KONGU ENGINEERING COLLEGE
PERUNDURAI ERODE – 638 060
(Autonomous)

VISION

To be a centre of excellence for development and dissemination of knowledge in Applied Sciences, Technology, Engineering and Management for the Nation and beyond.

MISSION

We are committed to value based Education, Research and Consultancy in Engineering and Management and to bring out technically competent, ethically strong and quality professionals to keep our Nation ahead in the competitive knowledge intensive world.

QUALITY POLICY

We are committed to

- Provide value based quality education for the development of students as competent and responsible citizens.
- Contribute to the nation and beyond through research and development
- Continuously improve our services

DEPARTMENT OF FOOD TECHNOLOGY

VISION

To be a centre of excellence for development and dissemination of knowledge in the field of Food Technology for the nation and beyond.

MISSION

Department of Food Technology is committed to:

MS1: Develop vibrant, competent and ethical food engineers who can promote technical advancements in the field of Food Technology

MS2: Foster the research activities of faculty and students to explore the state-of- the-art techniques to meet the industrial and societal needs.

MS3: Endeavour for constant upgradation of technical expertise to support continuous learning.

2018 REGULATIONS

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

Post Graduates of Food Technology will

PEO1: Apply Knowledge and Skills to improve Technological Practices in core and allied domains of Food Technology

PEO2: Contribute with high level of technical competency to Research and Development to generate innovative solutions for societal and industrial needs.

PEO3: Exhibit professionalism, ethics, team work, communication and interpersonal skills within organization and society.

MAPPING OF MISSION STATEMENTS (MS) WITH PEOs

MS\PEO	PEO1	PEO2	PEO3
MS1	3	3	2
MS2	3	3	2
MS3	2	2	2

1 – Slight, 2 – Moderate, 3 – Substantial

PROGRAM OUTCOMES (POs)	
Engineering Post Graduates will be able to:	
PO1:	Develop an ability to apply, integrate, analyze and disseminate the acquired knowledge in the field of Food Technology to fulfill national and global needs
PO2:	Contribute independently towards multidisciplinary scientific research and provide feasible technical solutions to solve real time problems
PO3:	Communicate effectively on technological activities and exhibit the capacity for self management and teamwork along with leadership quality with open mindedness to achieve common goals
PO4:	Demonstrate awareness on societal, safety, health, legal and cultural issues relevant to engineering practice midst of commitment to professional ethics
PO5:	Exhibit the high level of enthusiasm and commitment in recognizing the need for life-long learning in the broadest context of technological change

MAPPING OF PEOs WITH POs

PEO\PO	PO1	PO2	PO3	PO4	PO5
PEO1	3	3	2	2	2
PEO2	3	3	2	2	3
PEO3	2	2	3	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

CURRICULUM BREAKDOWN STRUCTURE UNDER REGULATIONS 2018

Curriculum Breakdown System	Curriculum content (% of total number of credits of the program)	Total number of contact hours	Total number of credits
Program Core(PC)	37.50	30	27
Program Electives(PE)	25.00	18	18
Humanities and Social Sciences and Management Studies (HSMS)	9.72	7	7
Project(s)/Internships(PR)/Others	27.78	40	20
		Total credits	**72**

KEC R2018: SCHEDULING OF COURSES – M Tech (Food Technology)

Semester	Theory/ Theory cum Practical / Practical								Internship & Projects	Special Courses	Credits
	1	2	3	4	5	6	7	8	10	11	
I	18AMT17 Applied Statistics for Food Technology (HS-3-1-0-4)	18MFT11 Unit operations in Food Process Engineeirng / 18MFT12 Food Chemistry and Microbiology (PC-3-0-0-3)	18MFT12 Lipid Science and Technology (PC-3-0-0-3)	18MFT14 Advanced Drying Technology (PC-3-1-0-4)	18MFT15 Instrumental Techniques and Methods for Food Analysis (PC-3-1-0-4)	18GET01 Introduction to Research (HS-3-0-0-3)	18MFL11 Drying Technology Laboratory (PC-0-0-2-1)	18MFL12 Instrumental Food Analysis Laboratory (PC-0-0-2-1)	---	---	23
II	18MFT21 Advanced Refrigeration and Cold Chain Management (PC-3-1-0-4)	18MFT22 Novel Technologies in Food Processing (PC-3-0-0-3)	18MFT23 Food Safety and Quality Control (PC-3-0-0-3)	Elective-I (Professional) (PE-3-0-0-3)	Elective-II (Professional) (PE-3-0-0-3)	Elective-III (Professional) (PE-3-0-0-3)	18MFL21 Food Analysis and Quality Control Laboratory (PC-0-0-3-1)		18MFP21 Mini Project (PR-0-0-4-2)	---	22
III	Elective-IV (Professional) (PE-3-0-0-3)	Elective-V (Professional) (PE-3-0-0-3)	Elective-VI (Professional) (PE-3-0-0-3)	---	---	---	---		18MFP31 Project Work – Phase I (PR-0-0-12-6)	---	15
IV	---	---	---	---	---	---	---		18MFP41 Project Work – Phase II (PR-0-0-24-12)	---	12

