DEPARTMENT OF BIOTECHNOLOGY

ANNA UNIVERSITY, CHENNAI

Vision:

The Department of Biotechnology is committed to evolve as a world class science and technology centre by integrating quality and ethics in teaching and research

Mission:

The mission of the department is

- Empowering students with an unique multidisciplinary learning experience and fostering the young minds to develop as a researcher, entrepreneur, etc.
- Enhancing academic and industrial collaborative research initiatives for the development of biotechnological, food and therapeutic products.
- Emphasizing and equipping the students towards innovative industrial and research developments.
- Serving the society with utmost commitment, integrity, enthusiasm, and dedication.

ANNA UNIVERSITY, CHENNAI: 600 025
UNIVERSITY DEPARTMENTS
M. TECH. FOOD TECHNOLOGY
REGULATIONS – 2023
CHOICE BASED CREDIT SYSTEM (CBCS)

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

The Master's program in Food Technology curriculum is designed to prepare the graduates to

1. Design and develop technologies for industrial production of food products.
2. Analyse, evaluate and offer technical solutions for the food sector.
3. Participate in research and development projects leading to research degree.
4. Acquire innovative ideas and integrate with existing knowledge in the field.
5. Become an entrepreneur and be part of a supply chain management.

Programme Outcomes (PO)

PO	Programme utcomes
1.	Ability to independently carry out research/investigation and development work to solve practical problems
2.	Ability to write and present a substantial technical report/document
3.	Able to demonstrate a degree of mastery over the area as per the specialization of the programme. The mastery shall be at a level higher than the requirements in the appropriate bachelor programme.
4.	Able to Identify, formulate and solve problems in areas of food storage, food processing & preservation, analytical and sensory techniques, food packaging and food engineering.
5.	Design new processes, modifying the existing system to improve the performance and to satisfy the constraints.
6.	Apply various food analytical tools and techniques to improve the efficiency of the process and product.

PEO/PO Mapping:

PEO	Programme Outcomes (PO)					
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
I.	**2**	**1**	**3**	**3**	**3**	**1**
II.	**-**	**-**	**2**	**1**	**2**	**3**
III.	**3**	**2**	**3**	**2**	**3**	**3**
IV.	**3**	**-**	**3**	**3**	**3**	**2**
V.	**2**	**-**	**2**	**2**	**2**	**2**

PROGRAM ARTICULATION MATRIX

Year	Semester	Course name	PO					
			1	2	3	4	5	6
I	I	Applied Statistics and Numerical Methods in Food Technology	2	2	3	-	1	2
		Research methodology and IPR						
		Transport Phenomena in Food Process	2.67	2.00	3.00	3.00	3.00	1.33
		Food Storage Engineering	2.25	2.40	2.75	2.25	2.50	2.33
		Food EngineeringLaboratory	2.33	2.50	3.00	2.00	3.00	2.00
I	II	Trends in Food packagingsystem	2.80	1.75	2.50	2.75	2.75	2.00
		Emerging Food Processing Techniques	2.00	2.75	2.60	2.50	2.20	2.00
		Non-Destructive QualityEvaluation of Foods	2.00	2.67	2.00	2.75	1.67	1.67
		Advanced Food Packaging systems Lab	3.00	3.00	2.33	2.67	3.00	2.00
		Emerging Food Processing Techniques lab	3.00	3.00	2.33	2.67	3.00	2.00
II	III	Food AnalyticalTechniques lab	2.33	1.67	1.67	2.67	2.67	3.00
		Food Storage Engineering lab	2.00	2.00	1.67	1.67	2.50	2.00
		Industrial Internship	2.33	2.00	2.33	2.33	2.33	2.67
		Project Work I	2.75	1.67	3	3.00	2.25	2.00
II	IV	Project Work II	3.00	2.00	2.33	2.00	2.50	3.00

ANNA UNIVERSITY, CHENNAI
UNIVERSITY DEPARTMENTS
M. TECH. FOOD TECHNOLOGY
REGULATIONS – 2023
CHOICE BASED CREDIT SYSTEM
CURRICULUM AND SYLLABI FOR I TO IV SEMESTERS

SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	FD3101	Applied Statistics and Numerical Methods in Food Technology	FC	3	1	0	4	4
2.	RM3151	Research methodology and IPR	RMC	2	1	0	3	3
3.	FD3102	Transport Phenomena in Food Process	PCC	3	1	0	4	4
4.	FD3103	Food Storage Engineering	PCC	2	1	0	3	3
5.		Professional Elective I	PEC	3	0	0	3	3
6.		Professional Elective II	PEC	3	0	0	3	3
7.		Professional Elective III	PEC	3	0	0	3	3
PRACTICALS								
8.	FD3111	Food Engineering Laboratory	PCC	0	0	4	4	2
			TOTAL	**19**	**4**	**4**	**27**	**25**

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	FD3201	Trends in Food packaging system	PCC	3	0	0	3	3
2.	FD3202	Emerging Food Processing Techniques	PCC	3	0	0	3	3
3.	FD3203	Non-Destructive Quality Evaluation of Foods	PCC	3	0	0	3	3
4.		Professional Elective IV	PEC	3	0	0	3	3
5.		Professional Elective V	PEC	3	0	0	3	3
6.		Professional Elective VI	PEC	3	0	0	3	3
PRACTICALS								
7.	FD3211	Advanced Food Packaging systems Laboratory	PCC	0	0	4	4	2
8.	FD3212	Emerging Food Processing Techniques Laboratory	PCC	0	0	4	4	2
9.	FD3213	Industrial Internship	PCC	0	0	0	0	0
			TOTAL	**18**	**0**	**8**	**26**	**22**

**** Minimum of 4-week industry internship**

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	FD3311	Food AnalyticalTechniques Laboratory	PCC	0	0	4	4	2
2.	FD3312	Food Storage Engineering Laboratory	PCC	0	0	4	4	2
3.	FD3313	Industrial Internship	EEC	-	-	-	-	2
4.	FD3314	Project Work I	EEC	0	0	12	12	6
			TOTAL	**0**	**0**	**20**	**20**	**12**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	FD3411	Project Work II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL NO. OF CREDITS: 71

PROFESSIONAL ELECTIVE COURSES

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	FD3001	Engineering Properties of Foods	PEC	3	0	0	3	3
2.	FD3002	Food Process Automation	PEC	3	0	0	3	3
3.	FD3003	Food Process modelling and simulation	PEC	3	0	0	3	3
4.	FD3004	Advanced Food Fermentation Technology	PEC	3	0	0	3	3
5.	FD3005	Dairy Technology	PEC	3	0	0	3	3
6.	FD3006	Cereal and Grain Process Technology	PEC	3	0	0	3	3
7.	FD3007	Pulse and Oilseed Process Technology	PEC	3	0	0	3	3
8.	FD3008	Meat and Poultry Process Technology	PEC	3	0	0	3	3
9.	FD3009	Marine Food process Technology	PEC	3	0	0	3	3
10.	FD3010	Spices, condiments and Plantation Products	PEC	3	0	0	3	3
11.	FD3011	By-product utilization in Food Industries	PEC	3	0	0	3	3
12.	FD3012	Flavour Technology	PEC	3	0	0	3	3
13.	FD3051	Functional Foods	PEC	3	0	0	3	3
14.	FD3013	Food legislation And standards	PEC	3	0	0	3	3
15.	FD3014	Control of Food Infestations	PEC	3	0	0	3	3
16.	FD3015	Establishment and Management of Food Industry Systems	PEC	3	0	0	3	3
17.	FD3016	Advanced Instrumentation for Food Safety and Quality	PEC	3	0	0	3	3

18.	FD3017	Food Safety and Risk analysis	PEC	3	0	0	3	3
19.	FD3018	Beverage Technology	PEC	3	0	0	3	3
20.	FD3019	Food Nutrigenomics	PEC	3	0	0	3	3
21.	FD3020	Food Informatics	PEC	3	0	0	3	3
22.	FD3021	Food Product Design and Development	PEC	3	0	0	3	3
23.	FD3022	Sensory Attributes and Evaluation of Foods	PEC	3	0	0	3	3
24.	FD3023	Advanced Food Microbial Analysis	PEC	3	0	0	3	3
25.	FD3024	Applications of Enzymes in Food Industry	PEC	3	0	0	3	3
26.	FD3025	Nanotechnology in food applications	PEC	3	0	0	3	3
27.	FD3026	Genetic Engineering and Genetically Modified Foods	PEC	3	0	0	3	3
28.	FD3027	Food Structuring Techniques	PEC	3	0	0	3	3
29.	FD3028	Food Supply Chain Management	PEC	3	0	0	3	3
30.	FD3029	Inventory management	PEC	3	0	0	3	3

LIST OF PROFESSIONAL CORE COURSES (PCC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			Lecture	Tutorial	Practical	
1.	FD3102	Transport Phenomena in Food Engineering	3	1	0	4
2.	FD3103	Food Storage Engineering	3	0	0	3
3.	FD3111	Food engineering lab	0	0	4	2
4.	FD3201	Trends in Food Packaging system	3	0	0	3
5.	FD3202	Emerging Food Processing Techniques	3	0	0	3
6	FD3203	Non-Destructive Quality Evaluation of Foods	3	0	0	3
7.	FD3211	Advanced food packaging systems lab	0	0	4	2
8.	FD3212	Emerging food processing techniques lab	0	0	4	2
9.	FD3311	Food Analytical Techniques lab	0	0	4	2
10.	FD3312	Food storage engineeringlab	0	0	4	2
TOTAL CREDITS						**23**

LIST OF EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			Lecture	Tutorial	Practical	
1.	FD3312	Industrial Internship	0	0	0	2
2.	FD3314	Project work I	0	0	12	6
3.	FD3411	Project work II	0	0	24	12
TOTAL CREDITS						**20**

CREDIT SUMMARY

	M.Tech Food Technology					
	SUBJECT AREA	**CREDITS PER SEMESTER**				**CREDITS TOTAL**
		I	**II**	**III**	**IV**	
1.	FC	4	-	-	-	**4**
2.	PCC	9	13	4	-	**26**
3.	PEC	9	9	-	-	**18**
4.	RMC	3	-	-	-	**3**
5.	EEC	-	-	8	12	**20**
6.	**TOTAL CREDIT**	**25**	**22**	**12**	**12**	**71**

Semester I

FD3101APPLIED STATISTICS AND NUMERICAL METHODS INFOOD TECHNOLOGL T P C
3 1 0 4

OBJECTIVES

The course aims to

- train the students to address the mathematical problems involved in biological sciences
- educate students on methods of sampling, quantitative and statistical problems pertaining to food technology.

UNIT I ROOT FINDING METHOD, SYSTEM OF LINEAR EQUATIONS ANDINTERPOLATION 12

Root finding – Newton Raphson method – Simultaneous linear equations – Direct method – Gauss elimination method – Pivoting – Gauss Jordan method – Iterative methods – Jacobi and Gauss Seidal methods – Difference table – Newton's forward and backward interpolation – Newton's divided differences – Lagrangian interpolation.

UNIT II NUMERICAL INTEGRATION AND INITIAL VALUE ROBLEM FOR ORDINARY DIFFERENTIALEQUATIONS 12

Trapezoidal and Simpson's 1/3 rules – Taylor series and Euler methods – Fourth order Runge-Kutta method for first order differential equations – Predictor-corrector method – Adam-Bashforth method

UNIT III EMPIRICAL STATISTICS 12

Types of sampling – Description of discrete and continuous data – Measures of Central tendency and dispersion for grouped and ungrouped data – Measures of position – Box and Whisker plot.

UNIT IV ESTIMATION THEORY 12

Unbiased Estimators – Method of Moments – Maximum Likelihood Estimation – Curve fitting by Principle of least squares – Regression Lines.

UNIT V TESTING OF HYPOTHESIS 12

Sampling distributions – Type I and Type II errors – Tests based on Normal, t, 2 and F distributions for testing of mean, variance and proportions – Tests for Independence of attributes and Goodness of fit.

TOTAL: 60 PERIODS

OUTCOMES:

At the end of the course, the student will be able to

CO1 Understand basic problem solving techniques.
CO2 Learn about advance integral and differential problems.
CO3 Understand different statistical analysis methods.
CO4 Appraise on estimation theory
CO5 Understand about sampling distribution

REFERENCES:

1. Grewal, B.S., "Numerical methods in Engineering and Science", 10 th Edition, Khanna Publishers, New Delhi, 2014.
2. Gupta S.C. and Kapoor V.K.," Fundamentals of Mathematical Statistics", Sultan Chand & Sons,11th Edition (Reprint), 2019.
3. Iyengar, S. R. K., Jain, R. K. and Mahinder Kumar Jain, "Numerical Methods for Scientific and Engineering Computation", 6 th Edition, New Age International Publishers, New Delhi, 2012.
4. Miller, I. and Miller, M., "John E. Freund's Mathematical Statistics", Pearson, 8th Edition, 2013.
5. Miller, I. and Freund, J. E., "Probability and Statistics for Engineers", Pearson, 9th Edition, 2017.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	3	-	1	2
	2	2	3	-	1	2
CO3	2	2	3	-	1	2
CO4	2	2	3	-	1	2
CO5	2	2	3	-	1	2
Avg	2	2	3	-	1	2

RM3151 RESEARCH METHODOLOGY AND IPR L T P C
2 1 0 3

UNIT I RESEARCH PROBLEM FORMULATION 9

Objectives of research, types of research, research process, approaches to research; conducting literature review- information sources, information retrieval, tools for identifying literature, Indexing and abstracting services, Citation indexes, summarizing the review, critical review, identifying research gap, conceptualizing and hypothesizing the research gap

UNIT II RESEARCH DESIGN AND DATA COLLECTION 9

Statistical design of experiments- types and principles; data types & classification; data collection - methods and tools

UNIT III DATA ANALYSIS, INTERPRETATION AND REPORTING 9

Sampling, sampling error, measures of central tendency and variation,; test of hypothesis- concepts; data presentation- types of tables and illustrations; guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript; guidelines for wring thesis, research proposal; References – Styles and methods, Citation and listing system of documents; plagiarism, ethical considerations in research

UNIT IV INTELLECTUAL PROPERTY RIGHTS 9

Concept of IPR, types of IPR – Patent, Designs, Trademarks and Trade secrets, Geographical indications, Copy rights, applicability of these IPR; , IPR & biodiversity; IPR development process, role of WIPO and WTO in IPR establishments, common rules of IPR practices, types and features of IPR agreement, functions of UNESCO in IPR maintenance.

UNIT V PATENTS 9

Patents – objectives and benefits of patent, concept, features of patent, inventive steps, specifications, types of patent application; patenting process - patent filling, examination of patent, grant of patent, revocation; equitable assignments; Licenses, licensing of patents; patent agents, registration of patent agents.

TOTAL: 45 PERIODS

REFERENCES:

1. Cooper Donald R, Schindler Pamela S and Sharma JK, “Business Research Methods”, Tata McGraw Hill Education, 11e (2012).
2. Soumitro Banerjee, “Research methodology for natural sciences”, IISc Press, Kolkata, 2022,
3. Catherine J. Holland, “Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets”, Entrepreneur Press, 2007.
4. David Hunt, Long Nguyen, Matthew Rodgers, “Patent searching: tools & techniques”, Wiley, 2007.
5. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, “Professional Programme Intellectual Property Rights, Law and practice”, September 2013.

FD3102 TRANSPORT PHENOMENA IN FOOD ENGINEERING

L	T	P	C
3	1	0	4

OBJECTIVES

The course aims to

- Acquaint and equip the students with the principles of heat and mass transfer and in food processing
- Equip the students with the latest technologies of dehydration of food products and the design features of different dryers.

UNIT I ENGINEERING PROPERTIES AND HEAT TRANSFER 9

Engineering properties of foods, their significance in processing and handling of food and food products. Introduction to engineering principles – classification of transport processes – conservation of mass andenergy balance – graphical, numerical and mathematical methods. Heat transfer- external and internal resistance, finite objects- temperature time charts. Prediction of temperature in transient heat transfer. Boiling heat transfer- pool boiling- flow boiling. Radiation intensity and properties- radiation shields and radiation effect on temperature measurements.

UNIT II MASS TRANSFER 9

Mass transfer — diffusion process- steady state diffusion of gases through solids, convective mass transfer- unsteady state mass transfer: transient state diffusion of gases. Multicomponent transport: binary systems, mass transport in food processing operations- osmotic dehydration and dimensional analysis.

UNIT III STERILIZATION PROCESS 9

Methods of sterilization and equipment involved- latest trends in thermal processing Sterilization value- definitions-lethal rates-reference temperatures-integrated F values - Arrhenius approach-cooking value-origin and rationale of cooking value-quality retention pasteurization value-process achievementstandards. thermal death rate kinetics - determination of F values: process safety-general method, graphical method, numerical method-analytical methods-formula methods Balls methods, Gillespis method, Hayakawa method-factor affecting F value-microbiological methods inoculated pack method- encapsulated spore method, heat penetration curves, cold point, calculation of processing time and temperature, Process evaluation techniques, optimization and validation of thermal processes

UNIT IV MEMBRANE SEPARATION PROCESS 9

Membrane filtration spectrum - membrane materials and structures - membrane modules-principles of membrane filtration - microfiltration, ultrafiltration, reverse osmosis and nanofiltration processes - transport model, estimation of model parameters, Performance Characteristics, design of membrane systems — batch, feed and bleed systems, single pass system, diafiltration systems, co-current permeate flow system, pilot plant trials, sample design calculations - batch, feed and bleed systems, continuous system, operation of membrane systems, membrane applications in the food industry.

UNIT V DRYING AND DEHYDRATION 9

Psychrometry in relation to drying, residence time equation and calculation, drying of food - innovation and trends in drying technologies, impinging steam drying: basic features, hydrodynamics and heat transfer pulsed fluid bed drying: principles and examples low pressure superheated steam drying: basic principle of LPSSD, LPSSD of food and biomaterials, mathematical modelling of LPSSD Airless drying, drying in mobilized beds, vacuum jet drying, acoustic drying, RF vacuum drying, contact sorption drying: mechanism, characteristics of sorbents/carriers, heat pump assisted drying: classification, fundamentals of heat pump dryers, heat and mass transfer mechanisms, optimum use of heat pump indrying systems, innovative heat pump design systems. Sonic drying: basic characteristics of sound, sound generation, mechanism of sonic drying, drying kinetics, sound assisted dryers. pulse combustion drying: principle, combustors design and construction, types of combustors, hybrid drying technologies:

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student will be able to

CO1 Analyse heat transfer, external and internal Resistance, finite objects and temperature time charts.

CO2 Understand validation of a thermal process a Methods of sterilization and equipment involved

CO3 Analyze industrial problems along with appropriate approximations and boundary conditions

CO4 Familiarize with batch, feed and bleed systems, continuous system, operation of membrane systems, membrane applications in the food industry.

CO5 enumerate principle and working of industrial dryers and design dryers specific for food products.

