Syllabus Structure: Master's courses 2017-18
BRANCH-Food Biotechnology
Semester I

No.	Contents	Course Code	Subjects	Hours/ Week	Marks	Credits
1.	Core I	FDT 2056	Introduction to Food Science and Technology	(2L+1T)	50	3
2.	Core II	FDT 2008	Comprehensive techniques in Food Analysis	(2L+1T)	50	3
3.	Core III	FDT 2053	Fundamentals of Food Process Engineering	(2L+1T)	50	3
4.	Elective I	FDT 2023	Food Packaging Science and Technology	(2L+1T)	50	3
5.	Elective II	FDT 2021	Food Standards and Safety Regulations	(2L+1T)	50	3
6.	Practical I	FDP 2067	Food Analysis and Processing Laboratory	6	50	3
7.		FDP 2066	Seminar and Critical Review of Research Paper	6	50	3
8		FDP 2068	Research I	12	100	6
			TOTAL	39	450	27

Semester II

No.	Contents	Course Code	Subjects	Hours/Week	Marks	Credits
1.	Core I	FDT 2057	Fundamentals of Food Biotechnology, Genetics, and Cell Culture Technology	(2L+1T)	50	3
2.	Core II	FDT 2055	Biotechnology of Fermented Foods	(2L+1T)	50	3
3.	Core III	FDT 2058	Bioprocess Engineering and Technology	(2L+1T)	50	3
4.	Elective I	FDT 2075	Basics of Human Nutrition	(2L+1T)	50	3
5.	Elective II	FDT 2002	Food Safety and Toxicology	(2L+1T)	50	3
6.	Practical II	FDP 2052	Food Biotechnology Laboratory	6	50	3
7.		FDP 2069	Research II	18	150	9
			TOTAL	39	450	27

Semester III

No.	Course Code	Course	Hours/Week	Marks	Credits
1.	FDP XXXX	Sem III Research	40 (15 Weeks)	450	30
		TOTAL	40	450	30

Semester IV

No.	Course Code	Course	Hours/Week	Marks	Credits
1.	FDP 2071	Research III	40 (15 Weeks)	450	30
		TOTAL	40	450	30

List of Electives

No.	Course Code	Subjects	Credit	Hours/ Week	Marks
1	FDT 2021	Food Standards and Safety Regulations	3	(2L+1T)	50
2	FDT 2023	Food Packaging Science and Technology	3	(2L+1T)	50
3	FDT2075	Basics of Human Nutrition	3	(2L+1T)	50
4	FDT2002	Food Safety and Toxicology	3	(2L+1T)	50
5	FDT 2026	Experimental Design and Optimization in Food Processing	3	(2L+1T)	50
6	FDT 2077	Enzymes in Food and Feed Industry	3	(2L+1T)	50
7	FDT 2025	Food Process and Equipment Design	3	(2L+1T)	50
8	FDT 2024	Separation Techniques in Food Industry	3	(2L+1T)	50

Syllabus
Semester I

Course Type	Course Code	Subject	Credit	Marks	Total Hours (L+T)
Core I	FDT 2056	**Introduction to Food Science and Technology**	**3**	**50**	**(30+15)**

Prerequisite: None

Course Objectives

1. To comprehend basic concepts of food sciences and properties of foods, and chemical and enzymatic factors affecting these properties.
2. To understand different food standards for various categories of foods.
3. To comprehend different analytical techniques employed across various categories of foods.
4. To explain the effect of food constituents on food quality.
5. To grasp the fundamentals of food processing and preservation.
6. To understand some emerging concepts in food technology.

Unit No.	Syllabus	L+T
1	**Introduction to food science and technology** Basics of chemistry of food constituents- carbohydrates, proteins, lipids, vitamins, minerals, water (different forms of water present in foods and their effect on quality and preservation of foods), minor constituents affecting texture, color, taste, odor; Food microbiology, Food biochemistry, Food additives, General food composition and effect of food constituents on food quality.	**10+5**
2	**Standards for food analysis** Standards of identity, purity, and methodology for analysis of a) Cereals, legumes, oil seeds and their products; b) Fruits, vegetables, tubers, and their products; c) Tea, coffee, cocoa, chocolate, spices, sugar, condiments; d) Milk and milk products; e) Meat, fish and poultry products; f) Miscellaneous foods e.g., fermented products.	**10+5**
3	**Food processing and preservation** Introduction to food processing of various foods including dairy, bakery, brewing, fruit and vegetable products, plantation products, oilseeds, meat, fish, poultry; pro and prebiotics and nutraceuticals. Principles of food preservation by dehydration, thermal treatments like pasteurization, sterilization, canning, retorting etc., low temperature i.e., chilling and freezing, chemical preservation/ bio-preservation, traditional methods like salting/ syruping, pickling, fermentation etc., non- thermal processes like MAP, irradiation, high pressure processing etc., and hurdle technology	**10+5**

Course outcomes

Student will be able to ….

1. understand basic concepts of food sciences and properties of foods, and chemical and enzymatic factors affecting these properties.
2. comprehend different food standards for various categories of foods.
3. understand different analytical techniques employed across various categories of foods.
4. describe the effect of food constituents on food quality.
5. grasp the fundamentals of food processing and preservation.
6. understand some emerging concepts in food technology.

Books Recommended

- Potter, Norman N., Hotchkiss, Joseph H. (1995), *Food Science*, 5th Ed. Springer US
- Manay, S.; Shadaksharaswami, M., (2004). *Foods: Facts and Principles*, 4th Ed. New Age Publishers.
- B. Srilakshmi., (2002), *Food science*, New Age Publishers.
- Meyer, (2004). *Food Chemistry*. New Age Publishers.
- Deman JM. (1990) *Principles of Food Chemistry*. 2nd ed. Van Nostrand Reinhold, NY
- Ramaswamy H. and Marcott M. (2005), *Food Processing Principles and Applications*. CRC Press.