Total Credits: 72

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M.Tech. DEGREE IN FOOD TECHNOLOGY

CURRICULUM

(For the candidates admitted from academic year 2018-19 onwards)

SEMESTER – I

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	Theory/Theory with Practical								
18AMT17	Applied Statistics for Food Technology	3	1	0	4	50	50	100	HS
18MFT11	Unit operations in Food Process Engineering (For Science Graduates)	3	0	0	3	50	50	100	PC
18MFT12	Food Chemistry and Microbiology (For Engineering Graduates								
18MFT13	Lipid Science and Technology	3	0	0	3	50	50	100	PC
18MFT14	Advanced Drying Technology	3	1	0	4	50	50	100	PC
18MFT15	Instrumental Techniques and Methods for Food Analysis	3	1	0	4	50	50	100	PC
18GET01	Introduction to Research	3	0	0	3	50	50	100	HS
	Practical								
18MFL11	Drying Technology Laboratory	0	0	2	1	100	0	100	PC
18MFL12	Instrumental Food Analysis Laboratory	0	0	2	1	100	0	100	PC
	Total				**23**				

CA – Continuous Assessment, ESE – End Semester Examination, CBS – Curriculum Breakdown Structure

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M.Tech. DEGREE IN FOOD TECHNOLOGY

CURRICULUM

(For the candidates admitted from academic year 2018-19 onwards)

SEMESTER – II

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	Theory/Theory with Practical								
18MFT21	Advanced Refrigeration and Cold Chain Management	3	1	0	4	50	50	100	PC
18MFT22	Novel Technologies in Food Processing	3	0	0	3	50	50	100	PC
18MFT23	Food Safety and Quality Control	3	0	0	3	50	50	100	PC
	Elective - I	3	0	0	3	50	50	100	PE
	Elective - II	3	0	0	3	50	50	100	PE
	Elective - III	3	0	0	3	50	50	100	PE
	Practical								
18MFL21	Food Analysis and Quality Control Laboratory	0	0	3	1	100	0	100	PC
18MFP21	Mini Project	0	0	4	2	100	0	100	PR
	Total				**22**				

CA – Continuous Assessment, ESE – End Semester Examination, CBS – Curriculum Breakdown Structure

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M.Tech. DEGREE IN FOOD TECHNOLOGY

CURRICULUM

(For the candidates admitted from academic year 2018-19 onwards)

SEMESTER – III

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	Theory/Theory with Practical								
	Elective - IV	3	0	0	3	50	50	100	PE
	Elective - V	3	0	0	3	50	50	100	PE
	Elective - VI	3	0	0	3	50	50	100	PE
	Practical								
18MFP31	Project Work Phase I	0	0	12	6	50	50	100	PR
	Total				**15**				

CA – Continuous Assessment, ESE – End Semester Examination, CBS – Curriculum Breakdown Structure

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M.Tech. DEGREE IN FOOD TECHNOLOGY

CURRICULUM

(For the candidates admitted from academic year 2018-19 onwards)

SEMESTER – IV

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	Practical								
18MFP41	Project Work Phase II	0	0	24	12	50	50	100	PR
	Total				**12**				

CA – Continuous Assessment, ESE – End Semester Examination, CBS – Curriculum Breakdown Structure

