Layout and design of poultry processing

plants, Plant sanitation; Poultry meat processing operations, equipment used – Defeathering, bleeding, scalding etc.; Packaging of poultry products, refrigerated storage of poultry meat and by-products

Structure, composition, nutritive value and functional properties of eggs and its preservation by different methods.Processing of egg products. Factors affecting egg quality and measures of egg quality. Packaging of eggs, egg products, Whole egg powder, Egg yolk products, their manufacture, packaging and storage.

Unit-3. Fish: 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. Commercially important marine products from India; product export and its sustenance; basic biochemistry and microbiology; preservation of postharvest fish freshness; transportation in refrigerated vehicles; deodorization of transport systems; design of refrigerated and insulated trucks; grading and preservation of shell fish; pickling and preparation of fish protein concentrate, fish oil and other by-products.

Unit-4. Alternative Protein: Lab grown/cultivated meat.

Practical

1. Slaughtering and dressing of meat animals;
2. Study of post-mortem changes;
3. Meat cutting and handling; evaluation of meat quality;
4. Preservation by dehydration, freezing, canning, curing, smoking and pickling of fish and meat;
5. Shelf-life studies on processed meat products;
6. Evaluation of quality of eggs;
7. Preservation of shell eggs;
8. Estimation of meat:bone ratios;
9. Preparation of meat products- barbecued sausages, loaves, burger, fish finger;
10. Application of meat testing kits for quality evaluation.
11. Visit to meat processing plants / modern abattoir

Course Outcomes

After completing this course, the students will be able to:

CO1: Learn about the scope of meat industry structure, chemical composition, and nutritive value of meat and gain knowledge of various changes in postmortem, meat cut, meat tenderization and utilization of by-products.

CO2: Understand preservation techniques used for meat and poultry and also learn about transportation processing and preservation techniques.

CO3: Gain knowledge of poultry chemical composition and nutritive value of poultry and learn about ante and post-mortem examination, methods of stunning, slaughter, scalding and dressing and utilization of poultry by products.

Text Books

1. Lawrie, R.A. 2006. Meat Science, 7th Edn. Pergamon Press, Oxford UK.

Reference Books

1. Fidel Toldrá. 2010. Handbook of Meat Processing. Blackwell Publishing, USA.
2. Legarreta IG & Hui Y.H. 2010. Handbook of Poultry Science and Technology, Wiley Publications.
3. Stadelmen, W.J. and Cotterill, O.J., 1995. Egg. Science and Technology. Fourth Edition. by CRC Press.
4. Mead G. 2004. Poultry Meat Processing and Quality, Woodhead Publishing, CRC Press, Boca Raton, New York.
5. Kerry, Kerry &Ledward. 2002. Meat Processing, Woodhead Publishing, CRC Press, Boca Raton, New York.
6. Hui YH. 2001. *Meat Science and Applications*. Marcel Dekker. 32
7. Pearson AM & Gillett TA. 1996. *Processed Meat*. 3rd Ed. Chapman & Hall.
8. Stadelman WJ &Cotterill OJ. 2002. *Egg Science and Technology*. 4th Ed. CBS publications, New Delhi.
9. Bremner H. 2002. Safety and Quality Issues in Fish Processing. Publishing, CRC Press, Boca Raton, New York.
10. Pearson A. M and **Dutso**n T. R. 1995. HACCP in Meat, Poultry, and Fish Processing. Springer Science+Business Media Dordrecht, U.K.

Course Code	Course Name	L – T – P	**Credits**
ACFT 513	**FOOD PACKAGING TECHNOLOGY**	3-0-1	**4**

Course Objectives:

- To acquaint the students with knowledge about goal of food packaging to satisfy industry requirements and consumer desires, maintains food safety, and minimizes environmental impact.
- To acquaint with various food packaging materials
- To help the student understand various aspects of packaging methods and technology including futuristic technologies in this field.

Course Contents

Unit-1.

Introduction to food packaging: Definition, objectives, functions and roles of food packaging, Packaging design and development, Packaging environment, Factors influencing the selection of packaging.

Packaging materials and their properties: Paper: pulping, fibrillation and beating, types of papers, paper boards, corrugated fibre board, Glass: composition, properties, types of closures, methods of bottle making; Metals: types of cans, tin and aluminium based cans, lacquers; Plastics: Polyethylene, polypropylene, polyester, polyamides, polycarbonates and vinyl polymers used in packaging, their chemical structure and properties.