Course Type	Course Code	Subject	Credit	Marks	Total Hours (L+T)
Core II	FDT 2008	**Comprehensive techniques in Food Analysis**	**3**	**50**	**(30+15)**

Prerequisite

Biochemistry, Food Chemistry, Instrumentation Lab

Course Objectives

1. To understand the principles of modern techniques used in food analysis for quality assurance
2. To design labels for food products on the basis of food analysis
3. To develop analytical techniques for on-line monitoring of food quality during processing and storage
4. To ensure consumer safety through analysis of food contaminants and adulterants and apply them in the light of regulatory requirements
5. To assess the environmental impact of products life from farm to fork.
6. To explain newer and relevant analytical techniques in food systems

Unit No.	Syllabus	L+T
1	Analysis of chemical constituents, their characterization and significance; Application of modern techniques including spectroscopy, chromatography including GC, GC –MS, HPLC, HPTLC, gel permeation, ion-exchange, etc.	**10+5**
2	Enzymes in food analysis; Supercritical fluid extraction in food analysis; Rapid methods for detection of food pathogens, biosensors, automation and use of computers in food analysis	**10+5**
3	Sensory evaluation – different scales, training, skills and importance for consumer acceptance, Quantification of sensory attributes - Artificial Tongue, Artificial Nose; Life cycle analysis	**10+5**

Course Outcomes

Student will be able to ….

1. Demonstrate the basic principles of modern techniques used in food analysis for quality assurance (K3)
2. Infer about labels for food products based on food analysis (K5)
3. Develop analytical techniques for on-line monitoring of food quality during processing and storage (K3)
4. Ensure consumer safety through analysis of food contaminants and adulterants and apply them in the light of regulatory requirements (K5)
5. Discuss about the newer and relevant analytical techniques in food systems (K4)

Books Recommended

- Introduction to Chemical Analysis of Foods. By Nielsen, S.(Eds), Jones & Bartlett, 1994.
- Spectral method in food analysis by Magdi Mossoba, 1999
- Sensory evaluation technique by Morton C. Meilgaard, 2007
- Sensory evaluation of food: Principle & practices by Harry L. Lawless, Hildegarde, Heymann, 1999
- Food Chemistry by W. Grosch by Belitz, H.D., Grosch, W. 2nd ed., 1999
- Sensory Evaluation of Food by M.O`Mahony,1986

Course Type	Course Code	Subject	Credit	Marks	Total Hours (L+T)
Core III	FDT 2053	**Fundamentals of Food Process Engineering**	**3**	**50**	**(30+15)**

Prerequisite: None

Course Objectives

1. To describe and analyze the transport phenomena in different food processing operations (K4)
2. To explain the principle of different food preservation methods (K3)
3. T0 describe the design aspects of different thermal processes and equipment (K2).
4. To describe the basic unit operation and design aspects involved in commodity specific food processing methods (K3).
5. To explain and develop basic flow sheet in food processing operations (K3)

Unit No.	Syllabus	L+T
1	**Food Engineering** Transport phenomenon in food processing: Heat transfer mechanism; Overall heat transfer coefficient; steady state and transient heat transfer. Momentum Transfer; fluid flow; viscosity; fluid flow and pressure measuring devices; Mass transfer; Fick's law; Case studies.	**12+5**
2	**Principles of food processing** Principles of thermal processing; Pasteurization and Sterilization; Calculation of process time temperature-schedules; Freezing and refrigeration in food processing; Freezing time calculation; Principles of alternative and Nonthermal processing of food; high pressure processing	**10+5**
3	**Commodity processing & Product development** Processing of fruits, vegetables, grains; dairy, meat and fish products; pro and prebiotics. Product and process development approaches. Flow sheets and preliminary cost analysis.	**5+2**
4	**Methods in food process engineering** Material and Energy Balance; Food processing unit operations such as drying, evaporation, membrane filtration.	**3+3**

Course Outcomes

Student will be able to ….

1. Describe and analyze the transport phenomena in different food processing operations (K4)
2. Explain the principle of different food preservation methods (K3)
3. Describe the design aspects of different thermal processes and equipment (K2).
4. Describe the basic unit operation and design aspects involved in commodity specific food processing methods (K3).
5. Explain and develop basic flow sheet in food processing operations (K3)

Books Recommended

- P. G. Smith, (2004), *Introduction to food process engineering*, Springer Pvt. Ltd.
- Lee B.H, (2014), *Fundamentals of food biotech*. Wiley-Blackwell.
- Pandey, (2004), *Experiments in food process engineering*. CBS Publishers.
- Romeo Toledo, (2007), *Fundamentals of food process engineering*. Springer India.
- Watson EL and Harper JC, (1989) *Elements of Food Engineering*, The Avi Publishing Co.
- Heldman DR and Singh RP, (1984) *Food Process Engineering*, Chapman and Hall.

Course Type	Course Code	Subject	Credit	Marks	Total Hours (L+T)
Practical	FDP 2067	**Food Analysis and Processing Laboratory**	**3**	**50**	**6h/week**

Course Objectives

1. Demonstrate the knowledge of redox chemical reactions to develop a protocol for analysing specific food attributes (K4)
2. Interpret different chemical and biochemical analysis specific to food (K4)
3. Develop protocols on different food formulations and analyse the sensory data (K5)
4. Interpret the effect of different process variables on specific attributes of fruits, vegetables, bakery, and dairy products (K4)

Unit No.	Syllabus	No of wk (6 h/wk)
1	Analysis of milk (liquid) & detection od adulterants in milk	1
2	Analysis of wheat flour and determination of damaged starch	1
3	Analysis of tea and coffee	2
4	Analysis of alcoholic beverages	1
5	Estimation of food bioactives (phenolics, pigments etc)	1
6	Detection of Food adulteration	1
7	Sensory analysis of Foods	1
8	Development of premixes and study of traditional food	1
9	Fruit and vegetable processing: Dehydration and Product Development	3
10	Baking: Effect of process parameters on quality	1
11	Milk processing: Development of dairy product	1
12	Demo of Hunterlab colorimeter, texturimeter, soxtech, DSC, HPLC, extruder, SCFE, spray drier, tray drier etc.	1

Course Outcomes

Student will be able to ….