Total Credits: 72

LIST OF PROFESSIONAL ELECTIVES						
Course Code	**Course Title**	**Hours/Week**			**Credit**	**CBS**
		L	**T**	**P**		
SEMESTER II						
18MHE05	Computational Fluids Dynamics	3	0	0	3	PE
18MFE01	Advanced Fruit and Vegetable Processing Technology	3	0	0	3	PE
18MFE02	Advanced Food Processing Technology	3	0	0	3	PE
18MFE03	Advanced Separation Techniques in Food Processing	3	0	0	3	PE
18MFE04	Enzyme Engineering and Technology	3	0	0	3	PE
18MFE05	Operational Research	3	0	0	3	PE
18MFE06	Heat and Mass Transfer Operations in Food Processing	3	0	0	3	PE
18MFE07	Food Additives, Nutraceuticals and Functional Foods	3	0	0	3	PE
18MFE08	Food Packaging and Storage Engineering	3	0	0	3	PE
18MFE09	Industrial Waste Management	3	0	0	3	PE
18MFE10	Advanced Baking and Confectionery Technology	3	0	0	3	PE
18MFE11	Advanced Grain Science and Technology	3	0	0	3	PE
18MFE12	Transport Phenomena in Food Processing	3	0	0	3	PE
18MFE13	Industrial Engineering	3	0	0	3	PE
18MFE14	Food Product Design and Development	3	0	0	3	PE
SEMESTER III						
18MHE18	Design and Analysis of Experiments	3	0	0	3	PE
18MFE15	Project Engineering and Management	3	0	0	3	PE
18MFE16	Sensory Evaluation of Foods	3	0	0	3	PE
18MFE17	Food Supply Chain Management	3	0	0	3	PE
18MFE18	Food Process Plant Layout and Design	3	0	0	3	PE
18MFE19	Scale up Methods in Process Engineering	3	0	0	3	PE
18MFE20	Food Rheology	3	0	0	3	PE
18MFE21	Plantation Crops and Spices Technology	3	0	0	3	PE
18MFE22	Industrial Process Automation	3	0	0	3	PE
18MFE23	Advanced Meat Processing Technology	3	0	0	3	PE
18MFE24	Advanced Dairy Technology	3	0	0	3	PE
18MFE25	Technology of Food Colours and Flavours	3	0	0	3	PE
18MFE26	Internet of Things in Food and Agriculture	3	0	0	3	PE
18MFE27	Machine Vision for Food Technology	3	0	0	3	PE

18AMT17 APPLIED STATISTICS FOR FOOD TECHNOLOGY

L	T	P	Credit
3	1	0	4

Preamble	This course will help the students to identify, formulate and optimize processes using statistical tools in order to achieve the best products in food industry.
Prerequisites	Basic knowledge of probability

UNIT – I **9**

Correlation and Regression Analysis: Curve fitting by method of Least Square - Correlation - Linear, multiple and partial correlation - Linear regression - Multiple regression.

UNIT – II **9**

Testing of Hypothesis: Sampling Distributions - Large sample tests - Testing the significance of single proportion - Difference of proportions - Single mean - Difference of means - Small sample tests - Testing the significance of means (student's t-test) - Testing the significance of Variances (F-test) - Testing the significance of goodness of fit - Independence of attributes (χ2-test).

UNIT – III **9**

Design of Experiments: Analysis of variance - One-way classification - Completely Randomized Design - Two way classification - Randomized block design - Latin Square Design - Factorial experiments - Two factor factorial experiments - 2k Factorial design.

UNIT – IV **9**

Time Series Analysis: Significance of time series analysis - Components of Time series - Secular trend - Graphical method - Semi-average method - Method of Moving Averages - Method of Least squares - Seasonal variations - Method of Simple Averages - Ratio to trend method - Ratio to moving average method.

UNIT – V **9**

Statistical Quality Control: Introduction to statistical quality control - Control charts - Control chart for variables: chart - R chart - s chart - Control charts for attributes: np chart - p chart - c chart.

Lecture :45, Tutorial:15, Total: 60

REFERENCES:

1. Jay L. Devore, "Probability and Statistics for Engineering and the Sciences", Thomson Asia, 2002.
2. Gupta S.C. and Kapoor V.K., "Fundamentals of Mathematical Statistics", 11th Edition, Sultan Chand & Sons, New Delhi, 2018.
3. Hines W.W., Montogomery D.G., Goldsman D.M. and Borror C.M., "Probability and Statistics in Engineering", 4th Edition, John Wiley & Sons Inc., UK, 2009.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	measure the relationship between variables	Understanding (K2)
CO2:	apply statistical tests in testing hypotheses on data	Evaluating (K5)
CO3:	adopt design of experiments techniques in engineering problems	Evaluating (K5)
CO4:	apply ideas to real time series data and interpret outcomes of analyses	Applying (K3)
CO5:	establish control charts for monitoring processes	Evaluating (K5)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	1	2			
CO2	1	2			
CO3	1	2			
CO4		2			
CO5	1	2			

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MFT11 UNIT OPERATIONS IN FOOD PROCESS ENGINEERING

L	T	P	Credit
3	0	0	3

Preamble	The subject will help the students to have knowledge on the Material and energy balance, fluid properties, mechanical operations, heat and mass transfer operations.
Prerequisites	Nil

UNIT – I **9**

Material and Energy Balance: Stoichiometric principles - Material balance without chemical reaction like distillation – Evaporation – Crystallization - Drying and extraction - Heat capacity of solids - Liquids, gases and solutions - Standard heat of reaction - Heats of formation - Combustion - Energy balance for systems without chemical reaction.