Unit-2.

Manufacture of flexible films: Blown film extrusion, cast film extrusion, film orientation process, co-extrusion process, conversion process. Container manufacture - sheet thermoforming, injection moulding.

Different forms of packaging: Rigid, semi rigid and flexible, Liquid and powder filling machines; bottling machines, Form fill seal and multilayer aseptic packaging machines, vacuum packs unit, shrink pack unit, tetra-pack unit

Unit-3.

Testing of packaging materials: Mechanical properties such as tensile strength, bursting strength, tearing resistance, puncture resistance, impact strength, tear strength, bond strength, heat seal strength, Cobbs value, their methods of testing and evaluation.

Barrier properties of packaging materials: Theory of permeability, factors affecting permeability, permeability coefficient, gas transmission rate (GTR) and its measurement, water vapour transmission rate (WVTR) and its measurement, prediction of shelf life of foods using different packaging materials.

Transport worthiness tests: Drop test, vibration test, compression strength and rolling test.

Migration from packaging materials: Overall and specific migration, physical process, partition coefficient and sorption process, determination of migration, food simulants, flavour adsorption and sorption, packaging flavour interaction, factors affecting flavour absorption, role of food matrix, flavour modifications and food quality.

Unit-4.

Recent trends in food packaging: Vacuum packaging, controlled atmospheric packaging (CAP), modified atmospheric packaging (MAP), gas packing, bioplastics in food packaging, aseptic packaging, retort pouch packaging, microwave packaging, active packaging, intelligent packaging, smart packaging, edible packaging, shrink and stretch packaging.

Packaging systems and methods: Packaging requirements and their selection for raw and processed foods, dehydrated foods, frozen foods, cereals and pulses, fats and oils, dairy products, beverages, fresh fruits and vegetables, meat, poultry and sea foods.

Unit-5.

Role of packaging in food marketing: aesthetic and graphic design; Coding and marking; nutrition labelling, Traceability: RFID tag, bar coding, QR code.

Packaging Laws and regulations: safety aspects of packaging materials,

Environmental & Economic issues, recycling and waste disposal.

Practical

1. Identification and testing of packaging materials
2. Determination of grammage, water proofness
3. Determination of physico-mechanical properties (thickness, tensile properties, tear strength and seal strength) of polymer packaging materials
4. Determination of total migration
5. Determination of water vapour transmission rate (WVTR) and gas transmission rate (GTR) of packaging material
6. Determination of gas composition by Head space analyser

Course Outcomes

After completing this course, the students will be able to:

CO1: Define different packaging materials and technologies

CO2: Explain the relationship between the packaging materials/technologies and food spoilage;

CO3: Explain food and drink labelling and packaging legislations, migration, permeability and recycling.

Text Books	
1.	Kadoya T. (Ed). 1990. Food Packaging, Academic Press INC.
2.	Robertson, G.L. 2006 Food Packaging: Principles and Practice (2nd ed.), Taylor & Fra
Reference Books	
1.	Mahadeviah M & Gowramma RV. 1996. Food Packaging Materials, Tata McGraw Hil
2.	Gowariker, V.R., Viswanatahan, N. V, Sreedhar, J. 1986, Polymer Science, New International (P) Ltd, New Delhi.
3.	Ahvenainen, R. (Ed.) 2003, Novel Food Packaging Techniques, CRC Press.
4.	Han, J.H. (Ed.) 2005, Innovations in Food Packaging, Elsevier Academic Press.
5.	Yam, K. L, Lee, D. S. (Ed.), 2012, Emerging Food Packaging Technologies: Principle Practice, Woodhead Publishing Ltd.

SEMISTER IV

Course Code	Course Name	L – T – P	**Credits**
RP 542	**PROJECT WORK**		**16**

Course Objectives:

- The aims of this course is to teach the students about planning, execution and reporting a research based study appropriate to their aspirations and chosen field of work within the Food Technology sphere
- The course aims to help the students to develop aptitude for research, learn to formulate hypothesis and design experiments to test the hypothesis.
- The research accomplished in their project work shall make them understand the relevance of food technology in addressing the nutrition, safety, sustainability problems and finding out technological solutions.

Course Outcomes

After completing this course, the students will be able to:

CO1: Plan and execute a research-based study using methodological approach under the guidance of mentor.

CO2: Demonstrate an ability to critically analyse current and futuristic technological advancements in the field of food technology.