1. Demonstrate the knowledge of redox chemical reactions to develop a protocol for analysing specific food attributes (K4)
2. Interpret different chemical and biochemical analysis specific to food (K4)
3. Develop protocols on different food formulations and analyse the sensory data (K5)
4. Interpret the effect of different process variables on specific attributes of fruits, vegetables, bakery, and dairy products (K4)

Books Recommended

- AOAC International. 2003. Official methods of analysis of AOAC International. 17th Ed. Gaithersburg, MD, USA, Association of Analytical Communities
- Kirk, RS and Sawyer, R. 1991. Pearson's Chemical Analysis of Foods. 9th Ed. Harlow, UK, Longman Scientific and Technical.
- Leo ML.2004. Handbook of Food Analysis. 2nd Edition. Vol 1,2 and 3, Marcel Dekker.
- Linden G. 1996. Analytical Techniques for Foods and Agricultural Products. VCH.
- Fuller, G.W. (2011). New Food Product Development: From Concept to Marketplace, 3rd ed, CRC Press, UK.
- Barbosa-Cánovas, G. V., Ma, L., & Barletta, B. J. (1997). Food Engg Laboratory Manual. CRC Press. UK

Course Type	Course Code	Subject	Credit	Marks	Total Hours
Practical	FDP 2066	Seminar and Critical Review of Research Paper	**3**	**50**	**6h/week 90 hours**
Unit No.	**Syllabus**				**Time**
1	• Each Student will conduct literature survey, collect full papers, reviews, book chapters etc. and prepare presentation and written review report on the given seminar topic. • Oral presentation and written report of the seminar will be evaluated for 2 credits.				**4h/week 60 hours**
2	• One original research paper from the same topic will be specified by the teacher for critical review in depth. • Separate presentation and critical review report of 1 paper will have to be done and will be evaluated for 1 credit.				**2h/week 30 hours**
	Course Outcomes Student will be able to …. 1. Develop critical thinking regarding the research paper given (K5) 2. Analyse different literature sources about a certain topic (K4) 3. Comment on others' work in terms of the scientific content, novelty, and correctness of published work (K5) 4. Evaluate the research methodologies, data analysis and interpretation (K5) 5. Develop skills for presentation and writing scientific documents (K6)				

Course Type	Course Code	Subject	Credit	Marks	Total Hours
Practical	FDP 2068	Research I	**6**	**100**	**12h/wk 180h**
Unit No.	**Syllabus**				**Time**
1	**Project Proposal Preparation** • Teachers will communicate various research project topics to all the students based on interest and facilities available and relevance to the area of Food Biotechnology. • Each student based on his/her interest and merit selects the research topic and is allotted a supervisor. • Review of literature, formulation of research project, hypothesis, objectives, methodology, possible expected outcomes, planning for experimentation, conducting preliminary experimental trials, data generation and analysis. • Oral presentation of proposed research work with initial data generated being shown • Submission of report of research proposal				**12h/week 180 hours**
	Course Outcomes Student will be able to …. 1. Develop critical thinking to identify the research gap for the project (K5) 2. Formulate a scientific question and approach to solve it (K6) 3. Plan the experimental methodology for the project (K5) 4. Develop skills to communicate the research plan effectively (K6) 5. Develop skills for writing scientific documents (K6)				

SEMESTER II

Course Type	Course Code	Subject	Credit	Marks	Total Hours (L+T)
Core I	FDT 2057	**Fundamentals of Food Biotechnology, Genetics, and Cell Culture Technology**	**3**	**50**	**(30+15)**

Prerequisite

Biochemistry, Microbiology, Plant and animal biology

Course Objectives

1. To understand the fundamentals of food biotechnology and genetics.
2. To have basic knowledge of cell culture technology.
3. To comprehend the principles behind important analytical techniques employed in biotechnology as well as in genetic modification of foods.
4. To comprehend the techniques utilised in production of different useful secondary metabolites.
5. To explain the applications of cell culture technology at the industrial level.

Unit No.	Syllabus	L+T
1	**Food Biotechnology** Fermentative production of enzymes used in food industry; solid state fermentation; recovery of enzymes from natural sources; cheese making and whey processing, impact of enzyme technology (bioethanol, protein hydrolysates, bioactive peptides); enzymatic processing of fruit juices. Role of enzymes in baking, meat and meat processing; comparative methods of toxicity test in (novel) foods; biosensors; enzymatic approach to tailor made fats; catabolic processes and oxygen-dependent reactions in food; use of lipases and reactions in organic solvents and two phases.	**8+4**
2	**Overview of Genetics** Chemical structure of nucleic acids, proteins; introduction to Genetics, DNA replication, transcription and translation; cell division, cell cycle, mitosis, meiosis; introduction to human genetics; Mendelian genetics; single cell disorders; complex traits; DNA repair mechanism; modifying enzymes; recombinant DNA technology; mutation and polymorphism and their detection; family based and case control study designs; pedigree analysis; linkage analysis and association studies.	**8+4**
3	**Genetic Engineering** PCR, RT-PCR, electrophoresis, electro blotting and capillary blotting; population & evolutionary genetics, gene mapping; microbial gene transfer mechanisms, mutation, types of mutations, molecular mechanism of mutations, practical applications; applications to produce genetically modified foods.	**8+4**
4	**Cell culture technology** Introduction to plant and animal tissue cultures and cell cultures in general. Cell culture lab design and equipment, Media and reagents. Animal, mammalian, and other cell lines for in-vitro testing of drugs, toxicity of environmental pollutants, production of vaccines and therapeutic proteins & production of stem cells. Principles of cryobiology and molecular diagnostics, Technological aspects for commercial utilization of cell cultures: Reactor studies, scale up and biosafety.	**6+3**

Course Outcomes

Student will be able to ….