UNIT – II **9**

Fluid flow: Principles of fluid flow - Properties of liquids - Fluid dynamics - Potential energy - Kinetic energy - Pressure energy - Friction loss - Mechanical energy - Newtonian and non-Newtonian fluids - Stream line and turbulent flow - Flow measurement and measurement of viscosity - Kinematics of fluid flow - Concept of boundary layer - Basic equation of fluid flow: Equation of continuity and Bernoulli equation - Correction of Bernoulli equation for fluid friction - Application of Bernoulli equation for pump work.

UNIT – III **9**

Mechanical Operation: Screening - Screening equipment - Effectiveness of screens - Gravity settling – Sedimentation - Thickening - Clarifier - Floatation - Filtration Principle - Types of filtration - equipment.

UNIT – IV **9**

Heat Transfer: Concept of heat conduction - Fourier's law of heat conduction - One dimensional steady state heat conduction equation for flat plate - Concept of heat convection - Natural and forced convection - Individual and overall heat transfer coefficient - Concept of radiations - Black body and grey body concept - Radiation Properties - Stefan Boltzmann's law - Emissivity and absorptivity - Kirchhoff's Law - Introduction to Heat exchanger and Evaporator equipment.

UNIT – V **9**

Mass Transfer: Types of mass transfer operations - Fick's law - Molecular and eddy diffusion in gas and liquids - Steady state diffusion under stagnant and laminar flow conditions - Diffusivity measurement - Local and overall mass transfer coefficients - Introduction to mass transfer operation: absorption - distillation - extraction - Leaching - Humidification.

Total: 45

REFERENCES:

1. McCabe W.L., Smith J.C. and Harriot P., "Unit Operations of Chemical Engineering", 7th Edition, McGraw-Hill, New York, 2005.
2. DuttaBinay K., "Heat Transfer: Principles and Applications", Prentice Hall of India, New Delhi, 2015.
3. Treybal R.E., "Mass Transfer Operations", 3rd Edition, McGraw-Hill, New York, 2012.
4. Gavahane K.A., "Unit operation I", 27th Edition, Nirali Prakasham Publications, Pune, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	make use of material and energy balance in food processing operations	Applying (K3)
CO2:	explain the concepts of fluids and fluid flow properties	Understanding (K2)
CO3:	outline the various mechanical operations carried in food processing	Understanding (K2)
CO4:	apply heat transfer concepts in food processing	Applying (K3)
CO5:	summarize the various mass transfer operations	Understanding (K2)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	1			1
CO2	3	2			1
CO3	3	3			1
CO4	3	2			1
CO5	3	2			1

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MFT12 FOOD CHEMISTRY AND MICROBIOLOGY

L	T	P	Credit
3	0	0	3

Preamble	This course provides knowledge about water activity, influence of biomolecules on food quality and understanding the microbial spoilage and food infection and the importance of sanitation and hygiene while handling foods
Prerequisites	Nil

UNIT – I **9**

Water relationships in Food: Water activity and its relevance to deteriorative processes in foods - Glass transitions and molecular mobility - their relevance to quality and stability of foods. **Carbohydrates:** Structure and properties of simple and complex food carbohydrates - Modified starch and cellulose - Manufacture of maltodextrins and corn syrup - Cyclodextrins - Chemistry and food applications - Polyols and its applications - Carbohydrates as fat substitutes.

UNIT – II **9**

Lipids: Classifications - Structure and roles of fatty acids - Processing of oils and fats - refining - hydrogenation - interesterification and winterization. Deterioration of oils - hydrolytic rancidity - oxidative rancidity and their prevention.

UNIT – III **9**

Proteins: Protein structure and conformation - Properties and reactions of proteins in food systems - Dissociation - Optical activity - solubility - hydration - swelling - foam formation - stabilization - gel formation - emulsifying effect - Denaturation of proteins - Food sources - functional role in foods - Texturized Proteins.

UNIT – IV **9**

Microbial growth: Types of microorganism normally associated with food-mold, yeast, and bacteria - Physical and chemical factors influencing destruction of microorganisms - Microorganisms in natural food products and their control - Biochemical changes caused by microorganisms - Microbial food fermentation - Microbiological standards for different foods - Food poisoning and microbial toxins. **Microbial Spoilage:** Spoilage of foods - Principles and types of spoilage - Microbial spoilage of different types of foods - Spoilage of fruits and vegetables - Fresh and processed meats, poultry, sea foods, cereals products, bakery products, dairy products, fermented foods and canned foods.