CO3: Communicate the work effectively and professionally to a specialist and non-specialist audience.

ELECTIVE I

Course Code	Course Name	L – T – P	**Credits**
ACFT 515	**ADVANCED FOOD TECHNOLOGY**	3-0-1	**4**

Course Objectives:

- To develop understanding of technological advancements to suite food processing industrial needs.
- Emphasis on applied aspects of Food Processing and Packaging
- To groom aptitude of students in the field of research and well as industries by using innovative food Preparation, Processing, Storage methods.

Course Contents

Unit-1. Introduction: Scope and importance of advanced techniques in food technology,Importance and types of thermal and non thermal processing techniques.

Unit-2. Dielectric heating, Microwave heating, Infrared heating, Combination processing, RF heating, Ohmic heating, Extrusion cooking (Introduction, processing equipment and design, Mode of action, Biological effect and application in food processing)

Unit-3. High hydrostatic pressure in food processing, High intensity pulsed electric field processing, High pressure CO_2 processing, O_3 (Ozone) processing ,Electron beam processing, Pulsed light processing, Ultrasonication. processing, (Introduction, processing equipment and design, Mode of action, Biological effect and application in food processing)

Unit-4. Application of nanotechnology in food systems, Introduction and applications in foods, human nutrition, preservation, processing, packaging.

Course Outcomes

After completing this course, the students will be able to:

CO1: Apply knowledge gained in food chemistry, microbiology, engineering, and sensory evaluation to the development, processing, and preservation of safe, nutritious, and high-quality food products

CO2: Utilize advanced instruments and technologies to process and analyze food products and to solve food safety problems.

Reference Books

1. Joslyn, M.A. Ed. 1970. Methods in Food Analysis. Academic Press, New York.
2. King, R.D. Ed. 1978. Developments in Food Analysis Techniques-1. Applied Science Publishers Ltd., London.

3. Morris, C.J. and Morris, P. 1976. Separation Methods in Biochemistry 2nd Ed. Pitman Pub., London.

4. Plummer, D.T. 1971. An Introduction to Practical Biochemistry. Mc-Graw Hill Pub. Co., New York.

5. Barbosa-Canovas, G.V., Pothakamury, U.R., Palou, E., Swanson, B.G. 1998. Non Thermal Preservation of Foods. Marcel Dekker, Inc. New York, Basel, Hong Kong.

6. Joslyn, M.A. Ed. 1970.Methods in Food Analysis. Academic Press, New York.

7. Raghuramulu, N., Madhavan Nair, K., and Kalyanasundaram, S. Ed.1983. A Manualof Laboratory Techniques. National Institute of Nutrition, ICMR, Hyderabad.

8. Fellows, P. and Ellis H. 1990. Food Processing Technology: Principles and Practice, New York.

9. Tatiana Koutchma, Larry J. Forney, Carmen I. Moraru, Ultraviolet Light in Food Technology: Principles and Applications, CRC Press, Boca Raotn 2009.

10. Awuah,G. B. Ramaswamy, H. S. ,Tang, J. Radio-Frequency Heating in Food Processing: Principles and Applications, CRC Press, Boca Raotn 2009.

11. Datta, Ashim K. Handbook of Microwave Technology for Food Application, Marcel Dekker Inc. New York 2001.

FOOD TECHNOLOGY – I SEMESTER

ACFT 501 : FOOD CHEMISTRY : PRACTICALS

1. Principles and working of common instruments.
2. Analysis of water with respect to pH, TDS/TSS, hardness, chlorine, etc.
3. Estimation of moisture and ash
4. Estimation of proteins by various methods
5. Estimation of reducing and non-reducing sugars, starch
6. Estimation of crude and dietary fibres
7. Estimation of minerals and vitamins
8. Analysis of lipids-saponification value, acid value and iodine value

ACFT 502 : FOOD MICROBIOLOGY : PRACTICALS

1. Principles and working of common instruments including microscopy.
2. Preparation of nutrient media, sterilization and inoculation techniques
3. Staining techniques–Monochrome staining, negative staining, gram staining, acid fast staining, spore staining, capsule staining and motility of bacteria.
4. Pure culture techniques: isolation of pure cultures from spoiled food
5. Growth characteristics: Methods for determination of microbial numbers– direct and plate count; Generation time.
6. Microbiological quality evaluation of processed food products: a) Water; b) Milk and milk products. c) Fruits and vegetables. d) Egg, meat and fish products; e) canned/ retort processed food and other commonly consumed processed and street foods.
7. **Pathogenic microorganisms**: Different methods for isolation of pathogenic bacteria and fungi from contaminated foods.