1. Understand the fundamentals of food biotechnology and genetics.
2. Have basic knowledge of cell culture technology.
3. comprehend the principles behind important analytical techniques employed in biotechnology as well as in genetic modification of foods.
4. Comprehend the techniques utilised in production of different useful secondary metabolites.
5. describe the applications of cell culture technology at the industrial level.

Books Recommended

1. Byong H.Lee, (2015), *Fundamentals of food biotechnology*. Wiley-Blackwell.
2. Anthony Pometto, Kalidas Shetty, Gopinadhan Paliyath, Robert E. Levin, (2005) *Food biotechnology*. CRC Press.
3. Roger Angold, Gordon A. Beech, John Taggart, (1989), *Food Biotech*. Cambridge University Press.
4. Lee B.H, (1996), *Fundamentals of food biotech*. Wiley-Interscience.

Course Type	Course Code	Subject	Credit	Marks	Total Hours (L+T)
Core II	FDT 2055	**Biotechnology of Fermented Foods**	**3**	**50**	**(30+15)**

Prerequisite

Microbiology, Biochemistry

Course Objectives

1. To emphasize the concept of functional foods and different fermented foods (K4)
2. To understand the role of microorganisms and enzymes involved in various food formulations (K5)
3. To analyse the principles and mechanism of immunological detection of pathogens in foods (K4)
4. To infer about the application of biotechnology in food processing and agricultural practices (K5)
5. To highlight the newer developments in processing technologies for fermented foods (K4)

Unit No.	Syllabus	L+T
1	**Overview of fermented foods** Traditional applications of food biotechnology- Fermented foods: eg dairy products, oriental fermentations, alcoholic beverages, and food ingredients; the role of biotechnology in fermented food products (dairy, meat, vegetable); Starter culture development, process development; Enzymes in the dairy industry: cheese making and whey processing, impact of enzyme technology; Functional foods.	**15+7.5**
2	**Biotechnology of fermented foods** Enzymatic processing of fruit juices; Role of enzymes in baking, meat and meat processing; Applications of immunological techniques to food industry; Detection methods for E. coli, Staphylococci, Yersinia, Campylobacter, B. cereus, Cl. Botulinum & Salmonella from food samples; Newer Processing Technology, Pesticide Residues, Newer Sources of Ingredients, Nutraceuticals, Use of Antibiotics & Hormones in Food Processing & Agricultural Practices etc.	**15+7.5**

Course Outcomes

Student will be able to ….

1. Highlight the concept of functional foods and different fermented foods (K4)
2. Interpret the role of microorganisms and enzymes involved in various food formulations (K5)
3. Analyse the principles and mechanism of immunological detection of pathogens in foods (K4)
4. Infer about the application of biotechnology in food processing and agricultural practices (K5)
5. Highlight the newer developments in processing technologies for fermented foods (K4)

Books Recommended

- Keith H. Steinkraus, (2004), *Industrialization of indigenous fermented foods*. CRC Press.
- Brian J.B.Wood, (1998), *Microbiology of fermented foods*. Springer US.
- Ghose, T. K., Fiechter, A., Blakebrough, N. (1974), *Advances in Biochemical engineering*, Vol 3. Springer-Verlag Berlin Heidelberg.

Course Type	Course Code	Subject	Credit	Marks	Total Hours (L+T)
Core III	FDT 2058	**Bioprocess Engineering and Technology**	**3**	**50**	**(30+15)**

Prerequisite

Fundamentals of Food Process Engineering

Course Objectives

1. To explain the basic principles of biochemical engineering and microbial growth kinetics
2. To describe the design aspects of bioreactor including the upstream and downstream processing
3. To describe the applications of microbial technology in food processing and biorefineries
4. To apply the biotechnological concept in the production of biologicals

Unit No.	Syllabus	L+T
1	**Basic principles of Biochemical engineering** Isolation, screening and maintenance of industrially important microbes; microbial growth and death kinetics (an example from each group, particularly with reference to industrially useful microorganisms); strain improvement for increased yield and other desirable characteristics.	**4+2**
2	**Stoichiometry and Models of Microbial Growth** Elemental balance equations; metabolic coupling: ATP and NAD+; yield coefficients; unstructured models of microbial growth; structured models of microbial growth, MATLAB basics for modeling and solving the equations.	**4+2**
3	**Bioreactor Design and Analysis** Batch and continuous fermenters; modifying batch and continuous reactors: chemostat with recycle, multistage chemostat systems, fed-batch operations; conventional fermentation v/s bio-transformations; immobilized cell systems; large scale animal and plant cell cultivation; upstream processing: media formulation and optimization; sterilization; aeration, agitation and heat transfer in bioprocess; scale up and scale down; measurement and control of bioprocess parameters.	**8+4**
4	**Downstream Processing and Process Economics** Separation of insoluble products - filtration, centrifugation, sedimentation, flocculation; Cell disruption; separation of soluble products: liquid-liquid extraction, precipitation, chromatographic techniques, reverse osmosis, ultra and micro filtration, electrophoresis; final purification: drying; crystallization; storage and packaging. Isolation of micro-organisms of potential industrial interest; strain improvement; market analysis; equipment and plant costs; media: sterilization, heating and cooling; aeration and agitation; batch-process cycle times and continuous cultures; recovery costs; water usage and recycling; effluent treatment and disposal.	**4+2**
5	**Applications of Microbial Technology in food processing and biorefineries** Fermented foods and beverages; food ingredients and additives prepared by fermentation and their purification; fermentation as a method of preparing and preserving foods; microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products; process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products; bacteriocins from lactic acid bacteria: production and applications in food preservation; biofuels and biorefinery; production of antibiotics in a reactor; single cell protein; probiotics and prebiotics.	**5+2.5**
6	**Applications of Biotechnology in the production of biologicals** Industrial production of penicillin via fungal route, insulin from recombinant *E. coli*; Production of metabolites such as shikonin using plant cell culture, astaxanthin from algae, and biotransformation routes for novel/specialty chemicals; Production of HBsAg using yeast cultures, erythropoietin using CHO cells, monoclonal antibodies such as Humira using mammalian cells.	**5+2.5**

Course Outcomes

Student will be able to ….