UNIT – V **9**

Microbiology and Food Preservation: Effect of high temperature on microbes - TDT, D value, Z value, 12D concept - Calculation of process time. Effect of low temperature, radiation, drying on microbes. Chemical preservatives. Advances in preservation of food by various biotechnological processes.

Total: 45

REFERENCES:

1. Belitz H. D., Grosch W. and Schieberle P., "Food Chemistry", 3rd Edition, Springer-Verley, Berlin, 2004.
2. Vaclavik V.A. and Christian E.W., "Essential of Food Science", 2nd Edition, Springer, 2005.
3. Frazier W.C. and Westhoff, "Food Microbiology", 4th Edition, Tata McGraw-Hill, New Delhi, 2011.
4. Vijaya R.K., "Food Microbiology", MJP Publishers, Chennai, 2007.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	analyze the role of water in food stability	Analyzing (K4)
CO2:	examine the structure and functional role of food biomolecules	Analyzing (K4)
CO3:	illustrate the modification of biomolecules	Understanding (K2)
CO4:	outline the significance and role of microbes in fermentation, spoilage and food borne infectious diseases	Understanding (K2)
CO5:	appraise the importance of preservation techniques in microbial control	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	2	1
CO2	3	3	2	2	1
CO3	3	3	2	2	1
CO4	3	3	2	3	1
CO5	3	3	2	3	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MFT13 LIPID SCIENCE AND TECHNOLOGY

L	T	P	Credit
3	0	0	3

Preamble	Course is designed to conceive an idea about the different techniques of oil processing and lipid based products.
Prerequisites	Nil

UNIT – I **9**

Food Lipids: Classification, composition, Sources - Nutritional profile and is significance in food industries - Physical properties - Color, odour, specific gravity - Chemical constants - Iodine value - Saponification value - Peroxide Value - Polenske Number - Reichert Meissl Value - Acetyl Value - Optical properties - Refractive index - Absorption spectra - Rheological and Thermal properties - Importance of flavour emulsion and its stability in food systems - Measurement of lipid degradation parameters during storage.

UNIT – II **9**

Processing of Oils and Fats: Extraction and refining of oils and fats - Traditional Method - Solvent Extraction - Mechanical Extraction - Modern trends in extraction of oils and fats - Supercritical technology - Membrane technology - Liquid-liquid extraction - Wipe film evaporation - Application of encapsulation and nano-encapsulation - Bioactive lipids extraction and stabilization - Basic Processing steps of refining -oil-degumming, neutralization, bleaching and deodorization - Chemical adjuncts - lecithin, mono-glycerides and its derivatives - Applications in food industries.

UNIT – III **9**

Modification of Oils and its Applications in Food Industries: Modification of oil - Recent developments in plant and processes – Hydrogenation – Fractionation – Blending – Winterization – Interesterification - Types of Interesterification - Applications of Interesterification - Cocoa butter alternatives - CBR, CBS, CBE - Fat mimetics and substitutes - Dairy Imitation Products - Enzymatic Modification - Structured Lipids - Speciality fats - Lipid as micronutrients and nutraceuticals.

UNIT – IV **9**

Formulation and Characterization: Margarines - Low-fat spreads - Peanut butter - Vegetable ghee – mayonnaise - whipped creams - salad oils and dressings - cooking oils - Fat powders - cream, butter, cod liver - Formulation and technological aspects of bakery and confectionery shortenings – Rendering - dry and wet methods - lard and tallow.

UNIT – V **9**

Frying and Storage of Oils: Frying of oil - Role of fat and oil in frying - Applications of frying oil - Selection of frying oil - Changes occurring in food and oil during frying - Rancidity - Types - Causes - Prevention - Quality standards of oil - Shortenings - Cooking oils - Salad oils. Packaging requirements of fats and oils.

Total: 45

REFERENCES:

1. Chakrabathy M.M., "Chemistry and Technology of Oils and Fats", Allied Publishers Pvt. Ltd., 2003.
2. Bailey, "Bailey's Industrial Oil and Fat Products", 6th Edition, Volume 1- 6, John Wiley & Sons, 2005.
3. Wolf Hamm and Richard J. Hamilton, "Edible Oil Processing", Blackwell Science Ltd., 2004.
4. Richard D. O'Brien, " Fats and Oils: Formulating and Processing for Application", CRC Press, 2008.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	explain the different properties of fats and oils and interpret its changes during storage	Understanding (K2)
CO2:	assess the different technologies for processing of fats and oil	Applying (K3)
CO3:	analyze the techniques of modifying oil and its application in food industries	Analyzing (K4)
CO4:	identify the formulations and characterization of different food lipids	Applying (K3)
CO5:	identify the type of frying and storage for lipid foods	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	3	1	1	1
CO2	3	3	1	2	1
CO3	3	3	1	2	1
CO4	3	3		1	1
CO5	3	3	1	1	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MFT14 ADVANCED DRYING TECHNOLOGY