REFERENCES:

1. Bird R. Byron, Warren E. Stewart and Edwin N. Lightfoot. Transport
2. Phenomena. John Wiley & Sons,Inc. New York. 2ND edition 2009.
3. Earle, R.L. Unit Operations in Food Processing. Pergamon Press, Oxford, U.K 2nd edition. 2013.
4. Wilhelm, L.R., D.A. Suter and G.H. Brusewitz. Food and Process Engineering Technology textbook.ASAE, American Society of Agricultural Engineers.1st edition. 2005.
5. Yunus A Cengel. Heat and Mass Transfer. Mc graw Hill Campanies Inc., New York 5th edition . 2011.
6. Holman. J. P. H. Heat Transfer. Mc Graw Hill Campanies Inc., New York 6th edition. 2009.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	2	2	-
CO2	-	2	1	-	1	3
CO3	3	3	3	3	-	2
CO4	3	1	3	3	-	1
CO5	2	2	3	3	3	1
Avg	2.67	2.00	3.00	3.00	3.00	1.33

FD3103 FOOD STORAGE ENGINEERING **L T P C**
2 1 0 3

OBJECTIVES

The course aims to provide In-depth knowledge on safe storage of food materials and design of storage Structures for various categories of food products

UNIT I FOOD GRAIN STORAGE **9**

Grain storage principles- factors- changes during storage. indoor storage system- bag storage, bulk storage, bunkers, cap storage bags outdoor storage system — cold storage, hermetic storage, vacuum and gas storage - moisture movement during bulk storage of grains — pressure distribution in storage bins - grain storage structures - location and material selection for storage building - types - traditional, modern, temporary and permanent storage structures, factors affecting qualities of grains during packaging and storage, functional requirements of storage structures - traditional storage structures in india and their improvements

UNIT II DESIGN OF GRAIN STORAGE SYSTEM **9**

Grain storage ecosystem- biotic and abiotic factors- moisture and temperature migration- cold spots and hot spots. aeration – cooling- dehydration in grain storage, grain storage in silos, bins and godowns-RCC and steel structures - aeration system for various storage structures, grain pressure theories - design of bulk storage structures, bag storage, godowns, theory and nature of grain flow, pressure distribution, flow patterns-hoppers and ducts — design - loading and unloading mechanism. Grain handling equipment - bulk handling of food grains - bulk conveying

equipment - design calculations, design and estimation of energy requirement and damage to biomaterials during mechanical handling -operational features - management and maintenance of grain storage, code of practices for safe storage of food grains.

UNIT III STORAGE OF FRUITS AND VEGETABLES 9

Harvest and pre-harvest factors, pre-storage treatments, controlled and modified atmosphere storage- effect of nitrogen, oxygen, and carbon dioxide on storage of durable and perishable commodities, gas exchange modelling, effect of storage temperature on shelf life in cas and mas; storage of intermediate moisture foods -storage of dehydrated fruits and vegetables. Novel map applications for fresh-prepared produce - MAP gases - testing novel MAP applications - pack houses, CA and MA storage — principles, methods - optimization of storage gas composition, rate
of supply, control systems for O2 and CO2. CA and MA transport technologies and applications.

UNIT IV COLD STORAGE SYSTEM 9

Food cooling and precooling, cooling process parameters – analysis – estimation of cooling time – for liquid, solid; food freezing process -- freezing time estimation, design of food freezers, equipment for refrigeration of liquid, bulky foods and thin/particulate foods, vacuum cooing, cryogenic freezers, thawing. ice manufacture: principles and systems of ice production basic types of ice, ice makers, treatment of water for making ice, brines, freezing tanks, , ice cans, air agitation, quality of ice; low temperature refrigeration: cryogenic fluid and fluid properties; liquefaction; application in food defining overall shelf-life, remaining shelf life in the context of chilled & frozen foods; - deterioration modes of food items; models of quality deterioration- kinetic model; shelf-life model; Q10/q10 model; TTT model for the remaining shelf – life; general procedure for shelf– life testing — the 11 steps procedure. Accelerated shelf-life testing – steps procedure.

UNIT V COLD STORAGE DESIGN AND LOAD ESTIMATION 9

Cold storage — importance — types of cold store - Design of cold storage and air conditioning systems -types of loads in cold storage and their calculations, Products going in cold chain, their temperature and humidity requirements, construction of cold storage, equipment selection, insulating materials, vapour barriers, care and maintenance of cold storage, packaging needs and their compatibility in cold chain, Design of cold storage for food products– Meat product, Fishery Product, Dairy Products. Storage of food commodities - biochemical changes during storage - storage factors affecting losses, storage requirements, thermal design of structures Cooling/Refrigeration load calculations: Load sources, product cooling, conducted heat, convection heat, internal heat sources, heat of respiration, peak load, miscellaneous load Cold chain: Introduction, scope and importance of cold chain in food processing industry and retail chain, components of cold chain and integration, components of cold chain, Cold chain maintenance, Repair and Replacement, refrigerated transport, cold chain and logistics management, Temperature recording devices used during transport, documentation and traceability.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student will be able to

CO1 Describe & analyse bulk storage, bunkers, cap storage bags, temporary & permanent storage structures

CO2 Understand theory and nature of grain flow, pressure distribution, flow patterns-hoppers and design of grain storage structures.

CO3 Differentiate the effect of storage temperature on shelf life of Intermediate moisture Foods -storage of dehydrated fruits and vegetables

CO4 Determine freezing Time, design food freezers and estimate shelf life of frozen food

CO5 Design cold storage facility, calculate refrigeration load & cold chain facility for food.

REFERENCES:

1. Chakravarty,Post-Harvest Technology of Cereals, Pulse and Oilseeds. IBH Publ. Mahajan and Goswami. Food and Process Engineering. Third edition 2019.

2. Ojha TP and Michael AM. Principles of Agricultural Engineering. Jain Brothers.15th edition Jan2023.
3. Multon, J.L. (ed). Preservation and storage of grains, seeds and their by - products. CBS Publishersand Distributors, 1989.
4. Koelet, P.C. and Gray T. B. Industrial refrigeration, Principles, Design and Applications.CRC, 2017.
5. Mascheroni. R.H. Operations in Food Refrigeration, CRC, 2012.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	3	1
CO2	2	1	-	3	2	3
CO3	-	3	3	1	-	3
CO4	3	3	3	-	2	-
CO5	1	2	2	3	3	-
Avg	2.25	2.40	2.75	2.25	2.50	2.33

FD3111 FOOD ENGINEERING LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES

The course aims to educate students on applications of heat and mass transfer principles and enablestudents to develop models for optimization of process conditions for different food applications

LIST OF EXPERIMENTS

1. Determination of engineering properties of foods - density, particle size, porosity, colour,texture, viscosity, specific heat, freezing point depression.
2. Separation of immiscible phase using appropriate centrifuge, fractional distillation of multicomponent mixtures
3. Determination of particle size index of powdered food materials
4. Determination of freezing curves for selected fresh fruits and vegetables
5. Convective heat transfer through IR radiation and its effect on baking of food products.
6. Construction of weibull diffusion model for diffusion of water out of food samples duringosmosis.
7. Calculation of D, Z and F value in retort and process time calculation
8. Study of ultra-filtration and reverse osmosis separation process
9. Performance evaluation of rapid extraction (filtration) for different particle size of fruits.
10. Construction of mathematical models for low pressure superheated steam drying of foodproducts.
11. Canning and bottling of food products for commercial sterility.
12. Optimization of process conditions for drying of food products in fluidized bed dryers, spraydryer.
13. Texture and Colour Measurement of foods

TOTAL: 60 PERIODS

OUTCOMES:

At the end of the course, the student will be able to

CO1 Analyse optimize production processes, improve product quality, and ensure consistency in food manufacturing.

CO2 Construct efficient and reliable transportation of food particles which can lead to the design and implementation of improved pneumatic conveying systems in food processing industries.

CO3 Determine the desired process duration, and improve the quality and shelf life of food products

REFERENCES:

1. Asimov, "Introduction to Design", 1st edition, Prentice Hall, 1962.
2. Halbert, "Resisting Intellectual Property", 1st edition, Taylor & Francis Ltd, 2007.
3. Mayall, "Industrial Design", 1st edition, McGraw Hill, 1992.
4. Niebel, "Product Design", 6th edition, McGraw Hill 2015.
5. Ranjit Kumar, "Research Methodology: A Step by Step Guide for beginners" 4th Edition,2014

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	3	3	3
CO2	3	2	-	1	-	-
CO3	1	3	3	2	3	1
Avg	2.33	2.50	3.00	2.00	3.00	2.00

FD3201 TRENDS IN FOOD PACKAGING SYSTEM

L	T	P	C
3	0	0	3

OBJECTIVES

The course aims to

- Educate and equip students with the latest food packaging technologies, enabling them to adopt these advancements in the food industry
- Facilitate students in gaining in-depth knowledge in the design and development of packaging systems for various categories of food products.

UNIT I PACKAGING SYSTEMS AND METHODS 9

Bag — in - box; microwave packaging; retort pouch technology, active packaging; intelligent packaging, antimicrobial packaging; bio-degradable packages, non-migratory bioactive polymers (NMBP)in food packaging - types and applications; application of nanotechnology in laminates, edible packages; bacterial production of polymer, packaging-flavour interactions, factors affecting flavour absorption, effect of irradiation of polymeric packaging material on the formation of volatile compounds, protective packaging of foods; packaging of food products sensitive to oxygen, light, moisture. Case studies: packaging and lipid oxidation, modelling lipid oxidation and absorption shelf life evaluation of packaged food, package characterization and testing; time - temperature indicators (TTIs), defining and classifying TTIs, requirements for TTIs.

UNIT II PACKAGING MATERIAL CHARACTERIZATION AND EQUIPMENT 9

Paper and paperboard — raw materials, manufacturing stages, pulping techniques, types of paper, specialty papers; glass — types of glass, properties, glass manufacturing, bottle forming process & designs, usp; cartons – designs, manufacturing, applications, corrugated fibre boards, fibre drums; plastic – classification, glass transition, melting, degradation temperature, properties of plastic – PE,PP, PS, PVC, EVA, PA, EVOH, PLA and others; metals in packaging and their properties; container cleaning – air blast, ionized air blast, water rinse, wash and rinse, aggressive wash and rinse, sterilization, bottle orienting systems. Filling equipment and method - solid, liquid, semi - solid food -types of fillers - filler for glass bottle, paper bottle, pouches, plastic cup thermoforming equipment; form-fill - seal equipment, sealing equipment, labelling, and capping, canning and cartoning equipment. industrial packaging: unitizing – shrink and stretch wrapping, palletizing, containerizing, rigid and semi-rigid containers; thermoformed packages – skin packaging and blister packaging; flexible containers; form – fill - seal systems.

UNIT III STRUCTURAL AND GRAPHIC DESIGN IN FOOD PACKAGING 9

Information required before designing a package for food product: product, targeted consumers,

marketing a product, branding requirements, style of packaging, budget – steps in designing of food packaging. Creating information architecture for printing, evaluation of packaging design, reuse of containers; child resistant package - design of security features, barcodes, RFID vision/inspection, metal detectors and x-ray inspectors, smart tracking systems, case study. Graphic design: typography, color, illustration, marketing studies, package aesthetics, decoration aspects. Closure design: function,types, selection considerations, closure dimensioning, metal closures, closure seals, plastic closures, injection moulds and closure design, tamper evident closures, child resistant closures. Special closures and functions.

UNIT IV PACKAGING OF FRESH FOODS 9

Food packaging laws and regulation, food labelling, packaging requirements for different foods and processing methods - general classification and packaging types, varieties and trends; packaging of convenience foods; packaging of food products – fresh fruits and vegetables, packaging of fruit juices, packaging of jams and jellies, packaging of pickles and chutneys, packaging of fats and edible oils, packaging of break - fast cereals, packaging of tea, coffee & other beverage products; packaging of soft drinks; packaging of bakery products - bread, biscuits & cakes; packaging of snack foods; packaging of ready - cook products; packaging of spices, condiments, oleoresins.

UNIT V PACKAGING OF PROCESSED FOODS 9

Packaging of meat and poultry products; packaging of fish and other sea - foods; packaging of dairy products ; packaging requirements for thermal -processed, dehydrated, frozen, irradiated and other specially processed foods - packaging for defence food, space food, high energy food for high altitude, functional foods, recent trends and advancements in food packaging

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student will be able to

CO1 Demonstrate smart food packaging techniques and design indicators for food quality evaluation.

CO2 Identify and choose suitable packaging system for various food products:

CO3 Describe on morphology of packaging materials and design closures for food products

CO4 Describe food packaging laws & regulations and design a packaging system for shelf lifeextension of fresh food products

CO5 Construct a packaging system for shelf-life extension of processed food products

REFERENCES:

1. Robertson,G.L.“Food Packaging: Principles and Practice”, 3rd Edition, Taylor & Francis,2012. .
2. Mathlouthi, M. “Food Packaging and Preservation” 1ST edition, Aspen Publisher2013.
3. Han,J.H.(Ed.)“Innovations in Food Packaging”, 2nd edition Elsevier/AcademicPress,2014.
4. Douglas Riccardi,“Food Packaging Design”1st editionDesign Media PublishingLimited,2015.
5. Marianne R.Klimchuk and Sandra A. Krasovec, “Packaging Design: Successful Product Branding from Concept to Shelf”, 2nd edition, 2013.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	3	3	2
CO2	3	1	2	3	-	2
CO3	3	2	-	3	2	3
CO4	2	1	3	-	3	1
CO5	3	3	2	2	3	-
Avg	2.80	1.75	2.50	2.75	2.75	2.00

FD3202 EMERGING FOOD PROCESSING TECHNIQUES

L	T	P	C
3	0	0	3

OBJECTIVES

The course aims to familiarize students with advanced food processing techniques and their applications.

UNIT I PRESSURE AND HEAT TREATMENT 9

Non thermal technologies in preservation of foods–necessity and advantages–status and trends of non-thermal technologies in preservation of foods-high pressure treatment of food–governing principles– process equipment, processing and effect on microorganisms -combined pressure-heat treatment on quality attributes of foods – effect on microorganism, texture, enzyme activity, nutrients – processing of salads and ready meals, high pressure freezing – ultra high static pressure, High hydrostatic pressure processing of cereals and pulses; high pressure CO2 processing of foods

UNIT II ULTRASOUND, LIGHT AND MICROWAVE 9

Ultrasound–principle of operation–mechanism of inactivation of microorganisms and enzymes– uv light and pulsed light preservation–principles of operation–microbial inactivation mechanism, microwave technology-principle–application–sterilization, tempering, drying, puffing, coagulation and other processing applications, ultrasonic assistance of food freezing-power ultrasonic processing; electron beam processing of food

UNIT III PEF AND OHMIC HEATING 9

Pulsed electric field–principles of operation–equipment–processing-control parameters– microbial inactivation mechanism–enzyme inactivation - effects on solid and fluid food - nutritional and quality parameters, ohmic heating–principle–equipment–effect on food quality and microbes inactivation- modelling of ohmic heating-ohmic heating application to specific foods

UNIT IV MAGNETIC FIELD AND RADIATION PROCESSING 9

Introduction to irradiation technologies–general modification–equipment and operational parameters– food safety and shelf life of irradiated liquid foods-oscillating magnetic fields-magneticfiles- generation- mechanisms- inactivation of microorganisms – magnetic fields in food preservation, infra-red– mechanism of IR absorption by food–IR emitters and spectral bands – applications. induced electric field (IEF) – mechanism and application-oscillating magnetic field processing

UNIT V OZONE, COLD PLASMA AND RF PROCESSING 9

Generation of ozone–batch and continuous process of ozone for inactivation–factors affecting efficacy of ozone processing–effect on food quality–methods of generation of cold plasma – control parameters- batch and continuous method of cold plasmatreatment for decontamination. radio wave frequency– principle–factors influencing RF heating process–applications

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student will be able to

CO1 Understand the principles of high pressure treatment and its effect on microorganisms, texture, enzyme activity, and nutrients in food.

CO2 Analyze the effect of sound, light and electro-magnetic waves on processing and preservation of solid and liquid food.

CO3 Demonstrate principle, significance of electric current on microbial inactivation mechanism, and its effects on solid and fluid foods.

CO4 Describe and apply the principles of irradiation technologies, describe on mechanism of preservation, operational parameters, and the impact on food safety and shelf life of foods

CO5 Describe and demonstrate principles and significance of ozone, UV and RF for microbial inactivation

REFERENCES:

1. Gustavo V. Barbosa-Cánovas, María S. Tapia and M. Pilar Cano, Novel Food Processing Technologies, special Indian edition ,CRC Press, 2018.
2. Sun,D,.Emerging Technologies for Food Processing ,2nd edition,AcademicPress,2014.
3. Gaurav Tewari and Vijay K. Juneja, Advances in Thermal and Non- Thermal Food Preservation, 2ND edition ,Blackwell Publishing. 2020.
4. Snehasis Chakraborty ,Rishab Dhar "Fundamentals of Non-Thermal process of food preservation" CRC press 1st edition 2022
5. Enrique Ortega-Rivas "Non Thermal Food Engineering Operations, CRC Press , 1st Edition2012

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	2	3
CO2	-	2	3	-	3	-
CO3	2	-	2	3	1	-
CO4	2	3	3	3	3	2
CO5	1	3	3	2	2	1
Avg	2.00	2.75	2.60	2.50	2.20	2.00

FD3203 NON-DESTRUCTIVE QUALITY EVALUATION OFFOODS L T P C
3 0 0 3

OBJECTIVES

To provide students with theoretical knowledge and practical skills in non-destructive evaluation methods and imaging techniques for analysing food quality, defects, and structural characteristics, enabling them to effectively apply these techniques in the food industry.

UNIT I COLOUR AND MORPHOLOGY 9

Non-destructive equality evaluation methods–machine vision system-food image formation - acquisition–analysis-interpretation–enhancement–determination of size, shape and color of food products-gray and color image processing of food–morphological image processing–applications, colour analysis: optical aspects, CIE colour system, tristimulus color system, bridged methods. electronic nose, eye and e-tongue for sensory evaluation of foods

UNIT II IMAGING TECHNIQUES 9

Cereal grain microstructure analysis, imaging of double emulsion, imaging of fermented dairy products, kinetics of bubble growth in bread dough and crest formation, non-destructive imaging of cellular solid food, microstructure of gluten-free baked products, Soft X-ray systems–principles and methods of soft X-ray generation-image formation– detection and recording of X-ray image of food products–processing area-analysis techniques– determination of internal defects in fruits and vegetables; Hyperspectral imaging – principle and instrumentation

UNIT III ACOUSTIC SYSTEM 9

Fundamentals of acoustic resonance system–acoustics properties–measurement of acoustic resonance–impact device–sound capturing device–amplifiers-attenuation coefficient - digital signal analyzer – determination of maturity level of fruits and vegetables - application in fruit quality evaluation.

UNIT IV THERMAL IMAGING 9

Thermal imaging–NIR hyperspectral imaging–FTIR-operation and components- generation of image– acquisition-interpretation-Determination of internal defects and quality evaluation in food grains. Absorption and transmission of IR-Thermal pattern and anomalies interpretation-Ethical

consideration and safety.