1. Demonstrate the concept of microbial kinetics in biochemical engineering (K3)
2. Apply the concept of stoichiometry in the modelling of microbial growth (K3)
3. Design and analyse different bioreactor systems and their components (K4)
4. Apply the principles of different upstream and downstream processes involved in bioprocesses (K3)
5. Apply the concept of microbial technologies in food processing and biorefineries as well as production of biologicals (K3)

Books Recommended

- Shuler, M. L., & Kargi, F. (2002). *Bioprocess engineering: Basic concepts*. Upper Saddle River, NJ: Prentice Hall.
- Stanbury, P. F., & Whitaker, A. (1997). *Principles of fermentation technology*. Oxford: Pergamon Press.
- Pauline Doran (1995) *Bioprocess engineering principles*. Elsevier Science & Technology Books
- Mansi EMTEL, Bryce CFA. *Fermentation Microbiology and Biotechnology*, 2nd Edition, Taylor & Francis Ltd, UK, 2007
- Harrison, R.G., Todd, P., Rudge, S.R., and Petrides, D.P. (2015). *Bioseparations Science and Engineering*. 2nd Edition. Oxford University Press.

Course Type	Course Code	Subject	Credit	Marks	Total Hours (L+T)
Practical	FDP 2052	**Food Biotechnology Lab**	**3**	**50**	**6h/week**
Unit No.	**Syllabus**				**No of wk (6 h/wk)**
1	Ammonium sulphate precipitation of proteins				1
2	Discontinuous native and SDS PAGE				2
3	Isolation of genomic DNA and 2 D gel electrophoresis demo				1
4	Agarose gel electrophoresis and 2 D gel electrophoresis demo completed				1
5	DNA amplification by PCR and Real Time PCR demo				1
6	Gel Purification of amplified DNA				1
7	Restriction digestion profiling of genomic DNA				1
8	HPLC and HPTLC separation demo				1
9	Immunological assay (ELISA) and Demo of Gel Filtration Chromatography/ IEC				1
10	Enzyme assay and factors affecting with kinetic study				1
11	Application of enzyme in Fruit processing, and inactivation of enzyme by blanching				1
12	Preparation of media, sterilization, serial dilution, plating, enumeration, Gram staining				2
13	Estimation of antioxidant value by ABTS/ FRAP				1

Course Outcomes

Student will be able to ….

1. Gain an understanding and hands on experience in practical aspects of various types of electrophoresis
2. Gain an understanding and hands on experience in practical aspects of enzyme purification by ammonium sulphate precipitation and three-phase partitioning
3. Gain an understanding on chromatographic techniques such as IEC, GPC, and TLC
4. Gain an understanding and hands on experience on DNA isolation and restriction digestion, and an understanding of amplification using PCR and RT-PCR and restriction digestion
5. Understand the methodology of enzyme assay, expressing activity and exemplify the applications of enzymes in food processing
6. Prepare themselves for research project work for parts of research involving applications of core biotechnological techniques and strengthen their abilities to pursue a research career in this field.

Course Type	Course Code	Subject	Credit	Marks	Total Hours
Practical	FDP 2069	Research II	**9**	**150**	**18h/wk 270h**
Unit No.	**Syllabus**				**Time**
1	The topic of the research with defined objectives and hypothesis should be explored by scientifically planned rational experiments. Students should have actual experimental data collected on the chosen research topic.				**12h/week 180 hours**
2	Oral presentation of proposed research work with data generated during actual trial targeted towards the objectives Submission of report of research proposal				**6h/week 90 hours**

Course Outcomes

Student will be able to ….

1. Perform various experiments and troubleshoot the methods in order to generate reliable data (K5)
2. Apply different statistical tools for scientific data analysis (K4)
3. Evaluate critically the experimental data and draw meaningful inferences (K5)
4. Develop skills to communicate scientific results effectively (K6)
5. Develop skills for writing scientific documents (K6)

Course Type	Course Code	Subject	Credit	Marks	Total Hours
Practical	FDP XXXX	Sem III Research	**30**	**450**	**40 h/week (15 weeks)**

Course Objectives

Student will be able to…

1. To perform experiments systematically to accomplish the set objectives (K3)
2. To evaluate critically the experimental data and draw meaningful inferences (K5)
3. To develop skills to defend own research effectively (K6)
4. To develop skills for writing scientific documents (K6)

Course Type	Course Code	Subject	Credit	Marks	Total Hours
Practical	FDP 2071	Research III	**30**	**450**	**40 h/week (15 weeks)**

Course Outcomes

Student will be able to ….

1. Perform experiments systematically to accomplish the set objectives (K3)
2. Evaluate critically the experimental data and draw meaningful inferences (K5)
3. Develop skills to defend own research effectively (K6)
4. Develop skills for writing scientific documents (K6)

ELECTIVES

Course Type	Course Code	Subjects	Credit	Marks	Total Hours (L+T)
Elective	FDT 2021	Food Standards and Safety Regulations	**3**	**50**	**(30+15)**

Prerequisite

Basic understanding of the Chemistry of Food Constituents, Food Processing

Course Objective

1. To explain the functional role and safety issues of food contaminants, food adulteration,
2. To describe the hygiene and sanitation in food processing plant, equipment, storage and handling
3. To explain the various quality attributes of food and emphasizing on microbial quality control in
4. food and water quality
5. To identify and analyse the critical quality control point in different stages of production of food
6. and thereby designing the HACCP system