L	T	P	Credit
3	1	0	4

Preamble	To gain insight on various advanced drying concepts in order to recommend suitable dryers based on the food product
Prerequisites	Nil

UNIT – I **9**

Introduction to Drying: Drying and dehydration - Principles - Mechanism of drying - Drying curves - Internal and external conditions of drying - Diffusion theories of drying - Effective Fickian diffusivity - Water activity - Water activity predictive models – Hysteresis - Determination of sorption isotherms - Gravimetric method - Manometric method and Hygroscopic methods.

UNIT – II **9**

Spray drying: Spray drying - Concept - Components of spray drier - Spray dryer nozzle - Mechanism of atomization - Drop size and drop distribution. Drying of droplets - Fundamentals, residence time - Heat and mass balance - New developments in Spray drying - Spray freeze drying. **Freeze drying:** Freeze drying - Concept, principle. Stages in freeze drying - Heat and mass transfer, types, design considerations - Industrial freeze dryers - Advances in freeze drying.

UNIT – III **9**

Drying on inert particles: Principle, Mechanism and process considerations. **Pneumatic and flash drying:** Principles - Working and its applications. **Fluidized bed drying:** Introduction - Principles of fluidization - Components of fluidized bed system - Classification of fluidized bed dryers - Conventional and modified FBD.

UNIT – IV **9**

Novel drying: Super-heated steam drying - Principles - Classification - Selection - Applications. Heat pump drying (HPD) - Principle - Low temperature HPD - Chemical HPD - Developments and trends. Contact-Sorption drying - Mechanism - Characteristics of sorbents/carriers - Conveyor dryers.

UNIT – V **9**

Advanced dryers: Microwave dryers - Basic concepts - Industrial applications - Hybrid microwave dryers - Infra-red drying - Principles - Industrial dryers - Applications - Sonic drying - Slush drying - Refractance Window drying.

Lecture:45, Tutorial: 15, Total: 60

REFERENCES:

1. Mujumdar A.S., "Handbook of Industrial Drying", 3rd Edition, CRC Press, Taylor and Francis group, UK, 2007.
2. Xiao Dong Chen and Mujumdar A.S., "Drying Technologies in Food Processing", 1st Edition, Wiley-Blackwell, 2008.
3. Kudra T. and Mujumdar A.S., "Advanced Drying Technologies", 2nd Edition, CRC Press, Taylor and Francis Group, UK, 2009.
4. Rao M.A. and Rizvi S.S.H., "Engineering Properties of Foods", Marcel Dekker Inc., New York, 1986.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	explain the mechanism of drying and solve problems related to drying	Evaluating (K5)
CO2:	make use of spray and freeze dryers and apply the techniques for food materials	Evaluating (K5)
CO3:	apply the concepts of drying using inert particles, pneumatic and fluidized drying	Applying (K3)
CO4:	select appropriate novel drying technique for drying of complex food materials	Applying (K3)
CO5:	make use of suitable advanced dryers depending on the raw materials	Applying (K3)

Mapping COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1	1	2
CO2	3	3	1	1	2
CO3	3	3	1	1	2
CO4	3	2	1	1	2
CO5	3	2	1	1	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MFT15 INSTRUMENTAL TECHNIQUES AND METHODS FOR FOOD ANALYSIS

L	T	P	Credit
3	1	0	4

Preamble	To gain knowledge about the principle and applications of different instrumental techniques used in food analysis
Prerequisites	Nil

UNIT – I **9**

Instrumental Methods: Introduction - Classification of instrumental methods based on physical properties - The Electromagnetic spectrum - Interaction of photons with matter - Absorbance and transmittance - Ultra violet and Visible spectrometry: Theory - Types of Transitions - Red and blue shifts - Instrumentation - Single beam and double beam spectrophotometers and applications - Spectrophotometric Titrations - Fluorimetry: Theory - Factors affecting fluorescence - Instrumentation and applications. **Infrared spectrometry**: Requirements for IR absorption - Modes of vibrations - Selection Rules Instrumentation- Applications - Position and Intensity of bands - Finger print region.