UNIT V THERMAL AND FOOD MICROSTRUCTURE ANALYSIS 9

Thermal analysis: food structure basics (amorphous, crystalline), principle and methods of analysis– TGA, DSC, modulated DSC–applications. Food Microstructure Techniques: Scanning and Transmission electron microscopes, atomic force microscope, Nuclear magneticresonance and its types–X–ray diffraction, X–ray diffraction Fluorescence analysis and its types – Structural analysis of macromolecules such as carbohydrates, proteins, and lipids –Structural analysis of micro molecular bio chemicals.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student will be able to

CO1 Utilize imaging techniques to analyze and interpret food colour and surface morphology
CO2 Define and describe principles of generation, image formation, detection, and recording of X-ray images of food products.
CO3 Demonstrate and develop a fundamental understanding of acoustic resonance systems, acoustics properties, and the measurement of acoustic resonance.
CO4 Explain and analyze the hyperspectral images of food
CO5 Apply and discuss thermal properties and illustrate food microstructure

REFERENCES:

1. Chris Solomon and Toby Breckon, Fundamentals of Digital Image Processing - A Practical Approach with Examples in MATLAB, 1st edition ,Wiley-Blackwell, 2012
2. David Attwood, Soft X-Rays and Extreme Ultraviolet Radiation: Principles and Applications, Cambridge University Press, 1st edition, 2012.
3. Hans Grahn, Paul Geladi, Techniques and Applications of Hyper spectral Image Analysis, Wiley-Vch, 1st edition 2007.
4. Michael Vollmer,Klaus-PeterMollmann, Infrared Thermal Imaging: Fundamentals, Research and Applications, Wiley-Vch 2nd edition, ,2018.
5. Siegfried Stapf ,Song-IHan , NMR Imaging in Chemical Engineering, Wiley-Vch, 2nd edition, 2006

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	-	3	2	-
CO2	2	-	3	-	1	1
CO3	-	3	-	3	-	2
CO4	1	-	2	3	-	-
CO5	-	2	1	2	2	2
Avg	2.00	2.67	2.00	2.75	1.67	1.67

FD3211 ADVANCED FOOD PACKAGING SYSTEMS LABORATORY L T P C
0 0 4 2

OBJECTIVES

The course aim is to facilitate students in acquiring in-depth knowledge of the design and development of packaging systems for various categories of food products

LIST OF EXPERIMENTS

1. Design of cans for packaging of food product and analyzing its effect on product.
2. Multilayer packaging system development for food products.
   a) Design of package for modified atmospheric storage of any fruits or vegetables.

b) To study textural characteristics of selected fruit/ vegetable under MAP storage
3. Testing of chemical resistance of various packaging materials
4. Evaluation of oxygen scavenger systems for food products
5. Designing and analysis of anti-microbial packaging for moisture sensitive foods
6. Examining migration of polymer residue from package to food
7. To design and evaluate performance of time temperature indicators
8. Determination of oxidative changes in packaged foods
9. Comparative evaluation of flexible and rigid packages for fragile foods
10. To Design an aseptic packaging system for highly perishable foods.
11. Determination of oil and grease resistant test for packaging films
12. Determination of respiration rate in fresh fruits and vegetables
13. Modelling flavour migration from packaging material

TOTAL: 60 PERIODS

OUTCOMES:

At the end of the course, the student will be able to

CO1 Understand the principles of can design and its impact on food product preservation and quality.

CO2 Understand the concept and importance of multilayer packaging systems for food products.

CO3 Design packaging systems that maintain the desired gas composition for prolonging the shelf life of produce.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	-	2	3	3
CO2	-	-	2	3	2	-
CO3	2	1	3	3	2	1
Avg	2.50	2.00	2.50	2.67	2.33	2.00

FD3212 EMERGING FOOD PROCESSING TECHNIQUES LAB

L	T	P	C
0	0	4	2

OBJECTIVES

Course aims to educate students on modern food process techniques for the extension of shelf life and inculcate about mechanisms and identification and characterization of biomolecules

LIST OF EXPERIMENTS

1. To Determine the effect of combined heat and pressure treatment in food using High Pressure processor
2. To evaluate efficiency of ultrasound on inactivation of microorganism and enzymes in food products
4. To determine effect of UV treatment on sterilization of food products
5. To perform microwave sterilization of food
6. To produce puffed and flaked of food products.
7. To perform structural elucidation of proteins through MALDI-TOF
8. To evaluate food microstructure by confocal microscopy.
9. To analyze, separate, identify and quantify of carbohydrates & amino acids of proteins through LC-MS.
10. To design three-dimensional processed food products
11. To optimize process parameters and produce a freeze-dried food products
12. To study on the In-vitro digestion process of various food products
13. To determine efficiency of PEF in shelf-life extension of liquid food.
14. Determination of Total Trans Fatty Acids using Infrared spectroscopy

15. To optimize process parameter for extraction of bioactive compounds using electrospning technique.

TOTAL: 60 PERIODS

OUTCOMES:

At the end of the course, the student will be able to

CO1 Define the effect of combined heat and pressure treatment in food using High-Pressure Processor for Increased microbial safety and extended shelf life of the treated food products.

CO2 Classify enhanced extraction of bioactive compounds and improved sensory characteristics

CO3 Visualize and analysis of the internal structure of food product

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	-	3
CO2	-	3	1	3	3	-
CO3	3	-	3	2	3	1
Avg	3.00	3.00	2.33	2.67	3.00	2.00

Semester III

FD3311 FOOD ANALYTICAL TECHNIQUES LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVE

- The course aims to develop proficiency in utilizing advanced instrumentation and methods to analyse the chemical, physical, and sensory properties of food samples.

LIST OF EXPERIMENTS

1. Determining the Degree of Methylation and Acetylation of Pectin.
2. Determination of Neutral Sugars by Gas Chromatography of Their Alditol Acetates.
3. Polarographic and Spectrophotometric Assay of Diphenol Oxidases (Polyphenol Oxidase).
4. Separation, identification and quantification of flavours through GC-MS.
5. Identification and estimation of minerals present in food products through AAS.
6. Identification and quantification of pesticide residues in food ingredients and products through LC-QTOF.
7. Determination of absorbed oil content in fried foods and Monitoring the primary and secondary oxidative rancidity in oils.
8. Determination of Caffeine/sugars/benzoic acid in Beverages by HPLC.
9. Viscosity Measurement of liquid Using a Brookfield Viscometer.
10. Calculation of CIE colour specification of food products
11. To identify functional groups in food products, packaging material and adulteration using FTIR.
12. Production of probiotic food products
13. Production of food enzymes - amylase, protease, lipase
14. To examine application of enzyme to tenderize Meat.

TOTAL :60 PERIODS

OUTCOME

At the end of the course, the student will be able to

CO1 Develop proficiency in utilizing advanced analytical techniques and instrumentation for the analysis of food samples.

CO2 Apply appropriate methods and procedures to accurately quantify and evaluatespecific chemical, physical, and sensory properties of food products.

CO3 Demonstrate a thorough understanding of the principles underlying food analysisand the relevance of analytical techniques in ensuring food safety, quality, and compliance with regulatory standards.

REFERENCES

1. Wrolstad, R. “Handbook of Food Analytical Chemistry”. John Wiley Sons, 2005.
2. Adriana S. Franca, Leo M.L. Nollet. “Spectroscopic Methods in Food Analysis”. 1st Edition, CRC Press, Taylor and Francis group, 2017.
3. Semih Otles. “Handbook of Food Analysis Instruments”. 1st Edition, CRC Press, Taylor and Francis group, 2008.0
4. Semih Otles. “Methods of Analysis of Food Components and Additives”. 2nd Edition, CRC Press, Taylor and Francis group, 2011.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	1	1	2	3	3
CO 2	2	2	2	3	2	3
CO 3	3	2	2	3	3	3
Avg	2.33	1.67	1.67	2.67	2.67	3.00

FD3312 FOOD STORAGE ENGINEERING LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVE

- The course aims to acquaint and equip the students with in-depth knowledge on safe storage of food materials.

LIST OF EXPERIMENTS

1. To study the Physical and thermal properties of grain
2. To evaluate the Grain drying and pressure drop in storage of grains
3. Analyse the Effect of humidity and temperature of storage on the quality of rice.
4. Design of packaging for storage of grains and effect of different packaging material on quality of grains.
5. Estimation of energy requirement and optimization for sieving of different grains to remove extraneous matters without affecting the grain structure.
6. Study on the effect of oxygen, nitrogen, and carbon dioxide on the storage of fruits and vegetables.
7. Effect of moisture content, water activity, and environmental conditions on the storage shelf life offruits and vegetables.
8. Study the effect of rapid and gradual cooling on food products in walk-in cold storage system.
9. Study the effect on microbial load in Storage of food products in different refrigerated temperatures
10. Calculate the amount of energy required to freeze 1 kg of mango to 0, -5, -10, -15 and -20 ºC.
11. Effect of freezing and thawing cycle on the physical, chemical and microbial nature offood productsin blast freezer.
12. Evaluate the effect of refrigeration and freezing on the cooked and uncooked food products. Calculate the energy requirement for both samples and also analyze the efficiency of the given process. Microscopic structural analysis of food products.
13. Study on effect of moisture content of the food product on the cooling and freezingload through thebatch freezing system.
14. Evaluate the effect of retail packaging materials on the efficiency of refrigeration and freezing of food products. Correlate the insulating nature of packaging materials with the energy requirement for freezing and refrigeration.
15. Calculate the heat dissipated during respiration of fruits and vegetables, to optimize the necessaryenergy requirement for refrigeration in batch system for 24hr in batch storage

conditions.

16. Study on the effect of air and water as a cooling medium for food products.
17. Estimate the effect of liquid nitrogen freezing on fruits and vegetables.

TOTAL: 60 PERIODS

OUTCOME

At the end of the course, the student will be able to

CO1 Develop a comprehensive understanding of the physical and thermal properties of grains and their implications for storage, processing, and quality control in the food industry.

CO2 Understand the influence of humidity and temperature during storage on the quality attributes of rice, and apply this knowledge to optimize storage conditions and prevent quality deterioration.

CO3 Acquire proficiency in estimating energy requirements and optimizing sieving processes for grain cleaning, ensuring the removal of extraneous matter without compromising grain integrity.

REFERENCES

1. Chakravarty, Post-Harvest Technology of Cereals, Pulse and Oilseeds. IBH Publ. Mahajan andGoswami.3rd edition. 2019.
2. Ojha TP and Michael AM. Principles of Agricultural Engineering. Jain Brothers 14th edition. 2021.
3. Osling, T. G. Applied Air conditioning and refrigeration. Applied Science Publishers Ltd. London. 3rd 1984.
4. Holowell, E.R., Cold Storage and Freezer Storage Manual, AVI Pub. Co.1st edition 1980.
5. A.Ciobanu,. and G.Lasku, V. Bersescu, Cooling Technology in the Food Industry,
6. Abacus Press, 1st edition 1976

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	-	-
CO2	2	2	1	2	3	2
CO3	2	2	2	1	2	2
Avg	2.00	2.00	1.67	1.67	2.50	2.00

FD3313 **INDUSTRIAL INTERNSHIP (4 WEEKS DURING II SEMESTER - SUMMER)** **L T P C 0 0 0 2**

OBJECTIVE:

The course aims to

- Encourage the students to get connected with any food industry.
- Acquire knowledge on solving practical problems, gaining work experience and skills.

The students individually undergo training in reputed Food processing companies for a specified duration. At the end of the training, a report on the work will be prepared and presented by the student. Students will be evaluated through a viva-voce examination by a team of as per the regulations of University.

OUTCOME

At the end of the course the students will be able

CO1 Work in an industry

CO2 Contribute efficiently in a team and communicate with others

CO3 Gain practical knowledge and enhance their confidence and skills required tothrive in work place

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	3	3
CO2	2	1	2	2	2	2
CO3	2	2	3	3	2	3
AVG	2.33	2.00	2.33	2.33	2.33	2.67

FD3314 **PROJECT WORK I** **L T P C**
0 0 12 6

OBJECTIVES

The course aims

- To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.
- To develop the methodology to solve the identified problem.
- To train the students in preparing project reports and to face reviews and viva-voce examination

TOTAL : 180 PERIODS

Course Content

Individual students will identify a problem relevant to his/her field of study, collect and analyze literature, design, and carryout experiment, collect data, interpret the result and prepare the project report.

OUTCOMES:

On Completion of the course the student will be able to
CO1 Demonstrate a sound technical knowledge of their selected project topic.
CO2 Undertake problem identification, formulation and solution.
CO3 Design solutions to identified problems utilizing a systematic approach
CO4 Conduct experiment, interpret the result and prepare project report

The students will have a clear idea of their area of work and they will be in a position to carry out the remaining phase II work in a systematic way

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	3	3	1	1
CO2	3	1	3	3	3	3
CO3	3	1	3	3	3	2
CO4	3	3	3	3	2	2
Avg	2.75	1.67	3	3	2.25	2

Semester IV

FD3411 **PROJECT WORK II** **L T P C**
0 0 24 12

OBJECTIVE:

The course aims

- To solve the identified problem based on the formulated methodology.
- To develop skills to analyze and discuss the test results, and make conclusions.

TOTAL :360 PERIODS

Course Content

The student should work on the selected topic as per the formulated methodology under the same

supervisor. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted. The students will be evaluated based on the report submitted and the viva-voce examination by a panel of examiners including one external examiner

COURSE OUTCOMES

At the end of the project the student will be able to

CO1 Formulate and analyze problems for developing new methods/solutions/processes.
CO2 Plan and conduct experiments to find solutions in a logical manner
CO3 Analyze the results, interpret and prepare project report/know the strategies for commercialization

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	2	1	-	-
CO2	3	1	2	2	3	3
CO3	3	3	3	3	2	3
Avg	3.00	2.00	2.33	2.00	2.50	3.00

FD3001 ENGINEERING PROPERTIES OF FOODS

L	T	P	C
3	0	0	3

OBJECTIVE

The course aims to

- Acquaint and equip the students with different techniques of measurement of engineering properties and make the students understand the nature of food constituents in the design of processing equipment

UNIT I SURFACE AND GAS EXCHANGE PROPERTIES 9

Importance and applications in the crop processing design - factors affecting the properties - physical characteristics - determination – apparatus. Aero dynamics of agricultural products - drag coefficients - terminal velocity - pressure drop in packed beds. Surface Properties - Gibbs Adsorption Equation, Contact Angle, Critical Surface Tension, Polar and Dispersive Contributions to Surface Energy, Effects of Adsorbed Layer Composition and Structure on Interfacial Energy, Measurement Techniques - Contact Angle, Liquid Surface Tension, γL^d and γS^d Gas Exchange Properties - Respiration and Fermentation Models, Gas Transport Properties, Measurement Techniques - O_2 and CO_2 Concentration, heat of respiration, Skin Resistance and Gas Diffusion Properties, Gas Exchange Data for Selected Fruits and Vegetables.

UNIT II ELECTRICAL AND COLORIMETRIC PROPERTIES 9

Electrical properties – Relations between Electrical Conductivity and Other Transport Properties, Effect of Microstructure, Temperature, Electric Field Strength, Ingredients for Solid Foods, Solid–Liquid Mixtures - Models for Effective Electrical Conductivity, Effects of Solids in Tube Flow, Methods of Measurement, effect of moisture content on electrical properties optical properties-transmittance-reflectance-image processing. Dielectric Properties - Measurement Principles, Frequency and Temperature Dependence - Dielectric Properties below Freezing and above Boiling Temperatures, Temperature Dependence of Loss Factor and Runaway Heating, Composition Dependence – effect on food, Assessment of Food Quality. Colorimetric Properties: Measurement of Color, Specialized Colorimeters, Research and Quality Control Approaches, Color Tolerances, Development of Instruments.

UNIT III THERMAL PROPERTIES 9

Unfrozen Foods - Importance on Quality and Safety of Foods, Modeling and Optimization of Processes, Sources of Data on Thermal Properties, Computerized and On-Line Databases, Software for Predicting Thermal Properties of Foods, Density, Specific Heat - Predictive Equations, Influence of Structure of Food, Measurement Methods, Other Properties Relevant to Thermal Processing of Foods - Compressibility and Thermal Expansion, Glass Transitions,

Sorption and Hydration Properties, thermal diffusivity – determination – effect of moisture content and temperature on thermal properties – differential scanning calorimetry (DSC) Frozen Foods - Experimental Approaches, Initial Freezing Point and Unfrozen Water, Density, Thermal Conductivity, Enthalpy, Specific Heat, Thermal Diffusivity - Modeling of the Thermal Properties of Frozen Foods, Prediction of Unfrozen Water During Freezing of Foods, Limitations of Predictive Models.

UNIT IV RHEOLOGY OF FOOD PRODUCTS 9

Rheology: Introduction, Stress and Deformation, Elastic Solids and Newtonian Fluids, Viscometric Functions, Rheological Classification of Fluid Foods, Viscoelasticity, Effect of Temperature, Effect of Concentration on Viscosity - Combined Effect Temperature – Concentration, Mechanical Models - Hooke's Model, Newton's Model, Kelvin's Model Maxwell's Model, Saint-Venant's Model, Mechanical Model of Bingham's Body Semiliquid Foods: Fundamental Methods - Rotational Viscometers Oscillating Flow, Capillary Flow, Back Extrusion Viscometry, Squeezing Flow Viscometry, Empirical methods - Adams Consistometer, Bostwick Consistometer, Tube Flow Viscometer, Imitative Methods, Obtaining the Rheological Parameters - Capillary Viscometer, Concentric Cylinder Viscometer, applied Problems. Texture of food materials - methods – subjective and objective methods - initiative and empirical tests - dynamic test for food texture evaluation, mechanical damage and maximum allowable load for agricultural products.

UNIT V PROPERTIES OF FOOD POWDERS 9

Physical Properties - Density and Porosity, Particle Shape, Strength Properties - Hardness and Abrasiveness, Friability and Attrition, Compression Properties of Food Powders, Compression Methods, Compression Mechanisms during Uniaxial Compression Tests, Surface Area, Chemical and Physicochemical Properties - Instant Properties and Evaluation, Stickiness in Food Powders – Bridging, Thermodynamic Adsorption, Cohesion and Cohesion Properties, Test Methods, Water Activity and Glass Transition Temperature - Application of Compression in Foods, Research Update in Food Powder Properties. Foodstructuring: traditional food structuring and texture improvement, approaches to food structuring, extrusion and spinning, structuring fat products, structure and stability, gels, gelation mechanisms, mixed gels, the microstructure of gels, structure-property relations in gels. Examining food microstructures: history of food microstructure studies, light microscopy, transmission electron microscopy, scanning electron microscopy, other instrumentation and techniques, image analysis: image acquisition, image processing, measurement analysis.

TOTAL 45 PERIODS

OUTCOME

At the end of the course the students will be able to

CO1 Describe and demonstrate significance of surface and gas exchange properties of food materials

CO2 Define, illustrate and explain electrical and calorimetric properties of food materials

CO3 Compare, examine and determine the effect of thermal processing on the structure and textureof food materials

CO4 Elaborate, examine and interpret the rheology of food products

CO5 Describe and characterize the physical and chemical properties of food powders

REFERENCE BOOKS

1. Mohesenin.Thermal properties of Foods and Agricultural Materials. Gordon and Breach Science Publishers, New York 1st edition 1980.
2. Mohesenin. N.N.Physical properties of Plant and Animal Materials. Gordon and Breach Science Publishers, New York 2nd edition 1986.
3. Peleg, M. and E.B.Bagelay. Physical properties of foods. AVI publishing Co. USA. 1st edition 1983.
4. Rao, M.A., S.S.H.Rizvi and A.K.Datta. Engineering properties of foods. CRC press, Taylor and Francis, London. 4th edition 2014.
5. Singhal,O.P. and D.V.K. Samuel. Engineering Properties of Biological Materials. Saroj Prakasan.1st edition 2003.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	2	3	2	-
CO2	1	1	3	3	2	2
CO3	-	-	1	3	1	1
CO4	1	1	1	1	2	-
CO5	2	1	1	1	2	-
Avg	1.25	1.00	1.60	2.20	1.80	1.50

FD3002 FOOD PROCESS AUTOMATION L T P C
3 0 0 3

OBJECTIVE

The course aims to inculcate students with the knowledge of automation of processes involved in the food industry

UNIT I INTRODUCTION 9

Food quality, automated evaluation of food quality, food quality quantization and process control, typical problems in food quality evaluation - beef quality evaluation; food odor measurement, continuous snack food frying quality. Data acquisition: Sampling elaboration with examples, concepts and systems for data acquisition such as: ultrasonic signalacquisition for beef grading, electronic nose data acquisition for food odor measurement, snack food frying data acquisition for quality process control, Image acquisition: elaboration with examples.

UNIT II DATA ANALYSIS 9

Data pre-processing, Static data analysis, Dynamic data analysis, Image processing: Image segmentation, Image feature extraction etc.