No.	Syllabus	L+T	Related CO
1	Salient features of Food Safety & Standards Act, 2006, Structure of FSSAI, Administrative set up at the State level. Roles and Responsibilities of diff. Food safety Regulators, Food Safety Commissioner, Designated Officer, Food safety Officer, Adjudicating Officer Licensing and registration, Licenses to be granted by Central Licensing Authority, Documents/ Format required for Registration/ Licensing	**5+3**	**1, 5**
2	Introduction to Food Safety, Food Contaminants (Microbial, Chemical, Physical), Food Adulteration (Common adulterants), Food Additives (functional role, safety issues), Food Packaging & labelling (Packaging types, understanding labelling rules & Regulations, Nutritional labelling, labelling requirements for pre-packaged food as per CODEX)	**5+2**	**1, 2, 5**
3	Organic food, Identifying Organic foods, Advantages, The Organic Certification Process, Organic Food labeling, GM food,Why are GM food produced, Main issues of concern for Human Health, How are GM Food regulated Internationally, Regulation in India.	**5+3**	**1, 4**
4	Role of WHO to improve evaluation of GM food, Benefits & Controversies, Irradiated Food, Labelling of Irradiated Food. Freeze dried food, Functional Foods & Nutraceuticals, Functional foods from plant sources, animal sources, dietary supplements, Regulation. World Trade Organization (WTO), Principles of trading system. SPS and TBT, Differences between SPS & TBT. WTO agreement on the application of SPS measures. Food & Agriculture Organization (FAO)	**5+2**	**1, 5**
5	FAO in India, Technical Cooperation programmes, Biosecurity in Food and Agriculture, World Health Organization (WHO), World Animal Health Organization (OIE), International Plant Protection Convention (IPPC); Codex Alimentarius Commission - Codex India – Role of Codex Contact point, National Codex contact point (NCCP), National Codex Committee of India – ToR, Functions, Shadow Committees etc.	**5+3**	**1, 5**
6	Need for Food analysis, Accreditation of Food Laboratory, Referral labs. Risk analysis and management in food safety, What is food surveillance, Steps to be taken for reporting and dealing with food incidents. Food alerts. Offences in food, Trials (Case Study) and procedure to launch prosecution	**5+2**	**2, 3, 4**

Course Outcomes

Student will be able to ….

1. Demonstrate the functional role and safety issues of food contaminants, adulteration, additives, packaging & labelling (K3).
2. Evaluate the hygiene and sanitation condition in food processing plant, equipment, storage and handling (K5)
3. Analyse the issues on microbial quality control of food and water in Food Processing Industry (K4)
4. Identify and analyse the critical quality control point for organic and GM food and thereby designing the HACCP system (K4)
5. Interpret the role, standard and law set by Indian and global regulatory authorities with respect to food quality control (K5)

Books Recommended

- Environmental regulation and food safety by Veena Jha.
- Microbiological safety of food by Hobbs, 1973
- Emerging technologies; food process by Da-wen, 2005
- Food safety by Laura K Egendorf, 2000
- International standards of food safety by Naomi Rees, David Watson, 2000
- Codex alimentarius by FAO & WHO, 2007

Course Type	Course Code	Subjects	Credit	Marks	Total Hours (L+T)
Elective	FDT 2023	Food Packaging Science and Technology	**3**	**50**	**(30+15)**

Prerequisite

None

Course Objectives

1. To highlight about food packaging as a method of food preservation (K4)
2. To interpret the role of different packaging materials and their physicochemical properties (K5)
3. To establish the concepts of quality evaluation and testing of packaging materials (K4)
4. To assess the criteria for selecting a packaging material for a specific application (K5)
5. Develop the packaging materials suitable for newer processing techniques (K6)

No.	Syllabus	L+T
1	Introduction to food packaging, causes of food spoilage, Packaging as a method for preservation of foods; functions of food packaging, levels of packaging, different materials used in food packaging such as paper, board, glass, metal containers, aluminum foil, plastics, composites, traditional materials and their physicochemical characteristics, additives used in packaging materials, packaging applications for various food commodities	**10+5**
2	Testing of various packaging materials and packages for evaluation of quality, for identification, for evaluation of performance (barrier and strength properties) for transport worthiness, for biodegradability, for migration etc; Package design; Cushioning materials; Criteria for selection of packaging materials and package design for food products; shelf life testing of packaged foods; food labeling	**10+5**
3	Packaging materials for newer techniques like radiation processing, microwave and radiowave processing, high pressure processing, CAP/ MAP and thermal processing as retortable pouches, aseptic packaging; biodegradable packaging; active packaging; intelligent packaging; migration; flavor scalping, application of nanotechnology in food packaging, environmental concerns and life cycle assessment	**10+5**

Course Outcomes

Student will be able to ….

1. Highlight about food packaging as a method of food preservation (K4)
2. Interpret the role of different packaging materials and their physicochemical properties (K5)
3. Establish the concepts of quality evaluation and testing of packaging materials (K4)
4. Asses the criteria for selecting a packaging material for a specific application (K5)
5. Develop the packaging materials suitable for newer processing techniques (K6)

Books Recommended

- Modern food packaging, Indian Institute of Packaging, 1998
- Profile on food packaging/C.F.T.R.I and Indian Institute of packaging, 1995.
- Food packaging and preservation by M.Malthlouthi, 1994
- Food and Packaging Interactions by Risch.S.H. 1991
- Handbook of Food Packaging by F.A. Paine and H.Y. Paine 1983
- Food Packaging Technology (Vol.1 & 2) by G. Bureau and J.L.Multon, 1996

Course Type	Course Code	Subject	Credit	Marks	Total Hours (L+T)
Elective	FDT 2075	**Basics of Human Nutrition**	**3**	**50**	**(30+15)**

Prerequisite

None

Course Objectives

1. To grasp basic concepts of energy value of foods and human daily need for energy.
2. To comprehend the role and requirement of macronutrients and micronutrients in health.
3. To impact of food processing/storage, interactions, and fortification on nutritional quality.
4. To understand role of diet in disease management and special nutritional needs.
5. To interpret the nutritional needs as a lifecycle approach.
6. To develop preliminary understanding of emerging areas of nutrition.