ACFT 504 PRINCIPLES OF FOOD PROCESSING AND PRESERVATION

1. Preparation of syrups and brine solutions
2. Determination of TSS, pH, acidity
3. Demonstration of food processing equipment
4. Calculation of dehydration and rehydration ratio
5. Calculation of water activity and moisture content

FOOD TECHNOLOGY – II SEMESTER

ACFT 505 FOOD ANALYSIS & SENSORY EVALUATION

1. Analysis of minerals by using Atomic Absorption Spectroscopy (AAS)/ICP
2. Fatty acid analysis by using GC
3. Determination of vitamins by chromatography
4. Taste evaluation
5. Evaluation of Taste thresholds
6. Taste evaluation by overall acceptability (OAA)

ACFT 506- TECHNOLOGY OF FERMENTED FOODS

1. Media preparation and sterilization
2. Fermentation of lactic acid at flask level.
3. Fermentation involving lactic acid bacteria.
4. Identification of simple secondary metabolites such as lactic acid bacteriocins.
5. Fermentation of molasses for ethanol production.

ACFT 508- TECHNOLOGY OF MILK AND DAIRY PRODUCTS

Practical

1. Study on basics of reception of milk at the plant; platform test of milk, physico-chemical, microbiological and sensory analysis of milk and milk products
2. Estimation of fat by Gerbers' method and SNF in milk;
3. Homogenization of milk.
4. Preparation of curd/lassi.
5. Operation of LTLT & HTST Pasteurization;
6. Spray drying of milk.
7. Preparation of special milks;
8. Cream separation.
9. Standardization of milk from cow and buffalo using Pearson's Method.
10. 10.Preparation and evaluation of table butter, ice cream, cheese and indigenous milk product such as *khoa, chhana, paneer, ghee, rosogolla, gulabjamun, shrikhand, lassi, burfi*
11. Determination of adulterants in milk-by-milk testing kit.

Determination of pH of Water Sample

- Calibration of pH meter

1. Select "Buffer solution 1 (4.0 pH)".
2. Switch on the pH meter.
3. pH meter will show the pH reading as 4.0
4. Change the buffer solution to "Buffer solution 2 (7.0 pH)".
5. Again switch on the pH meter.
6. Now pH meter will show 7.0

Your ph meter is calibrated successfully!!!

1. Select the water samples from the given list.
2. Switch on the pH meter.
3. pH meter will show the pH reading of the selected water samples.
4. Note down the readings.

When measuring the quality of water, pH is among the most important indicators. It tells you how acidic or alkaline the water is, which makes it easier to determine which contaminants are in the water.

If you discover that the water is acidic, you can take steps to filter contaminants and increase the pH level. While alkaline water isn't typically as harmful as an acidic solution, there are many industrial processes that require more neutral pH ranges. In this scenario, there are several treatments that can help you reduce the water's pH.

This type of testing is necessary for many applications. For example, bottled water manufacturers and municipalities must maintain specific pH ranges to ensure the quality of the water isn't poor. It's also common for pH testing to frequently occur in aquaculture and environmental monitoring. The following is the ultimate guide to pH testing, including relevant methods and best practices.

Understanding the pH Scale

To understand how pH works, you must first learn about the pH Scale. This scale goes from 0-14. **At 7.0, the pH is neutral, which means that it's clean and free of nearly all contaminants**. When the pH scale drops below 7.0, the solution will be acidic. Water can become more acidic in the environment when rock formations, tree roots, and soil microbes seep into the solution. Depending on the pH, acidic water is often considered to be dirty and unsafe to drink.
If the pH of a water sample is above 7.0, the solution is alkaline. There are numerous substances that can lead to an increase in the alkalinity of water, which include magnesium and calcium. The pH within blood and human cells can be anywhere from 6.8-7.4. The pH levels of some common substances are:

- Filtered water – 7.0
- Borax – 9.0
- Bananas – 4.0
- Apples – 3.0
- Lime water – 12.0
- Baking soda – 9.0
- Black coffee – 5.0
- Eggs – 8.0
- Rice – 6.0
- Carrots – 6.0
- Mangoes – 6.0
- Sugar – 7.0

There are many reasons why companies and scientists test pH levels in water. For drinking water, the pH range must be between 6.5-8.5. If the water is too acidic, it will likely taste and smell bad. It can also cause illness depending on the types of contaminants that are found in the water.
The main issue with drinking alkaline water is that it can have a bitter taste. **However, consuming too much alkaline water can cause digestive problems like vomiting, stomach pain, and nausea**.