UNIT III MODELLING 9

Modelling strategies: Theoretical and empirical modelling, Static and dynamic modelling, Linear statistical modelling, ANN modelling etc.

UNIT IV PREDICTION 9

Prediction and classification, Sample classification for beef grading, examples such as, based on linear statistical and ANN models, Electronic nose data classification for food odour pattern recognition, Snack food classification for eating quality evaluation based on linear statistical and ANN models, One-step-ahead prediction.

UNIT V CONTROL 9

Process control, internal model control, Predictive control, Neuro-fuzzy PDC for snack food frying process, Systems integration: Food quality quantization systems integration, Food quality process control systems integration, Food quality quantization and process control systems development

TOTAL 45 PERIODS

OUTCOME

At the end of the course the students will be able to

CO1 Describe and demonstrate the fundamentals of system integration for foods processing.
CO2 Identify, compare and evaluate the data collected
CO3 Choose, explain, compare and analyze the models
CO4 Describe, apply and interpret models for food quality evaluation
CO5 Gain expertise in process control methodologies, including internal model control, predictive control, and neuro-fuzzy proportional-derivative controller (PDC), specifically forthe snack food frying process

REFERENCE BOOKS

1. Doeblin, E. O. and Manik, D. N. Measurement Systems: Applications and Design, Tata McGraw Hill, 4th edition 2003.

2. Kuo, B. C. Automatic Control Systems, Prentice Hall, 10th edition 2017.
3. Huang, Y., Whittaker, D., and Lacey, R. E. Automation for food engineering: food quality quantization and process control, CRC Press, 1st edition 2001.
4. Bhuyan, M. Measurement and control in food processing, CRC Press,1st edition 2006.
5. Zude, M. Optical Monitoring of Fresh and Processed Agricultural Crops, CRC Press, 1st edition 2009.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	3	2	1
CO2	3	2	1	1	1	1
CO3	2	-	2	2	3	-
CO4	2	1	-	2	3	-
CO5	1	1	1	1	1	1
Avg	1.80	1.25	1.25	1.80	2.00	1.00

FD3003 FOOD PROCESS MODELLING AND SIMULATION L T P C
3 0 0 3

OBJECTIVE

The course aims to

- Elucidate students with advanced knowledge in engineering modeling of the food processes
- Inculcate students with recent trends in development and simulation of process models for prediction and scale up.

UNIT I PROCESS MODELING 9

Introduction to Process Modeling: Balance equations and rate equations, mathematical models, empirical models and linear regression, systematic modelling approach, general property balance models in food processing, analytical solutions to ordinary differential equations, Laplace transformations and numerical methods in mathematical modeling.

UNIT II TRANSPORT PHENOMENA MODELS 9

Transport Phenomena Models: Equation of continuity, equation of energy, equation of motion, ODE models in food processing, transport phenomena models involving PDE, chart solutions to unsteady state transport problem, interfacial mass transfer, and rheological modeling.

UNIT III KINETIC MODELING 9

Kinetic Modeling: Kinetics and food processing, the rate expression, temperature effects on the reaction rates, enzyme catalyzed reaction kinetics, metabolic process engineering, microbial kinetics, kinetics of microbial death, model of ideal reactors, modeling batch and continuous thermal processing operations of foods.

UNIT IV MATHEMATICAL MODELING 9

Mathematical Modeling in Food Engineering Operations Moving boundary and other transport phenomena models for processes involving phase change, unit operation models: drying, baking, frying, evaporation, distillation, extraction, crystallization.

UNIT V MODEL SOLUTION AND SIMULATION TOOLS 9

Model Solution and Simulation tools MATLAB/ SCILAB/ SIMULINK as tools for solving mathematical models and for simulation. Solution strategies for lumped parameter models and distributed parameter models. Simulation of food manufacturing processes.

TOTAL 45 HOURS

OUTCOME

At the end of the course the students will be able to

CO1 Understand the fundamental principles of food process modelling

CO2 Identify, describe and develop mechanistic process models for unit operations in food

processing.
CO3 Develop and validate food process models using experimental data and statistical techniques
CO4 Evaluate and apply mathematical modeling for food engineering operations
CO5 Describe and apply MATLAB, Scilab, and Simulink as tools for solving mathematical models and conducting simulations in the context of food engineering.

REFERENCE BOOKS

1. Hangos, K. M. andCameron, I. T. Process, Modeling and Model Analysis, Academic Press 1st edition, 2001.
2. Ozilgen, M. Food process modeling and control: chemical engineering applications, Gordon and Breach Science Publishers,2nd edition 2009.
3. Bakalis, S., Knoerzer, K., Fryer, P.J., (eds). Modeling food processing operations. Elsevier 3rd edition, 2015.
4. Ozilgen, M. Handbook of food process modeling and statistical quality control: with extensive MATLAB applications. (CRC Press,2nd edition, 2011)
5. Das, H. Food processing operations analysis. Asian books private limited; 1st edition 2005.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	-	2	2	-
CO2	2	3	2	2	2	2
CO3	-	1	1	3	3	2
CO4	2	1	-	3	1	1
CO5	1	1	-	2	2	1
Avg	2.00	1.40	1.50	2.40	2.00	1.50

FD3004 ADVANCED FOOD FERMENTATION TECHNOLOGY L T P C
3 0 0 3

OBJECTIVE

- The course aims to educate new fermentation processes and developments in the design of food fermenters and bioreactors.

UNIT I MEDIA FOR FERMENTATION & STRAIN DEVELOPMENT 9

Microbial culture, Screening and selection for fermentation processes; Preservation and improvement of industrially important microorganisms; Importance of media components for production of industrial products by fermentation; use of different sources of carbon, nitrogen, minerals and activators for commercial fermentation; optimization of fermentation media. Sterilization of media and air; Batch and Continuous sterilization, Thermal death kinetics Strain Development -Various techniques of modifying the strains for increased production of industrial products. Use of chemicals, UV rays, genetic engineering to produce newer strains. Strain development by mutagenesis, protoplast fusion and transformation of cloned genes

UNIT II TYPES AND DESIGN OF BIOREACTORS 9

Basic objective of fermenter design, aseptic operation & containment, body construction, agitator and sparger design, baffles. Process parameters and measurement techniques: measurement of temperature, pressure and pH, DO, foam etc.; flow rate of liquid and gases;Automation (processes computerization). Bioreactor configurations and types- Bubble column, airlift reactor, packed bed, fluidized bed, trickle bed, Membrane reactor, Photobioreactor, Solid state fermenter, Animal and plant cell bioreactors. Scale up and Scale down studies of bioreactors.

UNIT III FERMENTATION PATHWAYS FOR INDUSTRIAL PRODUCTS 9

Biochemical pathways of metabolic reactions for utilization of carbon sources and formation of different metabolites by microorganisms; possibility of control of the reactions for the increased

formation of useful metabolites

UNIT IV ADVANCED FERMENTATION PROCESSES 9

Recombinant protein expression with E.coli and fermentation. Expression in yeast Pichia pastoris, production of recombinant vaccines, purification of recombinant proteins. Animal cell culture, Plant cell culture; Cell culture practices, nutritional requirement of cultured cell,cell growth and propagation, prevention and eradication of contamination, Cell synchronization; Cell cloning. Scaling-up of animal and plant cell culture.

UNIT V DOWNSTREAM PROCESSING 9

Various equipment for product recovery; micro-filters and Ultra-filtration systems for separation of cells and fermentation medium and for concentration of medium containing product; chromatographic systems of separation; extraction of product with solvent; evaporation and crystallization; centrifugation, different types of centrifuges; drying techniques; instrumentation and controls.

TOTAL: 45 PERIODS

OUTCOME

At the end of the course the students will be able to

CO1 Explain the preservation aspects of microbial cultures using recent advanced techniques.
CO2 Demonstrate and design food fermenters and bioreactors.
CO3 Describe and demonstrate biochemical pathway
CO4 Demonstrate and evaluate the kinetics and mechanism of microbial growth
CO5 Explain and illustrate applications of downstream processing in food industry,

REFERENCE BOOKS

1. Joshi, V.K. and Ashok Pandey "Biotechnology: Food Fermentation, Microbiology, Biochemistry and Technology", Educational Publisher Vol. I & vol. II, 1999.
2. Peppler, H.J. and D. Perlman "Microbial Technology: Fermentation Technology",Academic Press / Elsevier 2nd Edition, Vol. II, 2004.
3. Bioprocess Engineering, Basic Concepts, II Ed. Michael L Shuler, FikretKargi, PrenticeHall of India pvt. Ltd. 2nd edition 2002.
4. Stanbury, P.F., A. Whitaker and S.J. Hall "Principles of Fermentation Technology AdityaBooks (P) Ltd., ", 2nd Edition 1997.
5. Industrial Biotechnology by Rita Singh, S. Ghosh, Global Vision Publishing Ho, 1st edition2004

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	1	2	1
CO2	-	-	1	2	2	1
CO3	3	2	2	2	3	-
CO4	1	1	2	2	2	-
CO5	1	1	1	2	2	2
Avg	1.50	1.25	1.40	1.80	2.20	1.33

FD3005 DAIRY TECHNOLOGY L T P C
3 0 0 3

OBJECTIVE

The course aims to educate students with different techniques used in preservation of milk and milk products

UNIT I PROCESSING AND STORAGE OF MILK 9

Introduction –Composition and Physico-chemical properties of milk and milk constituents – LP system, microbiology of milk and Quality assurance. Milk reception – Cooling methods-Transportation and Storage of milks. Quality determination and grading of milk. Cleaning and disinfection of transport, storage facilities and handling equipments. Milk processing - terminologies – Process flow diagram. Pasteurization – principles and objectives – methods– sterilization – UHT processed milk products, their properties and prospects, typesof UHT plants –

equipments and working principles, hybrid technology for pasteurization of milk, microwave processing of milk.

UNIT II UNIT OPERATIONS AND MILK PRODUCTS 9

Cream separation – principles – gravity and centrifugal separation – equipments and working principles. Homogenization – theory - effect on milk - working principle of homogenizers - Principles and equipment for bactofugation and Bactotherm processes, Microfluidization of milk: Principle, equipment, effects and applications, Cleaning and sanitization - CIP cleaning - bottle fillers and cappers- form fill seal machines— aseptic filling Recombined milk - fluid milk - standardized - toned - reconstituted milks. Special Milks - Soft curd milk – Flavoured milk - Vitaminized milk – sterilized milk - irradiated milk. Condensed milk PFA/BIS requirements of sweetened condensed milk - standardization. Evaporated milk- manufacturing technology - defects and remedies. Fermented Milk Products – Yoghurt- Acidophilus milk - technology and microbiology. Cheese – varieties - manufacturing methods

UNIT III ENZYME AND MICROBIAL INFLUENCE IN MILK PRODUCTS 9

Microbial rennet and recombinant chymosin, characteristics and application in cheese making; exogenous free and microencapsulated enzymes, immobilized enzymes-their application in accelerated ripening of cheese; enzymatically modified cheeses (EMC) their utilization in various food formulations. Technological requirements of modified micro- organisms for production of cheese and fermented milk products; technological innovations in the development of functional dairy foods with improved nutritional therapeutic and pro- biotic attributes; physiologically active bio-peptides/ nutraceuticals.

UNIT IV BY PRODUCTS AND ITS PROPERTIES 9

Protein hydrolysates – their physicochemical, therapeutic properties, production and application in food formulations; production of bio-yoghurt, probiotic cheese and fermented Milks; bifidus factors in infant food formulations their physicochemical, therapeutic properties, de-bittering and application in food formulations; Enzymatic hydrolysis of lactose for preparation of whey and UF-permeate beverages. Vegan foods. Microbial polysaccharides their properties and applications in foods, production of alcoholic beverages and industrial products from starch; whey and other by-products; bio-sweeteners types properties and their applications in dairy and food industry.

UNIT V SHELF LIFE PARAMETERS AND PRESERVATION 9

Bio-preservatives- characteristics and their application in enhancing the shelf life of dairy and food products. Practical Effect of exogenous enzymes on hydrolysis of protein and fat in culture containing milk systems; to study the various factors affecting the coagulation of milk by microbial rennets. Manufacture and evaluation of pro-biotic cheese and fermented milks; determination of glycolysis, proteolysis and lipolysis in cheese and fermented milk; enzymatic process for manufacture of low lactose milk whey products; preparation of casein hydrolysis; visit to a bio-processing unit. Current trends in cleaning and sanitization of dairy equipment: biological; detergents; Automation; Ultrasonic techniques in cleaning; bio- detergents, development of sanitizers- heat; chemical; radiation, mechanism of fouling and soil removal; Bio-films, assessing the effectiveness of cleaning and sanitization of dairy products.

TOTAL : 45 PERIODS

OUTCOME

At the end of the course the students will be able to

CO1 Classify, explain techniques involved in processing and storage of milk,

CO2 Describe and demonstrate methods involved in production of milk products

CO3 Select, explain and illustrate role of microbes and enzymes in development of milk products.

CO4 Demonstrate and Analyze production of bio-yoghurt, probiotic cheese and fermented Milks

CO5 Identify, explain and evaluate methods for shelf life extension of milk and milk products

REFERENCE BOOKS

1. Murlidhar Meghwal, Megh R. Goyal, Rupesh S. Chavan, Dairy Engineering: Advanced Technologies and Their Applications, , CRC Press 1st edition 2017

2. Engineering Aspects of Milk and Dairy Products, edited by Jane Selia dos Reis Coimbra, Jose A. Teixeira, , CRC Press,1st edition 2010
3. Goldberg Israel.. Functional Foods. Chapman & Hall, New York 1st edition 1994.
4. Walstra P, Geurts TJ, Noomen A, Jellema A & Van Boekel MAJS.. Dairy Technology – Principles of Milk Properties and Processes. Marcel Dekker, 1st edition 1999

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	1	2	1	1
CO2	1	1	-	2	2	2
CO3	1	1	1	1	1	1
CO4	-	-	2	2	1	2
CO5	1	1	2	2	2	-
Avg	1.00	1.00	1.50	1.80	1.40	1.50

FD3006 CEREAL AND GRAIN PROCESS TECHNOLOGY

L	T	P	C
3	0	0	3

OBJECTIVE

The course aims to Educate and equip students with latest cereal processing technologies for adoption in foodindustries and understand the various methods involved in safe storage of grains

UNIT I RICE PROCESSING **9**

Paddy – area and production- Paddy quality and classification- drying, cleaning, grading, sorting, packaging and storage -Process involved in rice milling - Machines for paddy processing – parboiling plant – types of dryers –cleaners - dehusking equipments – paddy separators- rice polishing equipments different types- Water mist rice polisher – rice moisture conditioning – types of graders - colour sorter and rice quality control - shelf life and spoilage.

UNIT II WHEAT PROCESSING **9**

Wheat-area and production-Nutritional quality-wheat varieties- drying, cleaning, grading, sorting, packaging and storage - modern wheat milling process- flour milling-Soft and Durum wheat processing – equipment for conditioning – break rolls – sifters – purifiers - shelf life and spoilage.

UNIT III MAIZE PROCESSING **9**

Maize – area and production – maize as food and feed- drying, cleaning, grading, sorting, packaging and storage - Milling process for maize- different unit operations- Beall degerminator – degermination with roller mills- Wet milling of maize – process - shelf life and spoilage.

UNIT IV MILLET PROCESSING **9**

Area and production of barley, oat and millets – nutritive value of barley, oat and millets –drying, cleaning, grading, sorting, packaging and storage - processing of barley- equipment - finished products and end-uses of barley- Process involved in modern oat milling process- different unit operations involved in oat processing – different methods of millet processing – malting of millets - shelf life and spoilage.

UNIT V BY-PRODUCTS **9**

Utilization of by-products - composition and nutritional value, consumption. Value addition - suitability of flour required for different products; Traditional process technique - parching, puffing, popping, roasting or toasting, frying, flaking, fermentation, extraction, malting - techniques - basic process - effectiveness in increase energy density, canning, papad process.

TOTAL: 45 PERIODS

OUTCOME

At the end of the course the students will be able to

CO1 Describe and demonstrate unit operations involved paddy processing and examine quality

of finished product

CO2 Explain and illustrate the methods of processing cereals and utilization of its by-products

CO3 Enumerate on methods of processing maize

CO4 Describe and analyze different unit operations millet processing

CO5 Describe and demonstrate about utilization of various by-products

REFERENCE BOOKS

1. Amalendu Chakraverty, Arun M.mujumdar, G.S.V.Raghavan and Hosahalli S. Ramaswamy. . Hand Book of Postharvest Technology – Cereals, Fruits, Vegetables, Tea and Spices.Marcel and Dekker Inc., New York, 2nd edition, 2010
2. Asiedu JJ.. Processing Tropical Crops. ELBS/MacMillan 1st edition 2017.
3. Chakraverty A.. Post-harvest technology of cereals, pulses and Oilseeds. Oxford and IBH Publishing Co., New Delhi 3rd edition 2019.
4. Gavin Owens,. Cereals processing technology, CRC Press 1st edition 2000.
5. Karel Kulp,. Handbook of Cereal Science and Technology, CRC Press,2nd edition 2000

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	2	1
CO2	1	1	1	2	1	1
CO3	1	-	-	1	1	1
CO4	-	1	1	2	2	3
CO5	1	-	-	2	2	3
AVG	1.50	1.67	1.33	1.80	1.60	1.80

FD3007 PULSE AND OILSEED PROCESS TECHNOLOGY **L T P C**
3 0 0 3

OBJECTIVE

The course aims to enable the students to gain an insight into basic aspect of pulse and oilseed processing technology and understand the importance of primary secondary and tertiary processing of pulse and oilseed with special emphasis on their process and equipment.

UNIT I INTRODUCTION **9**

Concept of primary secondary and tertiary processing, concept of milling, Expression and extraction process. Application of different pretreatment on pulse and oilseed processing like parboiling, thermal treatment, enzymatic treatment and their effect on recovery and milling efficiency.

UNIT II PULSE PROCESSING **9**

Production and consumption of different pulses in Indian and world, Milling of Pulses, Machinery and equipment for pulse, Dry and wet milling of pulses, anti-nutritional factor and removal methods, effect of processing on nutritional value, Technology of legume based and blended extrudates, shelf life and spoilage of pulses

UNIT III OIL EXTRACTION **9**

Mechanical expression of oil – ghani, power ghani, rotary, hydraulic press, screw press, expellers, filter press - principle of operation and maintenance-solvent extraction process –steps involved, batch and continuous-continuous solvent extraction process, Oil quality and standard quality regulations, shelf life and oxidative stability of oil, Other source of edible oil like corn germ, rice bran, almond oil, coconut oil.

UNIT IV OIL REFINING AND PROCESSING **9**

Refining of oil – objectives – characterization - degumming, deacidification, bleaching of oil, decolourising agents, deodorization process, and winterization processes. Hydrogenation of oil – selectivity – catalyst – batch type hydrogenation – regeneration of catalyst-vanaspati, ghee and margarine. Characterization and types of fat replacers and their specific uses

UNIT V PULSE AND OILSEED PRODUCTS 9

Legume based value added product, Instant dhal, Pulse flour products, soy based value added product, groundnut based value added product, fermented products, By product utilization of pulse milling, pulse broken, meal and cake utilization, lecithin, Technology of oilseed protein isolates

TOTAL: 45 PERIODS

OUTCOME

At the end of the course the students will be able to

CO1 Understand the application of scientific principles in processing of pulse and oil seed
CO2 Identify, understand and explain specific processing technologies used for pulses
CO3 Describe and demonstrate various oil extraction methods
CO4 Explain and illustrate refining of oil and hydrogenated fat.
CO5 Identify, compare and analyse by-products derived from pulse and oil seed processing.