Unit No.	Syllabus	L+T
1	**Introduction to human nutrition** Introduction to human nutrition, energy value of foods and its determination by calorimetry and from proximate principles, daily calorie needs for basal metabolism, physical activity and diet induced thermogenesis.	**5+2.5**
2	**Dietary requirements of nutrients** Requirements and role of carbohydrates, lipids, water, vitamins, and minerals in human health, recommended dietary allowance (RDA), dietary sources.	**5+2.5**
3	**Role of proteins** Requirements and role of proteins, in human health, RDAs, dietary sources and estimation of protein quality- *in vitro* and *in vivo* methods, anti-nutritional factors in plant foods.	**5+2.5**
4	**Different types of diets** Diet vs Disease, therapeutic diets, dietetic foods, health foods, formulation of diets and foods for special needs, sports nutrition.	**5+2.5**
5	**Nutrition management** Techniques of diet and health surveys, assessment of nutritional status, lifecycle nutrition, infant nutrition and infant foods, geriatric nutrition and geriatric foods, maternal nutrition	**5+2.5**
6	**Advances in nutrition** Effect of processing, preservation and storage on nutritional quality of foods, nutrient interactions, food fortification, nutritional labelling, nutraceuticals, functional foods and introduction to nutrigenomics.	**5+2.5**

Course Outcomes

Student will be able to ….

1. Grasp basic concepts of energy value of foods and human daily need for energy.
2. Comprehend the role and requirement of macronutrients and micronutrients in health.
3. Impact of food processing/storage, interactions, and fortification on nutritional quality.
4. Understand role of diet in disease management and special nutritional needs.
5. Interpret the nutritional needs as a lifecycle approach.
6. Develop preliminary understanding of emerging areas of nutrition.

Books Recommended

- Mehtab S.Bamji, Kamala Krishnaswamy. (2009), *Textbook of Human Nutrition,* 3 rd Ed. Oxford & IBH.
- Joshi SA. (2009). *Nutrition and Dietetics*. Tata McGraw Hill.
- Michael Gibney. (2009) *Introduction to Human Nutrition* (2 nd Ed.). Wiley Blackwell.
- Khanna K, Gupta S, Passi SJ, Seth R; Mahna R. (1997). *Nutrition and Dietetics*. Phoenix Publications.
- Swaminathan M. (1974). *Essentials of Foods and Nutrition*. Vol. II. Ganesh & Co.
- Shils, Shike, Olson, (1998), *Modern Nutrition in Health and Disease.* Lippincott Williams & Wilkins.
- L. Kathleen Mahan, Sylvia Escott-Stump, (1999), *Krause's Food, Nutrition and Diet Therapy*, Saunders.

Course Type	Course Code	Subjects	Credit	Marks	Total Hours (L+T)
Elective	FDT 2002	**Food Safety and Toxicology**	**3**	**50**	**(30+15)**

Prerequisite

Microbiology, biochemistry

Course Objectives

1. To investigate different types of hazards associated with foods and risk assessment for the hazards and safety evaluation systems (K4)
2. To describe the principles of toxicity testing in foods, role of additives in toxicity, and define sources of food allergens (K4)
3. To evaluate the action of different toxic compounds of chemical and biological origin (K4)
4. To interpret the mechanisms of action of various microbial toxins in foods (K5)
5. To propose appropriate detoxification strategies for microbial toxins (K5)

No.	Syllabus	L+T
1	Types of food hazards: biological, chemical and physical; Risk assessment; Existing and emerging pathogens due to globalization of food trade; Newer systems of safety evaluation such as HACCP	**10+5**
2	Testing of food ingredients & additives; Animal studies including LD50; Ames test for teratogenicity; Natural toxic constituents in plant foods; Shellfish poisoning; Chemicals from processing such as fumigants, chlorinated solvents, autoxidation products, carcinogens in smoked foods and pyrolysis, pesticides and herbicides	**10+5**
3	Intentional and unintentional additives; Toxicity due to microbial toxins including botulinum and staphylococcal toxins, mycotoxin and due to other food pathogens; Food allergy and intolerance; Detoxication strategy	**10+5**

Course Outcomes

Student will be able to ….

1. Analyze different types of hazards associated with foods and risk assessment for the hazards and safety evaluation systems (K4)
2. Explain the principles of toxicity testing in foods, role of additives in toxicity, and define sources of food allergens (K4)
3. Analyze the action of different toxic compounds of chemical and biological origin (K4)
4. Interpret the mechanisms of action of various microbial toxins in foods (K5)
5. Suggest appropriate detoxification strategies for microbial toxins (K5)

Books Recommended

- Handbook of food toxicology by S. S. Deshpande
- Nutritional and safety aspects of food processing by Tannenbaum SR
- Microbiological safety of food by Hobbs BC, 1973,
- Chemical toxicology of food by Galli, C.L, 1978
- Principle method of toxicology by Andrew Wallace Hayes, 2001
- Food toxicology by William Helferich, Karl Winter, 2001
- The food safety information handbook by Cynthia A. Robert, 2009

Course Type	Course Code	Subjects	Credit	Marks	Total Hours (L+T)
Elective	FDT 2077	**Enzymes in Food and Feed Industry**	**3**	**50**	**(30+15)**

Prerequisite

Biochemistry

Course Objectives

1. To highlight the action and mechanism of microbial enzymes and fermentative production of enzymes followed by isolation and purification (K4)
2. To analyze the role of specific enzymes in the processing of dairy, bakery, brewery, fruit and vegetable products, plantation crops (K4)
3. To analyze the role of specific enzymes in starch industry, confectionary, protein hydrolysis, extraction of oil (K4)
4. To analyze the role of specific enzymes in processing of meat, seafood and poultry products, waste management, animal feed industry (K4)
5. To analyze the role of specific enzymes as biosensors, additives, in packaging, and describe the concept of recombinant enzymes and safety of enzymes (K4)