Methods of pH Testing in Water

There are several types of testing you can use to measure the pH of water, which include everything from pH test strips to digital pH meters.

pH Test Strips

These test strips are available in the form of pH paper or a liquid-based solution. When you dip pH paper into water, it will change to a different color based on the current pH level. If you buy pH paper, **you should receive a color-coded scale that allows you to determine if the water is acidic or alkaline**.
In most cases, a color that's closer to orange or red is more acidic. If the color of the water takes on a bluish or greenish hue, it's likely alkaline. You can also buy liquid pH strips that involve placing a few drops of a pH solution into the water. Once you do this, the water will change color, which you can match to your pH strip.
The paper that's used for pH testing is coated with Flavin, a soluble chemical that can change color depending on the types of substances that are present in the water. If the solution has a neutral pH, the paper should turn light green.
The color of the pH paper changes depending on how many hydroxide or hydrogen ions are in the water. If the water contains high levels of hydrogen ions, the solution will be acidic. A higher concentration of hydroxide ions indicates a more alkaline or basic solution.

Digital pH Meters

A digital pH meter is a relatively modern instrument that you can use to identify the alkalinity or acidity of a solution. When you place the meter in water, it should provide a precise pH reading. Many industrial facilities use these meters to perform comparisons.
For example, a wastewater treatment facility will measure the pH of contaminated water before adding treatments and other solutions that should increase the pH. The water's pH will then be tested to identify the effectiveness of the treatments. Treated wastewater is safe to discharge into the environment.
There are numerous types of digital pH meters, which include combination, differential, laboratory, and process meters. Most digital pH meters are combination sensors that consist of a reference electrode and a measuring electrode. The measuring electrode checks for any changes in the water's pH value. In comparison, the reference electrode offers a stable signal that the measuring electrode can be compared against.

Determination of TS, TDS and TSS in Water

INTRODUCTION

Water contain different types of impurities like suspended, colloidal and dissolved materials in it. Based on its contaminants water can be broadly defined as mixture of different types of solids in a liquid base. Solids may be classified as settleable, suspended, dissolved, volatile and fixed. All these types together called as total solids. The settleable solids are those, which are capable of settling when, placed in a quiescent condition. The suspended solids are those which are not soluble in water and remain in suspension for a long period. These solids impart turbidity to the water. The dissolved solids impart colour and odour to water. The total, settleable, suspended and dissolved solids include volatile and fixed components.

Solids form an important component in treatment processes. The suspended and settleable solids have to be removed in the sedimentation units and the dissolved solids will have to be removed in the filtration and other secondary treatment facilities. The volatile solids play an important role in biological treatment of waste water.

Solids refer to matter suspended or dissolved in the water or wastewater and may affect water or effluent quality in adverse ways. Waters with high dissolved solids have poor palatability and may cause unfavourable physiological reactions in transient consumers. Solids analyses are critical for controlling biological and physical wastewater treatment processes as well as determining compliance with regulatory agency limits.

- **Total Dissolved Solid (TDS)** is the amount of combined contents of all inorganic and organic substances contained in a liquid in molecular, ionized or micro-granular (colloidal sol) suspended form. Total dissolved solids are usually discussed only for freshwater systems, as salinity includes some of the ions constituting the definition of TDS.

- **Total Suspended Solids (TSS)** are solids that can be trapped using a filter in water. TSS can include a wide variation in material, such as silt, decaying plant and animal matter, industrial wastes, and sewage. High concentrations of suspended solids can cause several problems to stream health and aquatic life.

- **Total Solids (TS)** can be found by summation of TSS and TDS.

- **Volatile Suspended Solids (VSS)** are the suspended solids associated with volatile fraction.

- **Fixed Suspended Solids (FSS)** are the suspended solids associated with the mineral fraction.

Relevant Indian Standard for TS, TDS and TSS Test :

1. IS 3025 (Part 15)- 1984: Method of Sampling and Test (Physical and Chemical) for Water and Wastewater : Total Residue (total Solids, Dissolved and Suspended, First Revision.