REFERENCE BOOKS

1. Acharia, K.T.. Oil seeds and oil milling in India. Oxford and IBH publication, New Delhi.1st edition1990
2. Chakraverty, A. Post Harvest Technology of Cereals, Pulses and Oilseeds. Oxford and IBH Publishing Co, Calcutta 1st edition 1995
3. H. Lawson, Food Oils and Fats- Technology, Utilization, and Nutrition, Chapman and Hall, 1st edition 2011
4. Harry Lawson. Food oils and Fats, Technology, Utilization and Nutrition. CBS Publishers and Distributors, New Delhi 1st edition 1997
5. J.Bachmann, Oilseed Processing for Small Scale Producers, ATTRA Publication,. K.K.Rajah, Fats in Food Technology, Sheffield Academic Press, 2nd edition 2004

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	1	2	2	2
CO2	--	1	1	2	2	2
CO3	1	1	1	3	3	2
CO4	-	-	-	2	2	-
CO5	1	1	1	1	1	1
Avg	1.00	1.00	1.00	2.00	2.00	1.75

FD3008 MEAT AND POULTRY PROCESS TECHNOLOGY L T P C
3 0 0 3

OBJECTIVE

The course aims to impart knowledge about the advancement in the processing of meat poultry

UNIT I SLAUGHTERING HOUSE AND EQUIPMENTS 9

Abattoir Layout, designing - equipment, operation and maintenance of slaughter houses and processing plants - hygiene and sanitary conditions in meat processing plant-pre- slaughter judging, inspection, grading of animals - Humane slaughter- principles and methods of stunning - machineries for slaughter and dressing. Automation in meat and poultry industry.

UNIT II ADVANCES IN MEAT AND POULTRY INDUSTRIES 9

Advances in meat industry, Advances in poultry dressing, meat yield. Automation in broiler farming, control of shrinkage and methods of slaughter - specifications, standards and marketing of egg and egg products- preservation and maintenance of quality of eggs - spoilage of egg and its prevention - freezing- pasteurization.

UNIT III NOVEL MEAT PROCESSING TECHNIQUES 9

Novel processing methods in meat and poultry processing. Effect of high-pressure processing, pulsed electric field, Power ultrasound, Irradiation of meat and poultry product,changes in

protein, lipid and carbohydrate profile if any in meat due to processing.

UNIT IV MEAT SAFETY AND QUALITY ANALYSIS 9

Quality and safety analysis: Microbial analysis, Chemical analysis and Physical analysis. Instrumental analysis to ensure safety and quality: Adulteration in meat and meat products, IR analysis system for identification on type of meat, Mass spec. and Chromatographic analysis. Pathogenic microbe identification, Aspects of meat preservation for control of meat spoilage.

UNIT V MEAT PACKAGING, BYPRODUCTS AND REGULATIONS 9

Packaging of meat and meat products - modified atmosphere packaging - vacuum packaging- retort pouch processing – packaging of egg and egg products - utilization of by- products and wastes from meat and poultry processing industries - waste treatment and pollution control- Environmental Audits-Regulations on pollution control.

TOTAL: 45 PERIODS

OUTCOME

At the end of the course the students will be able to

CO1 Understand and identify the specific processing technologies used for meat and suchfoods and the various products derived from these materials.

CO2 Demonstrate the changes in the composition of foods with respect to the type of processingtechnology used.

CO3 Understand and apply advanced preservation and packaging techniques for meatand poultry products.

CO4 Analyze and interpret about quality and safety analysis for meat and poultry

CO5 Identify and design a suitable packaging system for meat and meat products

REFERENCE BOOKS

1. Fidel Toldra., Handbook of Meat Processing,2nd edition 2012
2. Kerry J, Kerry J and Ledward D.. Meat Processing-Improving Quality. Woodhead publishing Ltd., UK,1st edition 2005
3. Leo M.L. Nollet, Fidel Toldra.. Advanced Technologies For Meat Processing. Taylor and Francis 2nd edition 2018
4. Panda, P.C.Text Book on Egg and Poultry Technology, Vikas Publishing House Pvt. Ltd., New Delhi 2nd edition 2013
5. Pearson AM and Dutson TR.. Advances in Meat Research. Vol. IX.Quality Attributes and their Measurement in Meat, Poultry and Fish 1st edition 2000

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	--	-	2	2	1
CO2	1	1	1	1	2	3
CO3	2	2	-	2	2	3
CO4	1	2	-	-	1	1
CO5	1	-	1	1	1	1
Avg	1.20	1.67	1.00	1.50	1.60	1.80

FD3009 MARINE FOOD PROCESS TECHNOLOGY L T P C
3 0 0 3

OBJECTIVE

The course aims to understand advanced concepts involved in the production, processingof marine products and study about quality assurance of marine products

UNIT I INTRODUCTION 9

Importance of marine products, fishing resources – inland, marine, blackish water fisheries - harvesting methods – crafts – gears

UNIT II COMPOSITION AND QUALITY OF MARINE FOOD 9

Composition and nutritive value of marine – protein, omega 3 fatty acid, toxic component-biochemical and microbiological changes in marine - evaluation of fish qualities - transportation of fish, washing and grading.

UNIT III PROCESSING OF MARINE FOOD 9

Processing of fish and shellfish – different types of ice and their advantage - freezing – individual quick freezing – canning – salting – drying and dehydration - smoking of fish- Irradiation- fish mince and surumi - packing, storage and transportation of chilled and frozen fish– packaging of frozen fish – marketing - cold chain and export trade – transportation and marketing of frozen products - packaging and packaging materials

UNIT IV MARINE FOOD PRODUCTS 9

Fish meal, bone meal, fish oil, surgical sutures from intestine, chitin and chitosan -fermented fish products – fish paste products (fish sausage and ham, etc.) – fish protein concentrates-utilization of fish processing

UNIT V SPOILAGE AND QUALITY CONTROL 9

Spoilage of marine products –quality control of fresh fish - quality control during freezingand chilling - HACCP of marine products – quality assurance of marine products

TOTAL: 45 PERIODS

OUTCOME

At the end of course, students will be able to

CO1 Classify and define marine species.

CO2 Describe and demonstrate on composition of marine meat and assess quality of marine food product

CO3 Explain on various methods of marine food preservation and create a suitable method for shelf life extension

CO4 Describe and develop food products related to marine foods

CO5 Understand and assess the level of Spoilage and quality of marine products

REFERENCE BOOKS

1. Andrew L. Winton, Kate Barber Winton,. Fish and Fish products Agro Botanical Publishers, India 1st edition 1993.
2. Balachandran K. K.. Post harvest technology of fish and fish products. Daya Publishing House, New Delhi 2nd edition 2002.
3. Gopakumar, K. Fish Packaging Technology (Materials and Methods) conceptpublishing company, New Delhi 1st edition 1993.
4. Govindan, T. K.. Fish Processing Technology. Oxford and IBH Pub. Co. Pvt. Ltd 1st edition 1985.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	1	1	1	1
CO2	1	-	2	2	2	-
CO3	1	1	1	2	2	2
CO4	1	1	1	1	1	1
CO5	--	-	-	1	1	1
Avg	1.00	1.00	1.25	1.40	1.40	1.25

FD3010 SPICES, CONDIMENTS AND PLANTATION PRODUCTS L T P C

3 0 0 3

OBJECTIVE

The course aims to study about processing of spices and plantation crops and understand the technology used for their processing, preservation and value addition.

UNIT I SIGNIFICANCE OF SPICES AND CONDIMENTS 9

Spices and Condiments - Description of various types of spices and condiments, their composition, functional properties, flavouring agents. Nutritive value of spices and their health benefits. Intermediate Moisture Products viz., ginger paste, ginger – garlic paste, tamarind paste, tamarind concentrate, processing of spices like chilli, turmeric pepper, ginger etc.

UNIT II POWDERS 9

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

UNIT III ESSENTIAL OIL AND OLEORESINS 9

Spice Oils – Concept and importance of spice oils from spices like and condiments like clove, cardamom, cinnamom etc. Extraction methods of spice oils by various techniques, viz., solvent extraction, steam distillation etc. Extraction of Oleoresins- Concept and importance of oleoresins in food processing, solvent extraction of oleoresins. De- solventization methods, regulatory and statutory requirements for oleoresin processing.

UNIT IV TEA AND COFFEE 9

Plantation crops-description of various types of plantation crops viz. coconut, areca nutcoffee, tea, cocoa etc. Production and processing of Tea leaves: Black tea, Green tea and Oolong tea. Chemistry of tea manufacturing and tea quality; tea aroma precursors; tea flavour; tea grades; storingof tea Instant tea, tea concentrates, decaffeinated tea, flavoured tea; herbal tea. Production and processing of coffee cherries by wet and dry methods to obtain coffee beans, grinding, storage and preparation of brew, Soluble /Instant coffee, Use of chicory in coffee, decaffeinated coffee, coffee concentrate.

UNIT V COCOA AND COCONUT 9

Production, processing and chemical composition of cocoa beans. Cocoa Processes: Cleaning, roasting, alkalization, cracking and fanning, Nib grinding for cocoa liquor, cocoa butter and cocoa powder. Manufacturing process for chocolate: Ingredients, Mixing, Refining, Conching, Tempering, Moulding etc. to obtain chocolate slabs, chocolate bars. Enrobed and other confectionary products. Composition, Structure and characteristics of cashew nut and other dry fruits. Coconut - processing and preservation methods, Value added and shelf stable products viz., bottled coconut water, desiccated coconut powder, processed products from cocoa like chocolate.

TOTAL : 45 PERIODS

OUTCOME

At the end of the course the students will be able to

CO1 Define and describe process spices, spice powders, essential oil and oleoresins.
CO2 Explain and illustrate steps involved in processing of spices and spice products
CO3 Understand and appraise method of extraction of essential oil and oleoresins
CO4 Describe and demonstrate methods involved in processing of plantation crops
CO5 Describe and analyze about the production, processing and preservation of cocoa beans and coconut

REFERENCE BOOKS

1. ASTA,. Official analytical methods of the American Spice Trade Association, 4th Edition 1997.
2. Pandey,P.H.. Post Harvest Engineering of Horticultural Crops through Objectives. Saroj Prakasan, Allahabad,1st edition 2002
3. Purthi, J. S. Minor Spices and Condiments: Crop Management and Post Harvest Technology, ICAR publication 1st edition , 2001
4. Purthi, J. S. Major Spices of India: Crop Management and Post Harvest Technology, (ICAR publication, J W Parry(1969). Spices : Morphology, History, Chemistry, Chemical Publishing Co., New York 1st edition 2003
5. Woodroof, J. G. Tree Nuts: Production, Processing, Products, (AVI Pub. Co., 1979) 3rd

edition 2015

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	2	2	2	1
CO2	2	2	-	1	1	1
CO3	1	1	-	2	1	1
CO4	1	-	1	2	2	1
CO5	1	1	1	3	2	2
Avg	1.25	1.33	1.33	2.00	1.60	1.20

FD3011 BY-PRODUCT UTILIZATION IN FOOD INDUSTRIES L T P C
3 0 0 3

OBJECTIVE

The course aims to educate students about the Origin and type of waste and by products, waste identification, classification and composition.

UNIT I FOOD INDUSTRY BY-PRODUCTS AND WASTE 9

Status in India, definition, origin and types of waste and by-products, their identification, classification, composition and characterization, need for treatment and utilization, impact on environment, food waste as source of biogenic raw material and energetic utilization, legal and statutory requirements for food waste handling, treatment & disposal.

UNIT II INTRODUCTION TO FOOD WASTE TREATMENT 9

Basic unit operations, techniques & equipment for treatment, primary treatments like screening, sedimentation, skimming, floatation coagulation & flocculation, flow equalization, filtration, adsorption, chemical oxidation, membrane separation, ion exchange. Anaerobic & aerobic digestion of organic wastes, activated sludge process, biomass generation & its utilization.

UNIT III FOOD WASTES AND BY-PRODUCTS RELATEDTO SPECIFIC PROCESSING INDUSTRIES 9

Fruit and vegetables, dairy industry, oil and oil seeds industry, sugar industry, grains and milling industry, fermentation industry, livestock and poultry, fish, meat processing industries, Spice processing industries etc.

UNIT IV WASTE UTILIZATION AND CASE STUDIES 9

Utilization of whey for protein extraction and beverages from dairy industry, Utilization of specific plant by-products for recovery of proteins, pectins, dietary fibres, antioxidants, colorants etc., Utilization of biomass for production of animal feed, Extraction of leaf protein, banana fibre, pectin from waste of fruits, lycopene from tomato waste, starch manufacture, production of gelatin, utilization of egg shell, extraction of oil from wheat germ, corn germ andrice bran, Extraction of protein from oil cake, deoiled rice bran etc.,soap formation, toffee/pinnifrom ghee residue.

UNIT V AGRO WASTE 9

Farm wastes, solid waste management and its disposal, Biogas generation, Biofuel, production of food packaging materials from agro waste, Compost/Vermicompost, Future Trends.

TOTAL: 45 PERIODS

OUTCOME

At the end of the course the students will be able to

CO1 Understand and appraise the basics of by-products generated in various food processingindustries

CO2 Describe and demonstrate wastes generated and the methods to dispose & to treat the wastes

CO3 Identify waste from various food processing industries, compare and explain

conversion of waste to value added products
CO4 Explain and illustrate methods of utilizing waste
CO5 Describe management of agro waste

REFERENCE BOOKS

1. Waste Management for the Food Industries, by Ioannis S. Arvanitoyannis, First edition, Elsevier Inc, 1st edition USA.
2. Food and Agricultural Wastewater Utilization and Treatment, Sean X. Liu,First edition Blackwell Publishing, Iowa 50014, 1st edition 2007 USA.
3. Managing Food Industry Waste, ROBERT R. ZALL, , Blackwell Publishing Professional,Iowa, USA 1st edition 2004.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	2	1	1
CO2	3	2	2	2	3	2
CO3	2	2	3	-	2	1
CO4	1	1	2	3	2	2
CO5	1	1	2	3	1	3
Avg	1.60	1.40	2.00	2.50	1.80	1.80

FD3012 FLAVOUR TECHNOLOGY

L	T	P	C
3	0	0	3

OBJECTIVE

The course aims to provide in-depth knowledge on food flavouring materials and flavour compounds involved in development of flavour and the analytical techniques involved in flavour analysis and mechanisms of flavour perception

UNIT I SOURCES AND TYPES OF FOOD FLAVOURS 9

Principal types of flavourings used in foods, Nature-identical flavouring substances, Artificial flavouring substances, Flavour constituents from onion, garlic, cheese, milk, meat, vegetables, fruits; Flavour constituents of wine, coffee, tea, chocolate, spices and condiments, Fragrance oil (Vanilla, Mandarin orange, Cinnamon, Lemongrass, Peppermint etc.) essential oil flavour. Basics of flavour, flavour and taste perception, smell and taste sensation, olfaction, flavour compounds, volatile flavour compounds, chemesthesis and chemesthetic responses, tactile response, Aroma compounds, flavour profile, bio-flavour and reconstituted flavour.

UNIT II FLAVOUR COMPOUNDS 9

Methods of flavour extraction, isolation, separation; Distillation, solvent extraction, enzymatic extraction, static headspace, dynamic headspace etc Flavouring materials: natural flavouring, derivatives of spices, essential oils, oleoresins, fruits and fruit juices and concentrates. Aromatic vegetable flavours, flavours derived from processing and roasting, enzymatically derived and modified flavouring, flavours made by fermentation, pyrolysis, biotechnology role to produce flavour, production of natural flavour by microbial and enzymatic action. Flavour intensifier/ potentiators – chemistry and technology, classifications – traditional, yeast extract, table salt as Flavour potentiators, HVP, MSG and 5'-Nucleotides – toxicity, other potentiators umami tasting glutamate conjugates, alapyridaine, sweetness potentiators, maltol and ethyl maltol, cyclic enolones.

UNIT III PROCESS FLAVOURS 9

Process flavours: Effect of processing on organoleptic quality of food, flavour precursors, flavour development on cooking, microwave heating, roasting, baking, smoking, boiling, cooling, freezing, caramelization, fermentation, pathway for flavour formation via maillard 41 41 reaction, kinetics of maillard reaction and flavour formation, flavours from lipids, deep fat fried flavours, Principles and techniques of flavour encapsulation, types of encapsulation; Factors affecting

stabilization of encapsulated flavour and their applications in food industry –Effect of storage, processing, transportation and environmental conditions on flavour components.

UNIT IV FLAVOUR ANALYSIS 9

Sample preparation and Aroma Isolation, methods of aroma isolation, instrumental analysis ofaroma isolates – GC, GC/O, GC-MS/O, E-nose, Taste compounds – volatile and non volatile compounds, off – flavour and taints in food, sensory aspects of off-flavour testing – due to chemical change, microbes.

UNIT V FLAVOUR LEGISLATION 9

Flavour legislation, Modelling flavour release, Useful principles to predict the performance of polymeric flavour delivery systems, Delivery of flavours from food matrices, Packaging and flavour compounds interaction On-line monitoring of flavour processes, Sensory methods of flavour analysis.

TOTAL: 45 PERIODS

OUTCOME

Upon completion of the courses, student can

CO1 Identify and understand the various mechanisms of flavour formation and flavour release
CO2 Explain metabolic routes leading to flavour formation in plants
CO3 Demonstrate and appraise off-flavour defects in foods and strategies of identification.
CO4 Discriminate, analyse and assess extracted and isolated flavour compounds.
CO5 Understand the legislation and regulations related to flavouring substances infood products.

REFERENCE BOOKS

1. Gray Reineccius, Flavour chemistry and Technology, CRC Press/Taylor &Francis, BocaRaton, 2nd edition 2006
2. Sources Book of Flavours, 2 nd Ed., G. Reineccius, Chapman and Hall. New York,928 pp2nd edition 1994.
3. Flavour measurents, , C.T.Ho & C. Manley Ed., Marcel Dekker Inc. IFT Basic Symposiumseries, 379 pp 1st edition 2006.
4. Heath, H. B. Flavour chemistry and technology, Springer Netherlands, 1st edition 1986. Piggott, J. R., Paterson, A. Understanding Natural Flavours, Springer US, 1st edition 1994

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	1	1	1	3
CO2	1	3	-	1	-	1
CO3	3	2	2	3	1	2
CO4	1	2	1	1	1	2
CO5	3	2	1	1	3	2
Avg	2.00	2.40	1.25	1.40	1.50	2.00

FD3051 FUNCTIONAL FOODS L T P C
3 0 0 3

OBJECTIVE

The course aims to impart the knowledge on the importance of functional ingredients and nutraceuticals and utilization of functional ingredients in development of new food products including health foods, functional foods and specialty foods.

UNIT I IMPORTANCE OF MICRONUTRIENTS AND BIOACTIVECOMPONENTS 9

Nutritional status and dietary requirement of different target group and deficiency diseases, in special reference to micronutrients. Dietary and therapeutic significance of nutrients, bioactive components in dairy products like lactose, whey proteins, milk minerals, CLA, fermented milks

etc. Infant nutrition and dietary Formulations for meeting normal and special needs of infants,current status of infant foods, additives for infant foods. Foods foraged persons, design consideration, ingredients for geriatric foods.

UNIT II FOOD FORTIFICATION 9

Food fortification - techniques for fortifying foods with minerals and vitamins, High proteinfoods prospective nutraceuticals for fortification of foods. Nutritional significance of dietary fibers, classes of dietary fibers, fortification techniques for fibers in foods.

UNIT III FOOD FOR HEALTH SIGNIFICANCE 9

Technological aspects of reduced calorie foods, alternatives for calorie reduction, low calorie sweeteners, bulking agents and their application, fat replacers and their utilization in low calorie dairy foods. Nutritional and health significance of sodium in foods,
Alternatives for sodium in foods, techniques for reducing sodium in processed dairy foods. Bio-flavours and flavour enhancers. Herbs, various classes of herbs, their therapeutic potential and application in foods, determination of bioavailability of nutrients.