No.	Syllabus	L+T
1	**Introduction to enzymes in food industry** Introduction to enzymes used in Food industry, Objectives of using enzymes in food processing and in food product development, Merits and demerits of using enzymes, Sources of enzymes, Microbial enzymes and their advantages/ disadvantages, Commercially important enzymes used in Food industry and their mode of action, Overview of applications of enzymes in the Food industry, Newer enzymes and their actual and potential applications, Fermentative production of enzymes used in food industry by SSF or SmF, Recovery and purification of enzymes	10+5
2	**Enzyme Applications in foods** Use of enzymes in: Dairy, Bakery, Brewery, Fruit and Vegetable Processing, Plantation Products, Starch industry and confectionery, Protein hydrolysis for protein hydrolysate and bioactive peptides, Oilseeds processing, formation of TAGs, extraction of fish oil, meat, seafood (surimi product), poultry, eggs, treatment of wastes from food industry, flavor bio-transformations.	10+5
3	**Applications of enzymes in Feed industry** Use of enzymes in poultry feed, animal feed.	4+2
4	**Advances in utilization of enzymes** Enzymes in biosensors, Enzymes as additives e.g. antioxidant or antimicrobial, Novel food applications of enzymes, Enzymes in active packaging and in edible coatings and films, safety of enzymes used in foods, food grade enzymes, Immobilization of enzymes for food applications, Recombinant enzymes from GMO.	6+3

Course Outcomes

Student will be able to ….

1. Highlight the action and mechanism of microbial enzymes and fermentative production of enzymes followed by isolation and purification (K4)
2. Analyze the role of specific enzymes in the processing of dairy, bakery, brewery, fruit and vegetable products, plantation crops (K4)
3. Analyze the role of specific enzymes in starch industry, confectionary, protein hydrolysis, extraction of oil (K4)
4. Analyze the role of specific enzymes in processing of meat, seafood and poultry products, waste management, animal feed industry (K4)
5. Analyze the role of specific enzymes as biosensors, additives, in packaging, and describe the concept of recombinant enzymes and safety of enzymes (K4)

Books Recommended

- Robert Rastall., (2007), *Novel Enzyme Technology for Food applications*, 1st ed, CRC Press, U.S.
- Marwaha, (2002). *Food Processing: Biotechnological Applications,* Asiatic Publishers, New Delhi

Course Type	Course Code	Subjects	Credit	Marks	Total Hours (L+T)
Elective	FDT 2025	Food Process and Equipment Design	3	50	(30+15)

Prerequisite

Food Engineering, Food Process Engineering

Course Objectives

1. To explain the basic design consideration for food plant and equipment
2. To describe the design criteria for different unit operations involved in food processing
3. To design and analyse different food equipment and processes

Unit No.	Syllabus	L+T
1	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. Design considerations for location of food plant; Equipment layout and ventilation in food process plants.	4+2
2	Materials of construction: welding and machining of stainless steel; Design of storage vessels for liquid food and grains; Pressure vessels design and design of vessel for drum drying; Design of fluid conveyance system; pipe, sanitary pipe fitting and valves; Performance characteristics and selection of centrifugal and positive displacement sanitary pumps. 6. Performance characteristics and selection of fans, blowers, ejector compressors and vacuum pumps.	8+4
3	Design of CIP system; Design of heat exchanger equipment-plate, scraped surface and extended surface for heating and cooling of gas and liquid. Design of evaporator calandria, vapour separator and condenser, Bulk milk cooler; Advanced dryer system;	10+5
4	Design aspects of different mechanical operations like homogenization, extrusion, filtration, differential settling, size reduction applied for food processes	8+4

Course Outcomes

Student will be able to ….

1. Apply the concept of material and energy balances, flow sheet and plant layout in designing the food processes (K4)
2. Describe the applicability of different materials of construction, and design criteria for pumps, storage and pressure vessel. (K4)
3. Design different CIP system specific to food processes (K3)
4. Design the equipment and mechanical operations required for specific food processes (K4)
5. Design the equipment required for different thermal processes in food (K4)

Books Recommended

- Handbook of Food Engineering, Dennis R. Heldman,Daryl B. Lund,Christina Sabliov, 2006
- Food Process Design, Zacharias B. Maroulis, George D. Saravacos, CRC Press, 2013
- Processing and Conveying Equipment Design. Phirke P.S. (2004), Publisher-Jain Brothers, New Delhi
- Food Processing Operations Analysis, H. Das, Asian Books Private Limited, 2005

Course Type	Course Code	Subjects	Credit	Marks	Total Hours (L+T)
Elective	FDT 2026	Experimental Design and Optimization in Food Processing	**3**	**50**	**(30+15)**

Prerequisite

Engineering Mathematics, Statistics

Course Objectives

1. To explain the basic concept of experimental design in food processes
2. To describe the concept of mathematical modelling in food systems
3. To familiarize students with different statistical analysis and optimization methods applied for food processing

Unit No.	Syllabus	L+T
1	Identification of design, operating and performance parameters in different food processing operations; Statistical tests; significance tests (t-tests, z-test, chi square test); Analysis of Variance (one way & two way), hypothesis testing.	7+3
2	Concept of Experimental Design: Factorial (Full and mixed), fractional factorial and rotatable central composite, face centered composite experimental design. Response surface methodology; Numerical optimization	5+3
3	Developing mathematical relationship between the independent and dependent variables affecting the food processing operations. Developing empirical equations using experimental data.	8+2
4	Predictive modelling using Neural network. Application of Genetic algorithm in process optimization; Fuzzy logic for descriptive sensory analysis and ranking of foods.	7+5
5	Multivariate statistical analysis; MANOVA; Principal component analysis; Multiple linear and non-linear regressions; Cluster analysis; Partial least square regression	3+2

Course Outcomes

Student will be able to ….

1. Analyse different the statistical tests and hypothesis testing methods used in food processes (K4)
2. Apply the concept of experimental design in different food processes (K3)
3. Develop empirical equation using experimental data (K6)
4. Evaluate different types of optimization techniques in food processing (K5)
5. Apply multivariate analysis on a data set (K3)

Books Recommended

- Food Processing Operations Analysis, H. Das, Asian Books Private Limited, 2005
- Design and Analysis of Experiments, Douglas Montgomery, 2001
- An Introduction to Neural Networks, Kevin Gurney, 1997