UNIT – II **9**

X-Ray: Absorption - Non-disperative Method - Diffraction - Rotating and powder crystal methods - Applications - Flame photometer, Polarimetry and Refractometry - Principle and instrumentation - Saccharimetry - Analysis of sugar. **Thermal Methods:** Thermogravimetry - Differential Thermal Analysis - Differential scanning calorimetry - Factors affecting the results - Instrumentation and applications. **Morphology Analysis** - Scanning Electron Microscopy - Transmission Electron Microscopy and Laser diffraction for particle analysis - Principle and Applications.

UNIT – III **9**

Electrophoresis: Basic Principle of paper - Starch gel, agarose, native, SDS-PAGE electrophoresis Immuno affinity techniques - Radio Assay Electrophoresis and applications. Isoelectric focusing capillary - Microchip and 2D electrophoresis. **Rapid Techniques**: Recent Development of Rapid Techniques - E sensors - e-nose, e-tongue instrumentation - Applications and working principles - Flow cytometry - Epifluorescence microscopy - Principle and Applications.

UNIT – IV **9**

Atomic Absorption Spectrophotometer: Principle, Advantages of ASS over FES - Instrumentation - Interference and applications. **Nuclear Magnetic Resonance:** Introduction to NMR - Energy levels of nucleus - Equivalent and non-equivalent protons - Chemical shift - Shielding - TMS - Factors affecting chemical shift - Splitting of signals and instrumentation (proton NMR only) - Applications. **Mass spectroscopy** - Theory - Types of ions produced - Rules for Interpretation of mass spectra - Components of mass spectrometer - Ion fragmentation - Applications.

UNIT – V **9**

Chromatography Techniques: Introduction - Classification of chromatographic methods: Column, Thin Layer, Paper, Gas - High Performance Liquid Chromatography (HPLC) - Principle, mode of separation and applications. **Hyphenated Techniques**: ICPMS, HRMS, HPTLC, GC-MS, LC-MS and GC- FTIR - Principle and analysis of food materials.

Lecture: 45, Tutorial:15, Total: 60

REFERENCES:

1. Chatwal Gurdeep R. and Anand Sham K., "Instrumentation Methods of Chemical Analysis", Himalaya Publications, Bombay, 2003.
2. Willard H.H., Merritt L.L., Dean J.A., and Settle F.A., "Instrumental Methods of Analysis", 7th Edition, C B S Publishers & Distributors, Delhi, 1988.
3. Yeshasahupomeranz and Clifton E. Meloan, "Food Analysis", CBS Publishers & Distributors, Delhi, 1996.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	interpret the application of UV-Visible and IR spectroscopy in food analysis	Understanding (K2)
CO2:	apply X-ray diffraction, flame photometers, polarimetry and thermal methods in food analysis	Applying (K3)
CO3:	choose the usage of electrophoresis and rapid techniques for analysis of components	Remembering (K1)
CO4:	make use of AAS, NMR and mass spectroscopy to analyze different food materials	Applying (K3)
CO5:	infer the chromatographic principles to separate and hyphenated techniques to analyze materials	Understanding (K2)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2		2
CO2	3	3	1		2
CO3	3	3	2		2
CO4	3	3	1		2
CO5	3	3	2		2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18GET01 INTRODUCTION TO RESEARCH

(Common to Engineering and Technology Branches)

L	T	P	Credit
3	0	0	3

Preamble	To familiarize the fundamental concepts/techniques adopted in research, problem formulation and patenting. To disseminate the process involved in collection, consolidation of published literature and rewriting them in a presentable form using latest tools.
Prerequisites	Nil

UNIT – I **9**

Concept of Research: Meaning and Significance of Research: Skills, Habits and Attitudes for Research - Time Management - Status of Research in India. Why, How and What a Research is? - Types and Process of Research - Outcome of Research - Sources of Research Problem - Characteristics of a Good Research Problem - Errors in Selecting a Research Problem - Importance of Keywords - Literature Collection – Analysis - Citation Study - Gap Analysis - Problem Formulation Techniques.

UNIT – II **9**

Research Methods and Journals: Interdisciplinary Research - Need for Experimental Investigations - Data Collection Methods - Appropriate Choice of Algorithms / Methodologies / Methods - Measurement and Result Analysis - Investigation of Solutions for Research Problem - Interpretation - Research Limitations. Journals in Science/Engineering - Indexing and Impact factor of Journals - Citations - h Index - i10 Index - Journal Policies - How to Read a Published Paper - Ethical issues Related to Publishing - Plagiarism and Self-Plagiarism.