UNIT IV FOOD FOR DISEASE CONTROL 9

Definition and various classes of phytochemicals, Special foods/nutrients their role in CVD, Cancer and immune system enhancer, utilization in functional foods, phytosterol, phytoestrogens, glucosinolates, organosulphur compounds, flavonoids, carotenoids, etc. Special foods/nutrients for persons suffering with milk allergy and lactose intolerance with special emphasis on nutrients and foods. Sports foods – ingredients, components in sportsfoods, sports drinks, design consideration, ergogenic aids in sports nutrition.

UNIT V CLASSIFICATION AND SAFETY 9

Definition, classes of functional foods, status of functional foods in world and India. Concept of new product development, classed of nutraceuticals and functional foods. Safety; marketing strategy and consumer response; economic analysis and costing of novel foods, recent advances in different categories and type of foods, Prebiotic substances and their utilization in functional foods, symbiotic foods, technological aspects and recent development in probiotics, prebiotics and synbiotics.

TOTAL: 45 PERIODS

OUTCOME

At the end of the course the students will be able to

CO1 Explain the concept of Functional Foods and differences with food supplements, fortified foods, novel foods and medicines

CO2 Acquire proficiency in formulation and delivery functional food products.

CO3 Describe and demonstrate the role of food in nutritional well being.

CO4 Explain and illustrate the diverse classes of phytochemicals and their significance in promoting health, preventing diseases, and enhancing the immune system,

CO5 Develop a critical understanding to judge the difference between marketing and consumer perception and scientifically based knowledge regarding potential future Functional Foods

REFERENCE BOOKS

1. Chadwick, R. Functional Foods. Springer Publ., Berlin. 1st edition 2003.
2. Desai, B. B., Handbook of Nutrition and Diet. Marcel Dekker, New York1stedition2019
3. Gibson, G., and William, Cristine. Functional Foods. CRC Press, Boca Roston,Boston 1st edition 2000.
4. Goldberg I (Ed.), Functional Foods. Chapman & Hall, New York. 1st edition1994.
5. Haberstroh, Chuck E., Fat and Cholesterol Reduced Foods. Gulf PublishingCompany, Huston. 1st edition 1991.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	-	1	3
CO2	2	1	2	1	2	2
CO3	3	2	3	2	1	2

CO4	1	1	1	2	1	1
CO5	2	2	1	1	2	3
Avg	2.00	1.40	2.00	1.50	1.40	2.20

FD3013 FOOD LEGISLATION AND STANDARDS L T P C
3 0 0 3

OBJECTIVE

The course aims to provide in-depth knowledge in topics related to food legislation and standardization and insight for the students in food manufacture and in food trade.

UNIT I INDIAN FOOD REGULATIONS 9

Need for food regulation, Food Safety and Food Standards Act 2006, Food Safety and Standards Authority of India (FSSAI) structure and functions, scientific committees and panels under FSSAI, Rule and Regulation making process.

Food Safety and Standards Act, 2006 and the regulations made thereunder like Licensing and Registration, Packaging and Labelling Regulation, Food Products Standards and Food Additives Regulation, Nutraceutical Regulation, Claim Regulation, Contaminants and Toxins Regulation.

UNIT II PRODUCT SPECIFIC INDIAN REGULATIONS 9

Indian Food Regulation - Food product categorization, Use of food additives in different products, Processing aid regulation New product /additive approval Food Product Recall, BIS mandatory certified products, Packaged Commodity Rules, AGMARK, etc including latest amendments.

UNIT III INTERNATIONAL FOOD REGULATIONS 9

Concepts and trends in food legislation, Information-Domination in the European Food Industry, Agriculture, Ethics and Law, WHO in Global Food Safety Governance, The Right to Food in International Law with Case Studies.

Intellectual Property and Food Labelling: Trademarks and Geographical Indications, Agricultural Innovation: Patenting and Plant Variety Rights Protection, Cross- Contamination, Genetic Drift, and GMO Co-existence with Non-GM Crops, Legal Barriers to International Food Trade, food policies.

UNIT IV PUBLIC HEALTH AND NUTRITION REGULATION 9

Roles on Nutrition Goals and Outcomes: Connecting of Food and Public Health Systems, Planetary Boundaries in Food and Agriculture Law, Food and Nutrition in Cancer Prevention and Treatment, Pesticides and Cancer in Conventionally-Grown Versus Organic Food.

UNIT V FOOD SECURITY AND SAFETY LEGISLATION 9

Internalizing Externalities: Techniques to Reduce Ecological Impacts of Food Production, Cooperatives and Producer Organizations Roles in Achieving Food Security, Governing the Global Food System Towards the Sustenance with Artificial Photosynthesis.

Food Safety and Policy, Trade, Labelling Law - European Food Law, United States and Canada, Australia and New Zealand, Africa, Asia, Association of Southeast Asian Nations (ASEAN).

TOTAL: 45 PERIODS

OUTCOME

At the end of the course the students will be able to

CO1 Identify the Agency responsible for legislation & implementation when facing a problem concerning a food

CO2 Describe about Food product categorization and explain the Use of food additives in different products

CO3 Explain and illustrate international food regulations

CO4 Describe and demonstrate national and international regulations for foods with nutraceutical benefits

CO5 Review legislative approaches for the management of food safety

REFERENCE BOOKS

1. Understanding the Codex Alimentarius, By Food and Agriculture Organization of the United Nations, World Health Organization, 2nd edition2016
2. International Food Law and Policy, edited by Gabriela Steier, Kiran K. Patel, FoodLaw International, Springer, 1st edition 2016.
3. Singal RS.. Handbook of Indices of Food Quality and Authenticity; Woodhead Publ. Cambridge, UK 1st edition 1997.
4. H J Heinz, David A. Shapton, Norah F. Shapton., Principles and Practices of Safe Processing of Foods; Butterworth Publication, London 2nd edition 2013.
5. Jacob MB. The Chemical Analysis of Foods and Food Products; CBS Publ. New Delhi 1st edition 1999

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	2	2	3	1
CO2	1	2	1	3	1	3
CO3	2	3	-	1	2	1
CO4	2	-	1	2	1	3
CO5	3	1	2	3	2	2
Avg	1.80	1.75	1.50	2.20	1.80	2.00

FD3014 CONTROL OF FOOD INFESTATIONS

L	T	P	C
3	0	0	3

OBJECTIVE

The course aims to inculcate in-depth knowledge about pest infestation and its associated risk.

UNIT I FOOD INFESTATION **9**

Post harvest problems of infestation in stored food grains, spices and processed foods and food processing units; Economic losses and safety issues.

UNIT II COMMON PESTS **9**

Common pests involved in food storage and handling: pests and their habits: rodents, cockroaches, flies, ants, stored product insects – beetles, weevils, moths; birds and other vertebrates.

UNIT III RISK FROM PESTS **9**

Risk posed by pests to foods, food handlers and public; contamination, toxicology and microbiology, transmission of pathogens, food infection and food poisoning. Food hygiene: regulations, GHP and GMP relevant to pest control.

UNIT IV PEST PREVENTION **9**

Pest prevention- E-R-D Exclusion, restriction, destruction in food operations; building design and pest proofing, warehousing and storage areas, water and drains. Waste collection and disposal.

UNIT V PEST CONTROL **9**

Inspection and auditing, physical methods: use of monitoring traps/detectors – electric flycontrol units, pheromone traps; Chemical control methods – use of insecticides, pesticides and rodenticides, safety and environmental consideration of chemicals used for control, biopesticides; fumigation and disinfection; Pest awareness training and education. Integrated Pest Management in the food industry, Regulatory aspects of pest management.

TOTAL: 45 PERIODS

OUTCOME

At the end of the course the students will be able to

CO1 Understand and appraise post-harvest issues in stored grains and processed foods

caused by pests
CO 2 Identify, classify and describe on the types of pests
CO3 Describe and demonstrate role of pest in safe handling of food
CO4 Explain and illustrate on pest prevention techniques
CO5 Analyze about Regulatory aspects of pest management

REFERENCE BOOKS

1. Dennis, S. H. "Pests of Stored Foodstuffs and their Control", Springer, 1st edition2002
2. Hall, F.R and Menn, J.J. "Biopesticides: Use and Delivery", Humana Press, 1st edition1999
3. Rami, H., et al. "Integrated Pest Management: Potential, Constraints and Challenges Insect Pest Management: Field and Protected Crops", 1st edition 2004
4. David Pimentel, Encyclopedia of Pest Management, Volume 2, CRC Press, 1st edition 2007

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	1	2	1	3
CO2	1	3	1	1	3	2
CO3	1	2	-	1	2	2
CO4	3	3	1	2	3	2
CO5	1	3	2	1	1	2
Avg	1.80	2.80	1.25	1.40	2.00	2.20

FD3015 ESTABLISHMENT AND MANAGEMENT OF FOODINDUSTRY SYSTEMS L T P C
3 0 0 3

OBJECTIVE

This course aims to inculcate students with management skills required for the start-up of the food industry.

UNIT I OVERALL DESIGN OF AN ENTERPRISE 9

Plant design, sales planning for plant design. Plant Location, levels of Plant location. Location of layout: location factors, plant site selection. Location theory and models, industrial buildings and grounds. farm level collection and Chilling center. Space requirement.

UNIT II PREPARATION OF A PLANT LAYOUT 9

Plant Layout problem, importance, objectives, classical types of layouts. Evaluation of Plant Layout. Advantages of good layout. Organizing for Plant Layout, Data forms. Development and Presentation of Layout: Development of the pilot layout, constructing the detailed layout: Functional de sign: Sitting of different sections in a plant, Layout installations. Quantitative analysis for Plant Layout: Engineering economy. Linear programming. Queing theory. Common Problems in Plant Layout and Process scheduling.

UNIT III PRACTICAL ASPECTS OF DESIGNING PLANT LAYOUT 9

Siting of Process sections, Equipment selection and capacity determination, Arrangement of process, and service equipment. Estimation of Services and Utilities. Office layout, line balancing, Flexibility. Practical Layouts. Common materials of construction of Food plant, building. Maintenance of Food Plant Building, Illumination and ventilation, Cleaning & sanitization, painting and colour coding, Fly and insect control.

UNIT IV LICENSING AND REGISTRATION 9

FSSAI regulations: Central Licensing Authority- Registration of Petty Food Business- License for food business- Conditions of License- Sanitary and hygienic requirements- foodoperations and controls - Management and Supervision - Food Testing Facilities - Audit, Documentation and Records

UNIT V FUNDING AGENCIES 9

Technology development funds-NRDC, DSIR; Funds for patent protection- Ministry of

MSME,NIF; Technology in licensing funds- DSIR; Technology scale- up/ validation/ de- risking funds-DST, SIDBI, DIT; Market entry funds- NIF, KITVEN, Ministry of new and renewable energy, Angel network; Expansion funds- Venture capitalists, NABARD, Smalland medium stock exchanges, Venture Funds with Govt. of India involvement.

TOTAL: 45 PERIODS

OUTCOME

At the end of the course the students will be able to

CO1 Understand the basics of designing a plant.

CO2 Describe, demonstrate and prepare a plant layout .

CO3 Identify and appraise the practical aspects of designing a plant layout

CO4 Understand and apply FSSAI regulations at various stages of business establishment

CO5 Analyze Technology development funds

REFERENCE BOOKS

1. J. Andres Vasconcellos, "Quality Assurance for the Food Industry: A Practical Approach, Quality Assurance for the Food Industry: A Practical Approach", CRC Press, 1st edition2003,
2. R. Bruce Tompkin, "Microbiological Testing in Food Safety Management", SpringerScience & Business Media, 1st edition 2002,

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	3	2	3	1
CO2	-	2	2	2	-	-
CO3	-	2	-	2	1	-
CO4	-	3	1	3	2	3
CO5	1	-	-	-	-	2
Avg	1.50	2.50	2.00	2.25	2.00	2.00

FD3016 ADVANCED INSTRUMENTATION FOR FOOD SAFETY AND QUALITY **L T P C**
3 0 0 3

OBJECTIVE

This course aims to impart advanced knowledge on the principles and instrumentation of spectroscopic and chromatographic hyphenated techniques used in food safety and quality assessments. This course also emphasizes on inculcating knowledge on modern analytical instruments that are used for food testing

UNIT I HPLC ANALYSIS OF FOOD **9**

HPLC analysis of food: HPLC (High performance liquid chromatography). Introduction, principle of separation, components of an HPLC system. Pump, injector, column (column hardware and column packing materials in brief) detector and different types of detectors, recorder, Application of HPLC, Minimum Response, Performance level- operation quotientand performance quotient.

UNIT II GCMS ANALYSIS OF FOOD **9**

Gas Chromatography: Gas chromatography Introduction, sample preparation, principle of separations, components gas supply system, injection port, oven, column and stationary phases, types of columns, detectors different types of detectors, recorder, types of carriergases used. Gas liquid chromatography: principle; different types of detectors and its applications: discharge ionization detector (DID), electron capture detector (ECD), flamephotometric detector (FPD), Hall electrolytic conductivity detector (ElCD), helium ionization detector(HID), Nitrogen phosphorous detector (NPD), mass selective detector (MSD), photo ionization detector (PID), pulsed discharge ionization detector (PDD), thermal energyanalyzer (TEA); various applications of GLC. Gas chromatography-mass spectrometry (GC- MS): principles and applications in foods, flavors and fragrances, residue analysis of veterinary hormonal substances and endocrine disruptors, identification of terpenes.

UNIT III LCMS ANALYSIS OF FOOD 9

Liquid chromatography-mass spectrometry (LC-MS): principles and applications, plant phenols, proteins, proteomics, LC-MS for identification of post-translational modifications, oligosaccharides, lipids and phospholipids, nucleic acids. Inductively coupled plasma atomic emission spectroscopy (ICP/MS/OES/AES): principles and its applications. Scanning Electron Microscopy principles and applications, study of the structure of variety of food gels

UNIT IV NON DESTRUCTIVE TECHNIQUES IN FOOD ANALYSIS 9

Non Destructive Techniques in Food Analysis: optical methods like visible, NIR, and FTIR spectroscopy; computer vision, delayed light emission and fluorescence; X-ray imaging for classifying food products based on internal defects; nuclear magnetic resonance techniques; ultrasonics; firmness measurement methods; linear visco-elastic methods; biosensors in food quality evaluation, new techniques for food quality data analysis and control.

UNIT V MICROBIAL TECHNIQUES IN FOOD ANALYSIS 9

Microbial techniques in food analysis: Infectious and toxigenic agents of food borne diseases: detection, identification and control methods. Antibiotic resistant strains; methods of detection, conventional, modern, rapid methods, genetic approaches. Molecular based techniques in food analysis: Gel Electrophoresis of Plasmid DNA, Polymerase Chain Reaction (PCR) & Sequencing; Setting up a Gene-Specific Polymerase Chain Reaction, Gel Electrophoresis of Gene-Specific PCR Products, Determining DNA Concentration Using Fluorometer, Amplification of cDNA Using PCR, Sequencing of Gene-Specific
Products. Real-time PCR assay for detection of microbial spoilage of foods.

TOTAL: 45 PERIODS

OUTCOME

At the end of course, students will be able to

CO 1 Demonstrate, analyze, construct and assess quality of food using HPLC
CO 2 Demonstrate, analyze, construct and assess quality of food using GCMS
CO 3 Demonstrate, analyze, construct and assess quality of food using LCMS
CO 4 Demonstrate, analyze, construct and assess quality of food using Non- destructive techniques
CO 5 Demonstrate, construct microbial analytical techniques.

REFERENCE BOOKS

1. Nielsen, S.S. Introduction to the chemical analysis of foods. Jones and Bartlett Publishers,
2. Boston, London.2004.
3. Mahindru,S.N. Food additives. Characteristics, detection and estimation.Tata McGraw-Hill Publishing Company Limited, New Delhi.2000.
4. Pearson, D. The Chemical Analysis of Foods. Churchill Livingstone, New York. 2002.
5. Sharma, B.K. Instrumental Methods of Chemical Analysis. Goel Publishing House, New Delhi. 2004.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	3	1	3
CO2	3	1	3	3	1	3
CO3	3	1	3	3	1	3
CO4	3	1	3	3	1	3
CO5	3	1	3	3	1	3
Avg	3	1	3	3	1	3

FD3017 FOOD SAFETY AND RISK ANALYSIS L T P C
3 0 0 3

OBJECTIVE

To inculcate students about food safety and risk analysis for the modern day foods and food

based products

UNIT I OVERVIEW OF FOOD SAFETY 9

The importance of food safety, how food borne illness affects consumers and retailers, howpoor safety practices affect food products, Food hazards, the food business, the responsibilities of the managers, Penalties applicable to poor food handlers, Enforcement officers, Basic rules regarding personal hygiene, good manufacturing and hygiene practicesat various sectors of food processing.

UNIT II INTRODUCTION TO RISK ANALYSIS 9

Introduction, Changing International Environment, Increasing Demand for "Safe and Wholesale Food", Risk Analysis Definitions related to Food Safety, Risk Analysis: Structure of Risk Analysis, Carrying out Risk Analysis, Risk Analysis at International and National Levels. Challenges and benefits in the application of risk analysis.

UNIT III RISK MANAGEMENT 9

Introduction, Definitions of key Risk Management Terms, General principles of Food Safety Risk Management, General Risk Management Framework: Preliminary Risk management activities, selection of risk management options, implementation of risk management decisions, monitoring and review. Role of food chain professionals in Risk Management: Self-monitoring and company Laboratory Accreditation, Guides to good hygiene practices, the development of company certification, product standardization, contribution to product traceability

UNIT IV RISK ASSESSMENT 9

Introduction, Definitions related to risk assessment, principles of Food safety risk assessment, scientific approaches for assessing risks, responsibilities of risk managers incommissioning and guiding a risk assessment, general criteria of risk assessment, risk assessment methodology, risk assessment for chemical hazards, risk assessment for biological hazards, Biotechnology risk assessment, sensitivity analysis, validation, establishment of 'Targets' in the food chain as Regulatory standards

UNIT V RISK COMMUNICATION 9

Introduction, Understanding risk communication, the goals of risk communication, key communication stages during food safety risk analysis, role and responsibilities for risk communication, principles of risk communication, some practical aspects of risk communication.

TOTAL: 45 PERIODS

OUTCOME

At the end of the course the students will be able to

CO1 Understand about Basic rules regarding personal hygiene, good manufacturing and hygiene practices at various sectors of food processing

CO2 Understand and explain the principles of risk analysis, and how to utilize it to make decisions related to food safety and other health issues.

CO3 De scribe and demonstrate the risk management decision process

CO4 Enumerate on various risk assessment techniques

CO5 Understanding risk communication, the goals of risk communication.

REFERENCE BOOKS

1. Yasmine Motarjemi Huub Lelieveld, "A practical Guide for Food Industry",Academic Press, 2nd edition 2013
2. Jan Mei Soon and Richard Baines" Managing Food Safety Risks in Agri Food Industries", CRC Press 2nd edition 2014
3. Barbara Almanza Richard Ghiselli "Food Safety, Researching the Hazard in Hazardous Foods", Apple Academic Press 1st edition 2014

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	-	2	1	-

CO2	-	2	-	3	2	1
CO3	3	2	-	3	2	-
CO4	2	3	-	2	1	1
CO5	2	3	-	2	1	1
Avg	2.25	2.60	-	2.40	1.40	1.00

FD3018 BEVERAGE TECHNOLOGY L T P C
3 0 0 3

OBJECTIVE

The course aims to educate students on basic ingredients used in production of alcoholic and non- alcoholic beverages and familiarize students with regulations and quality control involved in beverage industry.

UNIT I BASIC INGREDIENTS IN BEVERAGES 9

Beverage-definition-why we drink beverages-ingredients- water, carbon dioxide, bulk andintense sweeteners, water miscible and water dispersible flavouring agents, colours – natural and artificial, Micro and nano emulsions of flavours and colors in beverages, preservatives, emulsifiers and stabilizers. Plant based beverages – fruits, vegetables, cereals and pulses.

UNIT II BEER AND WINE 9

Ingredients- Malt- hops- adjuncts- water, yeast. Beer manufacturing process, distillation,malting, preparation of sweet wort, brewing, fermentation, pasteurization and packaging. Beer defects and Spoilage. Wine-fermentation-types –red and white. Wine defects and spoilage

UNIT III CARBONATED BEVERAGES 9

Procedures-carbonation equipment-ingredients-preparation of the Syrups-Filling system-packaging containers and closures

UNIT IV NON-CARBONATED BEVERAGES 9

Coffee bean preparation-processing-brewing-decaffeination- instant Coffee-Teatypes- black, green and oolong- fruit juices, nectars, quash, RTS beverages, isotonic Beverages. Flash pasteurization, Canning and Aseptic Packaging of beverages

UNIT V PACKAGING AND QUALITY CONTROL 9

Packaging of beverages – selection and effectiveness of pack, Effective application of quality controls, brix, acidity to brix ratio, single strength of juice- sanitation and hygiene in beverage Industry-Quality of water used in beverages - threshold limits of various ingredients according to PFA, EFSA and FDA – Absolute requirements of Soluble solids and titrable acidity in beverages.

TOTAL: 45 PERIODS

OUTCOME

At the end of the course the students will be able to

CO1 Understand various concepts, principles and procedures involved in processing of beverages.

CO2 Demonstrate various unit operations involved in the food beverage manufacturing.

CO3 Describe and demonstrate the methods of manufacturing carbonated beverages

CO4 Explain and illustrate methods of manufacturing non-carbonated beverages.

CO5 Analyze the regulations and standards related to ingredient thresholds and quality parameters.

REFERENCE BOOKS

1. Ashurst, P.R, "Chemistry and technology of Soft drink and fruit juices", Blackwell Publishing Ltd. 2nd edition2005.
2. Steen, D.P and Ashurst, P.R, "Carbonated soft drinks – Formulation and manufacture", Blackwell Publishing Ltd. 1st edition 2000.
3. Shankunthala Manay, N. and Shadakdharaswamy, M, "Foods – Facts and Principles", New Age International Pvt. Ltd, 3rd revised edition 2000.

4. Charles, W. Bamforth, “Food, fermentation and microorganisms”, Blackwell Science Publishing Ltd. 4th edition 2005.
5. Amalendu Chakraverty et al, “Handbook of Post-Harvest Technology”,Ed:.,Marcel Dekker Inc. volume 9 (Special Indian edition) 2000.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	3	3	1
CO2	2	2	-	2	2	1
CO3	1	2	1	3	1	-
CO4	3	2	-	2	3	-
CO5	1	2	2	-	-	-
Avg	2.00	2.00	1.33	2.50	2.25	1.00

FD3019 FOOD NUTRIGENOMICS L T P C
3 0 0 3

OBJECTIVE

The course aims to familiarize students with the basic concepts in nutritional genomics and to develop an understanding of genomics and gene regulation with respect to diet and obtain an appreciation for the role and importance of nutrition in prevention of polygenicdiseases.

UNIT I GENE-DIET INTERACTIONS 9

Nutrigenomics: Scope and Importance to Human Health and Industry Transporter gene polymorphisms -interaction with effects of micronutrients in humans. Polymorphisms in genes affecting the uptake and transport of omega-6 and omega-3 polyunsaturated fatty acids: interactions with dietary lipids and chronic disease risk. Nutrigenomics approaches to unraveling physiological effects of complex foods. The intestinal microbiota - role in nutrigenomics.

UNIT II MODULATING DISEASE RISK 9

Modulating the risk of cardiovascular disease through nutrigenomics; Modulating the risk of diabetes through nutrigenomics; Modulating the risk of inflammatory bowel diseases through nutrigenomics; Modulating the risk of obesity through nutrigenomics; Modulating the risk of cancer through nutrigenomics; Modulating the malnutrition through nutrigenomics

UNIT III GENOMICS AND PROTEOMICS TECHNIQUES 9

GENOMICS TECHNIQUES: Different sequencing approaches, Microarray, Mass array, SNP genotyping, PCR and RT-PCR techniques. Proteomics Techniques:1-D, 2-D gelelectrophoresis, DIGE, novel peptide identification, peptide sequencing methods

UNIT IV METABOLOMICS AND COMPUTATIONAL APPROACHES 9

Metabolomics techniques: Chromatography and mass spectrometry techniques, Discovery and validation of biomarkers for important diseases and disorders. Computational approaches: Introduction to different types of public domain databases, data mining strategies, primer designing.

UNIT V NUTRIGENOMICS 9

Bringing nutrigenomics to the food industry: Industry-Academia partnerships as an important challenge; Bringing nutrigenomics to the public: direct-to-consumer testing and future of nutritional genomics, Interaction with health professionals in bringing nutrigenomics to the public; status of contemporary society for nutrigenomic science, Public health significance of nutrigenomics and nutrigenetics

TOTAL: 45 PERIODS

OUTCOME

At the end of the course the students will be able to

CO1 Understand about Nutrigenomics approaches to unraveling physiological effects of complex foods

CO2 Analyze about Modulating the risk of inflammatory bowel diseases throughnutrigenomics
CO3 Differentiate between Different sequencing approaches, Micro array, Mass array,SNP genotyping, PCR and RT-PCR techniques
CO4 Define Chromatography and mass spectrometry techniques, Discovery and validationof biomarkers for important diseases and disorders
CO5 Bringing nutrigenomics to the public

REFERENCE BOOKS

1. Lynnette R. Ferguson, Nutrigenomics and Nutrigenetics in Functional Foods and Personalized Nutrition. 1st edition CRC Press, 2016.
2. J. Alfredo Martinez, Martin Kohlmeier, Raffaele De Caterina, Principles of Nutrigenetics and Nutrigenomics: Fundamentals of Individualized Nutrition. Netherlands: Elsevier Science, 2019.
3. Nutrigenomics and the Future of Nutrition: Proceedings of a Workshop. United States, National Academies Press, 2018.
4. Chukwuebuka Egbuna, Genevieve Dable-Tupas, Role of Nutrigenomics in Modern-day Healthcare and Drug Discovery. Netherlands, Elsevier Science, 2022.
5. Martin Kussmann, Patrick J. Stover, Nutrigenomics and Proteomics in Health and Disease: Towards a Systems-level Understanding of Gene-diet Interactions. United Kingdom, Wiley, 2017.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	2	2
CO2	3	3	-	2	-	3
CO3	2	2	-	2	2	3
CO4	1	2	-	2	1	2
CO5	2	2	-	2	2	2
Avg	2.20	2.40	3.00	2.00	1.75	2.40

FD3020 FOOD INFORMATICS L T P C
3 0 0 3

OBJECTIVE
The course aims to educate students on basics of bioinformatics and structural modelling of food ingredients and the biological sequences including next generation sequencingdata, tools and analysis and applications in food relevant topics

UNIT I INTRODUCTION TO BIOINFORMATICS AND SEQUENCEANALYSIS 9
Molecular sequences- Biological databases- Food specific Databases- Plant Databases- Sequence Alignment- Local and Global Alignment- BLAST family of programs- Multiple sequence alignment and its applications-Introduction to Phylogenetics- Building UPGMA- Neighbour Joining- Parsimonious and Maximum Likelihood trees.

UNIT II OMICS TECHNIQUES, NEXT GENERATION SEQUENCING DATAAND APPLICATIONS 9
Genome sequencing, Sequencing Pipeline, Genome sequences of fermentation related microorganisms, Lactic Acid Bacteria, Comparative genomics and tool, NGS Data Resources, GEO and SRA databases, RNA-Seq Data Analysis, Differential Gene expression analysis

UNIT III PROTEIN STRUCTURE, MODELING AND DOCKING 9
Protein Structure Basics, Visualization, Prediction of Secondary Structure and Tertiary Structure, Homology Modeling, Taste receptors and their structures, Molecular docking and applications, Ligand interactions with taste receptors

UNIT IV MICROBIOME, MICROARRAYS AND OTHER ADVANCEDTOPICS 9
Microbiome; Beneficial effects of diet and microbiome modulation; Microarrays, Clustering

techniques for microarray analysis; Introduction to Systems Biology; Metabolic networks; Metabolomic data resources, Building Stoichiometric matrices; Metabolic modeling

UNIT V APPLICATIONS OF INFORMATICS IN FOOD INDUSTRY 9

Enzymes in food industry, Systems Biology applications of metabolic modeling for strain improvement in fermentation, NGS data analysis for detection of food related pathogens, Comparative Genomics of food related pathogens. Laboratory Demonstrations for Biological Databases, Sequence alignment: BLAST family of programs, Crustal Omega for multiple sequence alignment, Phylogenetics software, Homology Modeling and Model evaluation, Auto Dock, NGS Data resources

TOTAL: 45 PERIODS

OUTCOME

At the end of course, student will be able to

CO1 Understand about BLAST family of programs, Multiple sequence alignment and its applications

CO2 Analyze about GEO and SRA databases

CO3 elaborate on Prediction of Secondary Structure and Tertiary Structure

CO4 Understand about Beneficial effects of diet and microbiome modulation

CO5 Differentiate among Systems Biology applications of metabolic modeling for strain improvement in fermentation

REFERENCE BOOKS

1. Dan Gusfield. Algorithms on Strings Trees and Sequences, , Cambridge UniversityPress 11th edition 2008
2. David W. Mount Bioinformatics: Sequence and Genome Analysis , ,Cold Spring Harbor Laboratory Press 2nd edition 2004
3. Arthur M. Lesk, Introduction to Bioinformatics, , Oxford University Press,5th edition2019
4. Andrew R. Leach, Molecular Modelling Principles and Applications, Prentice Hall 2nd edition 2010.
5. Durbin, R. Eddy S., Krogh A., Mitchison G. Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids, Cambridge university press 2ndedition 2013,

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	2	3	2	3
CO2	1	3	2	2	3	3
CO3	2	3	1	2	2	2
CO4	2	2	2	1	1	2
CO5	1	2	1	1	2	1
Avg	1.60	2.60	1.60	1.80	2.00	2.20

FD3021 FOOD PRODUCT DESIGN AND DEVELOPMENT L T P C
3 0 0 3

OBJECTIVE

The course aims to familiarize students with design, develop and scale up of food products and regulations in quality, safety and marketing of food products

UNIT I FOOD NEEDS & CONSUMER PREFERENCE 9

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

UNIT II DESIGNING NEW FOOD PRODUCTS 9

New Food Product Development (NPD) process and activities, NPD success factors, new product design, food innovation case studies, market-oriented NPD methodologies, organization for successful NPD; Recipe Development; use of traditional recipe and modification; recent

developments in food ingredients/additives flavourings, colorings, emulsifiers, stabilizer and sweeteners; involvement of consumers, chefs and recipe experts;selection of materials/ingredients for specific purposes; modifications for production on large scale, cost effectiveness, nutritional needs or uniqueness; use of novel food ingredients and novel processing technologies.

UNIT III STANDARDIZATION & LARGE-SCALE PRODUCTION 9

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

UNIT IV QUALITY, SAFETY & REGULATORY ASPECTS 9

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

UNIT V ADVERTISEMENT, MARKETING & CASE STUDIES 9

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

TOTAL: 45 PERIODS

OUTCOME

At the end of course, student will be able to

CO1 Describe and demonstrate various aspects of Creativity, Innovation and New Product Development

CO2 Design and develop new food products

CO3 Understand methods of standardization and apply for scaling up of production

CO4 Explain and Analyse about standard product and conformation to standards

CO5 Familiarize with food choice models and new product trends

REFERENCE BOOKS

1. Brody, A. L. and John B. L. “Developing New Food Products for a Changing Marketplace”, , CRC / Taylor & Francis, 2nd Edition 2008
2. Fuller, G.W. “New Food Product Development: From Concept to Marketplace”, CRC,3rd edition 2011
3. Macfie, H. “Consumer-led Food Product Development”, CRC/Wood Head, 1st edition2007
4. Side, C. “Food Product Development: Based on Experience”, Iowa State Press/Blackwell,2nd edition 2008
5. Gupta, R. “Food Retailing: Emerging Trends”, ICFAI University, Press, 1st edition2005

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	2	3	3
CO2	2	3	2	3	2	2
CO3	2	3	3	2	1	3
CO4	2	2	2	1	2	2
CO5	1	2	1	3	3	2
Avg	2.00	2.40	2.00	2.20	2.20	2.40

FD3022 SENSORY ATTRIBUTES AND EVALUATION OF FOODS L T P C
3 0 0 3

OBJECTIVE

The course aims to inculcate students with knowledge on principles and significance of the sensory perception mechanism

UNIT I PRINCIPLES AND SIGNIFICANCE 9

Definition and importance of sensory evaluation in relation to consumer acceptability and economic aspects; Factors affecting food acceptance; Terminology related to sensory evaluation, test protocol considerations; Basic principles: Senses and sensory perception, physiology of sensory organs, classificationof tastes and odours, threshold value factors affecting senses, visual, auditory, tactile and other responses.

UNIT II FLAVOURS AND ODOUR 9

Flavour: Definition and its role in food quality; Taste: Classification, taste qualities, relative intensity, reaction time, effect of disease, temperature, and taste medium on taste, basic tastes, interaction of tastes; Odour: Definition, classification, neutral-mechanisms, olfactory abnormalities, odor testing, techniques, thresholds, odour intensities, olfaction; Visual, auditory, tactile and other senses, vision, audition, oral perception other than taste;

UNIT III SENSORY MEASUREMENTS 9

Factors influencing sensory measurements: Attitudinal factors, motivation psychological errors in judgment, relation between stimulus and perception adaptation; Correlation of sensory and instrumental analysis; Requirements of sensory evaluation, sampling procedures; Interrelationship between sensory properties of food products and various instrumental and physio-chemical tests

UNIT IV SENSORY QUALITY EVALUATIONS 9

Application of sensory testing: sensory evaluation in food product development, sensory evaluation in quality control. Laboratory quality measurement: Types of tests, panel selection and testing environment, serving procedures, instruction to judges, difference tests, directional difference tests, classification of difference tests, two-sample tests, three-sample tests, multisampling tests, comparison of procedures, ranking, scoring, hedonic scaling, statistical interpretation of results, dilution procedures, descriptive sensory analysis, contour method, other procedures

UNIT V MARKET ANALYSIS 9

Consumer measurement: Factors influencing acceptance and preference, objectives of consumer preference studies, information obtained from consumer study, factors influencing results from consumer surveys, methods of approach, development of the questionnaire, types of questionnaires, serving procedures; Comparison of laboratory panels with consumer panels; Limitations of consumer survey

TOTAL: 45 PERIODS

OUTCOME

At the end of course, student will be able to

CO1 Describe and demonstrate basic anatomy and physiology of the sensory organs used to evaluate food

CO2 Define, classify and understand mechanism of flavour and odour preception

CO3 Understand, design and undertake sensory testing using different types of methodologies

CO4 Understand how to analyse sensory data and draw appropriate conclusion

CO5 Understand the factors that influence acceptance and preference in consumer behaviour

REFERENCE BOOKS

1. Amerine, M.A., Pangborn, R.M. and Rossles, E.B. Principles of Sensory Evaluation of Food. Academic Press, London e-book edition 2013.
2. Early, R. Guide to Quality Management Systems for Food Industries. BlackieAcademic 2nd edition 2012
3. Jellinek, G. . Sensory Evaluation of Food - Theory and Practice. Ellis Horwood 1stedition

1985.
4. Lawless, H.T. and Klein, B.P. . Sensory Science Theory and Applications in Foods.Marcel Dekker 1st edition 1991.
5. Macrae, R., Rolonson Roles and Sadlu, M.J.. Encyclopedia of Food Science & Technology & Nutrition. Vol. XI. Academic Press e-book edition 2003.

Course Articulation Matrix – MTech

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3	2	2	1	2	2
CO3	2	3	2	2	2	1
CO4	2	2	3	3	2	2
CO5	2	1	2	1	1	1
Avg	2.40	2.20	2.40	2.00	2.00	1.80

FD3023 ADVANCED FOOD MICROBIAL ANALYSIS L T P C
3 0 0 3

OBJECTIVE

The course aims to educate students on significance of microbial metabolism in food and application of food microbiology in preservation and safety of food

UNIT I MICROBIOLOGY OF FOODS 9

Fresh and fermented foods; common food borne bacteria and fungi – their general roles; parameters effecting microbial growth – extrinsic and intrinsic, combined intrinsic and extrinsic lactic antagonism and hurdle concept; growth kinetics

UNIT II MICROBIAL METABOLISM AND THE FOOD MATRIX 9

CHO metabolism, chemiosmotic theory of ATP synthesis; degradation of aromatics, alicyclics, aliphatics, alkenes, aromatic; anaerobic respiration, fermentation, chemolithotrophy, phototrophy; synthesis of carbon compounds. Action of microbes on food components; nature of microbial growth in food; principles of structural, mechanical and dynamic characteristics of food systems; introduction to predictive microbiology

UNIT III METHODS OF BACTERIAL IDENTIFICATION 9

Microbial genomics and the microbiome; morphological, physiological, biochemical, immunological/serological, phage typing, chemotaxonomic, numerical, molecular methods; genome sequencing, gene mapping

UNIT IV APPLICATIONS OF FOOD MICROBIOLOGY 9

Beneficial uses of bacteria in food; intestinal probiotics; concept of prebiotics, synbiotics; techniques for characterizing functional properties; problems of the food matrix; technologies for encapsulation; food and beverages for certain target groups; modified foods; stability and preservation of microbe functionality during processing; biosensors

UNIT V BIO-FUNCTIONALITY AND SAFETY OF FOOD 9

Toxicokinetic; mechanistic principles of toxic effects; genotoxic ology and carcinogenesis; functionality and potential dangers of food ingredients; effect of food additives; structure and chemistry of the most important residues and contaminants in food and feed; modern methods for their determination; requirements for trace analysis; microbial examination of food – recommended and supplementary tests

TOTAL: 45 PERIODS

OUTCOME

At the end of course, students will be able to

CO1 Discuss the incidence and types of microorganisms in foods

CO2 Describe microbial metabolism and its interactions with the food matrix

CO3 Analyse different methods of bacterial identification, including morphological,

physiological, biochemical, immunological.
CO4 Explain the effects of fermentation in food production and how it influences the microbiological quality and status of the food product.
CO5 Asses the bio-functionality and safety aspects of food, including toxico-kinetics, toxic effects, genotoxicology, food additives, residues and contaminants in food

REFERENCE BOOKS

1. Robert, E Levin. "Rapid detection and characterization of food borne pathogens by molecular techniques". CRC publications, 1st edition,2009.
2. Gobbetti, Marco, Di Cagno, Raffaella. "Bacterial Communication in Foods".Springer. 1st edition 2013.
3. Osman erkmen, T. faruk Bozoglu, "Food microbiology" John Wiley and sons, 1st
4. Fernando- Perez- Rodriguez, Antonio Valero, "Predictive microbiology in foods", 5, Springer 1st edition, , 2013.
5. Bergey's Manual of Systematic Bacteriology. Springer. 2nd edition, 2012

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	2	1
CO2	2	2	2	3	1	3
CO3	2	2	3	2	2	2
CO4	2	1	1	1	2	1
CO5	2	3	2	3	3	2
Avg	2.20	2.20	2.00	2.20	2.00	1.80

FD3024 APPLICATIONS OF ENZYMES IN FOOD INDUSTRY L T P C
3 0 0 3

OBJECTIVE
The course aims to provide in-depth knowledge on enzymes used in food product Development and application of enzymes in purification and their impact onsensory and nutritional quality

UNIT I INTRODUCTION TO ENZYMES USED IN FOOD INDUSTRY 9
Classification of enzymes, 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 enzymesused in Food industry and their mode of action, Overview of applications of enzymes in theFood industry, Newer enzymes and their actual and potential applications, fermentative production of enzymes (amylases, proteases, cellulases, pectinases, xylanases, lipases) used in food industry and their downstream processing

UNIT II ENZYMES IN PLANT PRODUCTS PROCESSING 9
Enzymes for production of protein hydrolysates and bioactive peptides, maltodextrins and corn syrup solids (liquefaction, saccharification, dextrinization, isomerization for production of high-fructose-corn-syrup), fructose and fructo-oligosaccharides. Fruit juices (cell wall degrading enzymes for liquefaction, clarification, peeling, debittering, decolourization of very dark coloured juices such as anthocyanases); baking (fungal α-amylase for bread making; maltogenic α-amylases for anti-staling; xylanses and pentosanases as dough conditioners; lipases or dough conditioning; oxidases as replacers of chemical oxidants; synergistic effect of enzymes); Oilseeds processing, formation of TAGs

UNIT III ENZYMES IN ANIMAL PRODUCTS PROCESSING 9
Enzymes as processing aids: Role of enzymes in cheese making and whey processing;meat and meat processing (meat tenderization); egg processing, extraction of fish oil, seafood (like surimi product), poultry, eggs, Animal feed

UNIT IV ENZYMES FOR PRODUCTION OF FOOD ADDITIVES 9

Enzyme processing for flavours through biotransformation's (enzyme-aided extraction of plant materials for production of flavours, production of flavour enhancers such as nucleotides; flavours from hydrolysed vegetable/animal protein); enzymatic approach to tailor- made fats, Enzymes as additives e.g. antioxidant or antimicrobial

UNIT V ENZYMES FOR FOOD PACKAGING & OTHER APPLICATIONS 9

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

TOTAL: 45 PERIODS

OUTCOME

At the end of course of course, students will be able to

CO1 List different enzymes applied in processing of foods

CO2 Describe and demonstrate the applications of enzymes in the production of various plant and animalproducts in food industries

CO3 Explain and illustrate the role of enzymes in the production of food additivesand novel applications on food packaging as sensors

CO4 Demonstrate the role of enzymes as additives in the food industry, including their useas antioxidants or antimicrobial agents.

CO5 Apply the knowledge about the use of enzymes inactive packaging and edible coatings and films

REFERENCE BOOKS

1. Flickinger MC & Drew SW.. Encyclopedia of Bioprocess Technology. A Wiley- Inter Science Publ volume 1-5 1999.
2. Kruger JE. Et al.. Enzymes and their Role in Cereal Technology. American Association of Cereal Chemists Inc 1st edition 1987
3. Nagodawithana T & Reed G.. Enzymes in Food Processing. Academic Press., 3rd edition 1993
4. Tucker GA & Woods LFJ.. Enzymes in Food Processing 2nd edition 1995. Whitehurst R & Law B.. Enzymes in Food Technology. Blackwell Publ, 2nd edition 2009

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	3	2	2	1
CO2	1	2	2	1	2	1
CO3	2	1	2	3	3	3
CO4	2	2	2	2	3	2
CO5	2	2	1	2	1	2
Avg	1.80	2.00	2.00	2.00	2.20	1.80

FD3025 NANOTECHNOLOGY IN FOOD APPLICATIONS

L	T	P	C
3	0	0	3

OBJECTIVE

The course aims to expose the students with the advanced concepts of nanotechnology and use of nanotechnology in processing and packaging of foods

UNIT I NANOPARTICLES- INTRODUCTION AND PREPARATION 9

Classifications of nanostructured materials- Nanoparticles and nanofibers- quantum dots, nanowires, Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic, Biological and Thermal properties. General methods of preparation- Bottom-up Synthesis-Top-down Approach: Co- Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE

UNIT II CHARACTERIZATION TECHNIQUES 9

X- ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysistechniques-AFM, SPM, STM, SNOM, ESCA, SIMS-Nanoindentation

UNIT III NANOTECHNOLOGY IN FOOD PROCESSING 9

Nanoencapsulation & microencapsulation- flavour & aroma encapsulation- Nano formulations for the delivery of bioactive compounds- Nanocarriers- Lipid Nanocarriers for Phytochemical Delivery in Foods- Nano-emulsions- Nano-dispersions Characterization & stability- Bioavailability studies- limitations- Electrospinning and Electrospraying Technologies- Applications in the food Industry, Nano-filtration, Nanoclusters, Nanochelates

UNIT IV NANOPACKAGING 9

Nanopackaging for enhanced shelf life- Potential of nanomaterials in food packaging- Nanopolymers, Nanocomposites, Nanolaminates and Nanostructured Coatings in Food Packaging- Smart/Intelligent packaging- Nano antimicrobials in enhancement of shelf-life offoods

UNIT V NANO SENSORS 9

Nanotechnology in Microbial Food Safety & bio-security- Electrochemical sensors for food analysis and contaminant detection- Monitoring and separation of food-borne pathogens using nanoparticles- Safety Assessment for Use of Nanomaterials in Food and Food Production- Efficacy Evaluation and Risk Assessment- Regulatory Framework for Food Nanotechnology

TOTAL: 45 PERIODS

OUTCOME

At the end of the course the students will be able to

CO1 Describe and demonstrate different methods for preparation and characterization of importantproperties of nanomaterials, commonly used in food sector

CO2 Enumerate nanoparticles applications in different food technology operations like processing & packaging

CO3 Accqrire knowledge on food safety components using nanomaterials

CO4 Analyze about the Potential of nanomaterials in food packaging like Nano polymers, Nanocomposites, Nanolaminates

CO5 Explain and apply Regulatory Framework for Food Nanotechnology

REFERENCE BOOKS

1. V. Ravishankar Rai, Jamuna A Bai, “Nanotechnology applications in the food industry”,CRC Press, 1st edition 2018
2. Jennifer Kuzma and Peter VerHage, Nanotechnology in agriculture and food production, Woodrow Wilson International Center, 1st edition 2006.
3. Lynn J. Frewer, Willehm Norde, R. H. Fischer and W. H. Kampers, Nanotechnology inthe Agri-food sector, Wiley-VCH Verlag, 1st edition 2011.
4. Alexandra Elena Oprea & Alexandru Mihai Grumezescu, ”Nanotechnology applications in food: Flavour, stability, Nutrition & Safety”, Academic Press, 1st edition 2017.
5. Mick Wilson, Kamali Kannangara, Geof smith, “Nanotechnology: Basic Science &emerging technologies” , Overseas press 1st edition 2005.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	-	2	3	3
CO2	2	-	2	2	3	2
CO3	3	2	1	3	3	2
CO4	3	1	2	1	3	3
CO5	1	2	2	2	2	2
Avg	2.20	1.50	1.75	2.00	2.80	2.40

FD3026 GENETIC ENGINEERING AND GENETICALLY MODIFIED FOODS **L T P C**
3 0 0 3

OBJECTIVE

To educate students on

- genetically modified plants, transgenicanimals and their engineering method
- genetically modified microorganisms & their applications in foods

UNIT I BASICS OF RECOMBINANT DNA TECHNOLOGY 9

Manipulation of DNA and RNA — Restriction and Modification enzymes, Design of linkers and adaptors. Characteristics of cloning and expression vectors based on plasmid and bacteriophage, Vectors for insect, yeast and mammalian system, Prokaryotic and eukaryotic host systems, Introduction of recombinant DNA in to host cells and selection methods.

UNIT II DNA LIBRARIES 9

Construction of genomic and cDNA libraries, Artificial chromosomes – BACs and YACs, Screening of DNA libraries using nucleic acid probes and antisera.

UNIT III SEQUENCING AND AMPLIFICATION OF DNA 9

Maxam Gilbert's and Sanger's methods of DNA sequencing. Inverse PCR, Nested PCR, AFLPPCR, Allele specific PCR, Assembly PCR, Asymmetric PCR, Hot start PCR, inverse PCR, Colony PCR, single cell PCR, Real-time PCR/qPCR — SYBR green assay, Taqman assay, Molecular beacons. Site directed mutagenesis.

UNIT IV TRANSGENIC TECHNOLOGY 9

DNA microinjection, Retroviral vectors, Transgenic animals – Knock in and knock out animals, Transgenic plants – Ti plasmid.

UNIT V APPLICATIONS OF RDNA TECHNOLOGY IN FOODS 9

Genetically engineered proteins: Bovine Somatotropin in Milk; Genetically engineered bacteria: ChymosinLite beer; Tryptophan; Transgenic plants: Calgene Flavr Savr TM tomato, Monsanto Round-Up TM Ready, Ciba GeigyBasta TM resistant crops; Edible vaccines: Cholera vaccine in potatoes; Transgenic Fish: Atlantic salmon.

TOTAL: 45 PERIODS

OUTCOME

At the end of the course the students will be able to

1. Understand genetically modified plants, animals and modifiedmicroorganisms
2. Describe and demonstrate applications of genetically engineered plants
3. Explain Risk and safety assessment of the GM foods and their label.
4. Apply the genetically modified microorganisms and their applications in foods
5. Explain and illustrate the applications of genetically engineered organisms and rDNA technology in foods.

REFERENCE BOOKS

1. Rees, Andy "Genetically Modifies Food: A Short Guide for the Confused". Pluto Press,1st edition 2006.
2. Ahmed, Farid E. "Testing of Genetically Modified Organisms in Food". Food
3. Products Press, Halford, Nigel G. "Genetically Modified Crops". Imperial College Press, 1st edition 2004.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	-	1	-
CO2	2	-	1	-	2	2
CO3	1	1	2	1	1	2
CO4	2	2	2	3	2	2
CO5	2	1	2	3	3	3
Avg	1.80	1.25	2.00	2.33	1.80	2.25

FD3027 FOOD STRUCTURING TECHNIQUES L T P C
3 0 0 3

OBJECTIVE

The course aims to

- Introduce the techniques of developing structured food products.
- Educate the technical and functional performance of structured food materials.

UNIT I INTRODUCTION 9

Nature of food structure, Food structure development, Role of hydrocolloids and proteins infood structure development, making of structured foods, Destruction, destabilization and deformation of food matrix, Application of materials science in food design and developmentof engineered food materials**,** the systematic approach to food engineering systems (SAFES),Complex Disperse System (CDS) formalism, Top-down and Bottom-up strategies of constructing food matrix. Modelling and Computer Simulation Approaches to Understand andPredict Food Structure Development.

UNIT II TECHNIQUES FOR FIBROUS STRUCTURE FORMATION 9

Cultured meat, Mycoprotein, Wet spinning, Electrospinning, Extrusion, Mixing of proteins andhydrocolloids, Freeze structuring, Shear cell technology. **Food Printing:** 3D food printing; Approaches, Technologies in food printing, Printability offood components, Factors affecting the printability, 4D Printing; Concept and Functionality, smart food materials, shape memory effect in 4D food printing, Deformation and breakup, Coalescence and alignment, Applications of 3D and 4D food printing.

UNIT III FOOD STRUCTURE DEVELOPMENT IN EMULSION SYSTEMS 9

Emulsions: Principles and Preparation, Basic constituents of Food emulsion, Emulsion architecture, Microstructure design and performance. Food Structure Development in Oil andFat Systems; nanoscale crystals and the structures of lipids and fat, fat crystal network. Role of bubbles in food structure development; Formation of foam/bubble microstructures, Rheological behaviour, Characteristics of bubble-containing structures.

UNIT IV STRUCTURING POLYPHASIC FOOD SYSTEMS 9

Structuring Dairy Products by means of Processing and Matrix Design, Processing of Food Powders, Structured Cereal Products, Structured Meat Products, Structured Chocolate Products, Edible Moisture Barriers for Food Product Stabilization. Encapsulation of food materials; Micro and nano encapsulation, selection of wall and core materials, structural characterization of encapsulates.

UNIT V PERFORMANCE OF STRUCTURED FOOD 9

Food Structure Development for Rheological/Tribological Performance; structure-property- oral process relationships. Developing Food Structure for Mechanical Performance; structureand bulk behavior of soft solid foods, particulate composites and gels, cellular solidfoams, and short fiber-reinforced foods. Design Structures for Optimal Sensory Performance, Development of Food Structures for the Encapsulation and Delivery of Bioactive Compounds.

TOTAL: 45 PERIODS

OUTCOME

At the end of the course the students will be able to

- Understand the techniques of developing structured food products.
- Enumerate the concepts and principles of food structuring.
- Describe and demonstrate modern techniques of food structure development.
- Evaluate the technical and functional performance of structured food materials.
- Explain the & illustrate the food Structure for Mechanical Performance

REFERENCE BOOKS

1. Fotis Spyropoulos, Aris Lazidis & Ian Norton, “Handbook of Food Structure Development” Royal Society of Chemistry, volume 18 2020.
2. Bhesh Bhandari & Yrjö H. Roos. “Food Materials Science and Engineering”Wiley-Blackwell Publishing,1st edition 2012.

3. José Miguel Aguilera & Peter J. Lillford, "Food Materials Science - Principles andPractice", Springer New York, 2nd edition 2008.
4. Alexandru Mihai Grumezescu & Alina Maria Holban, "Handbook of food bioengineering" Elsevier Science, volume 19 2018.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	3	2	2
CO2	2	2	3	3	2	1
CO3	2	1	2	2	3	3
CO4	3	2	1	3	3	3
CO5	3	2	2	2	3	3
Avg	2.40	1.80	2.00	2.60	2.60	2.40

FD3028 FOOD SUPPLY CHAIN MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVE

This course aims to educate students on operational strategies, tools and techniques involved in supply chain management of agri-food sector and their intriguing correlations.

UNIT I SUPPLY CHAIN AND QUALITY MANAGEMENT 9

Introduction, actors in supply chain management, supply chain vs. value chain, factors affecting quality in supply chain management, challenges in supply chain and quality management, pricing and performance measurement in supply chains.

UNIT II FOOD SUPPLY CHAIN MANAGEMENT SYSTEMS ANDINSTITUTIONS 9

Introduction to FSMS - ISO, GFSI, BRC, IFS, SQF, FSSC; HACCP, Codex, BIS and BIS standards, QCI, EIC, EPC and export regulation, AEPDA, FSSAI and FSSAI Act

UNIT III MARKETING AND QUANTIFYING SUPPLY CHAIN 9

An overview, product differentiation and quality standards, major players in supply chain, marketing channels and legislations, case studies: national and international supply chain management of horticultural produce.

UNIT IV ERP IN SUPPLY CHAIN 9

Introduction to Enterprise Resource Planning (ERP), inventory management, manufacturing, sales and purchase module, finance module, supply chain management, customer relationship management, HR management module.

UNIT V LOGISTICS & DISTRIBUTION MANAGEMENT 9

Physical distribution, distribution channels, channel conflict management, big data analysis, block technology, internet of things, artificial intelligence and sensor based traceability systems in supply chain.

TOTAL: 45 PERIODS

OUTCOME

After successful completion of this course, students will be able to

CO1 Understand basic principles, strategies and dynamics involved in supply chainmanagement

CO2 Comprehend various food supply chain management systems and their regulations.

CO3 Apply knowledge to evaluate and manage an effective supply chain in agri-hotri produce

CO4. Correlate the fundamentals of logistics and distribution management to evaluatequality management during supply chain

CO5 Analyze and improve supply chain system in food sector

REFERENCE BOOKS

1. M. A. Bourlakis and P. W.H. Weightman (2003), Food supply chain management, Blackwell Publishing.
2. R. Accorsi and R. Manzini (2016) Sustainable food supply chains-Planning,design,and

control through interdisciplinary methodologies, Elsevier.
3. Raghuram, G. and N. Rangaraj (2000), Logistics and Supply chain management: Case and Concepts, Macmillan, New Delhi.
4. C.J.M. Ondersteijn, Jo H.M. Wijnands, R. B.M. Huirne and O. V. Kooten (2006), Quantifying the agri-food supply chain, Springer
5. Simchi-Levi, D., Kaminsky, P., Simchi-Levi, E. and Shankar, R. (2008). Designingand managing the supply chain: Concepts, strategies and case studies. Tata McGraw-Hill Education

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	1	1	-
CO2	2	2	2	2	1	1
CO3	1	1	-	2	2	1
CO4	2	1	3	1	1	-
CO5	2	2	2	1	2	3
Avg	1.80	1.60	2.25	1.40	1.40	1.67

FD3029 INVENTORY MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVE

This course aims to educate students on principles of logistics, different models, statistics, modelling systems, system organization and overall aspects of Enterprise Resource Planning (ERP).

UNIT I INTRODUCTION TO INVENTORY MANAGEMENT 9

Fundamental Principles of Inventory Management and Cost of Inventory, UnderstandingLean Management Planning for Inventory Management, Inventory Performance Measurements and Inventory Turnover, Role of Inventory in the Logistics Process and Organization.

UNIT II INVENTORY MODELS 9

Basic Inventory Models, Discrete Lot-Sizing Techniques, Basic Sizing Models and DecisionRules; Independent Demand Inventory Systems, Dependent Demand Inventory System, Deterministic Inventory Models, Probabilistic Inventory Models. JIT Model and its Importance in food processing industry.

UNIT III INVENTORY SYSTEM PLANNING 9

Manufacturing Systems and Models Fundamental, Manufacturing Planning & Scheduling Fundamental, Shop Scheduling with High Product Mix, Heuristics-based Planning and Scheduling, Hands-on - Heuristics-based Planning and Scheduling.

UNIT IV SIMULATION MODELLING SYSTEMS 9

Finite Capacity Scheduling applications, trend and practical issues, Revision, Basic Simulation Modelling and Modelling Complex System. Hands-on-Simulation Modelling usingFlexsim, Review of Basic Probability and Statistics, Simulation-based Scheduling, Hands- on- Simulation-based Scheduling System Emerging Techniques and Trends.

UNIT V ERP IN INVENTORY MANAGEMENT 9

Overview of Enterprise Resource Planning (ERP) Solution, Excel Revisited, Sales Order Management, Capacity Management, Extended ERP System, Sourcing and Purchasing, ERP Solution Selection and Implementation, formalities related to bill of materials (BOM); Material Management: Purchase, handling, distribution/allocation, Forecasting Technique: Time Series, Regression.

TOTAL: 45 PERIODS

OUTCOME

After successful completion of this course, students will be able to

CO1. Comprehend the dynamics of inventory management's principles, concepts,and techniques as they relate to the entire supply chain
CO2. Understand the methods used by organizations to obtain the right quantities ofstock or inventory.
CO3. Describe the functions and costs of an inventory system.
CO4. Understanding of inventory management and control practices.
CO5. Apply different methods and practices to address inventory managementproblems.

REFERENCE BOOKS

1. William J. Stevenson (2011), Operations Management.
2. Andrew Greasley (2007), Operations Management.
3. Scott T. Young (2009), Essentials of Operations Management.
4. Paul R. Dittmer, J. Desmond Keefe (2008), Principles of Food, Beverage,and Labor Cost Controls.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	1	3	2	-	-
CO2	1	-	2	1	2	2
CO3	2	2	2	1	1	-
CO4	2	2	3	1	2	-
CO5	1	2	2	2	2	1
AVG	1.50	1.75	2.40	1.40	1.75	1.50