UNIT – III **9**

Paper Writing and Research Tools: Types of Research Papers - Original Article/Review Paper/Short Communication/Case Study - When and Where to Publish? - Journal Selection Methods. Layout of a Research Paper - Guidelines for Submitting the Research Paper - Review Process - Addressing Reviewer Comments. Use of tools / Techniques for Research - Hands on Training related to Reference Management Software - EndNote, Software for Paper Formatting like LaTeX/MS Office. Introduction to Origin, SPSS, ANOVA etc., Software for detection of Plagiarism.

UNIT – IV **9**

Effective Technical Thesis Writing/Presentation: How to Write a Report - Language and Style - Format of Project Report - Use of Quotations - Method of Transcription Special Elements: Title Page - Abstract - Table of Contents - Headings and Sub-Headings - Footnotes - Tables and Figures - Appendix - Bibliography etc. - Different Reference Formats. Presentation using PPTs.

UNIT – V **9**

Nature of Intellectual Property: Patents - Designs - Trade and Copyright. Process of Patenting and Development: Technological research - Innovation - Patenting – Development - International Scenario: International cooperation on Intellectual Property - Procedure for grants of patents.

Total: 45

REFERENCES:

1. DePoy, Elizabeth, and Laura N. Gitlin, "Introduction to Research-E-Book: Understanding and Applying Multiple Strategies", Elsevier Health Sciences, 2015.
2. Walliman, Nicholas, "Research Methods: The Basics", Routledge, 2017.
3. Bettig Ronald V., "Copyrighting culture: The political economy of intellectual property", Routledge, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	list various stages in research/patenting and categorize the quality of journals	Analyzing (K4)
CO2:	formulate a research problem from published literature/journal papers	Evaluating (K5)
CO3:	write, present a journal paper/ project report using latest tools in proper format	Creating (K6)
CO4:	select suitable journal and submit a research paper	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	3	2	1
CO2	3	2	3
CO3	3	3	1
CO4	3	2	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MFL11 DRYING TECHNOLOGY LABORATORY

L	T	P	Credit
0	0	2	1

Preamble	To provide practical exposure to different drying experiments
Prerequisites	Nil

List of Experiments:

1. Determination of drying rate, moisture ratio
2. Determination of effective moisture diffusivity for food materials
3. Experiment on determination of best fitting thin layer drying model using MATLAB
4. Experiment on moisture sorption isotherm
5. Experiment on spray dryer
6. Experiment on freeze dryer
7. Experiment on drying characteristics of food materials using fluidized bed dryers
8. Experiment on microwave and vacuum dryer
9. Experiment on rehydration characteristics of dried products
10. Study on characteristics of dried food materials

Total: 30

REFERENCES / MANUALS / SOFTWARES:

1. Majumdar A.S., "Handbook of Industrial Drying", 3rd Edition, CRC Press, Taylor and Francis Group, UK, 2007.
2. Xiao Dong Chen and Majumdar A.S., "Drying Technologies in Food Processing", 1st Edition, Wiley-Blackwell, 2008.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	perform drying of food materials and determine the drying parameters	Evaluating (K5)
CO2:	apply suitable drying technique based on the raw material	Applying (K3)
CO3:	assess the characteristics of dried food materials	Evaluating (K5)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	3	1		1
CO2	3	3	1		1
CO3	3	3	1		1

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

18MFL12 INSTRUMENTAL FOOD ANALYSIS LABORATORY

L	T	P	Credit
0	0	2	1

Preamble	To provide practical exposure to different equipment for food analysis
Prerequisites	Nil

List of Experiments:

1. Estimation of synthetic color present in food materials by UV-Visible spectrophotometer
2. Estimation of sodium and potassium present in fruit juice by Flame photometer
3. Estimation of lead and chromium present in industrial waste water by AAS
4. Separation of Amino Acids by Thin Layer Chromatography
5. Estimation of curcumin present in Turmeric by HPLC
6. Estimation of natural color present in food materials by Spectrophotometer
7. Estimation of calcium present in beverage by FES
8. Analysis of sugars present in food materials by HPLC
9. Determination of calorific value of food materials by Bomb Calorimeter
10. Determination of antioxidant value of materials by spectrophotometer

Total: 30

REFERENCES / MANUALS / SOFTWARES:

1. Chatwal Gurdeep R. and Anand Sham K., "Instrumentation Methods of Chemical Analysis", Himalaya Publications, Bombay, 2003.
2. Willard H.H., Merritt L.L., Dean J.A. and Settle F.A., "Instrumental Methods of Analysis", 7th Edition, C B S Publishers & Distributors, Delhi, 1988.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	apply suitable instrumental techniques methods for food analysis based on raw material	Applying (K3)
CO2:	identify the components present in food material by molecular spectroscopy	Applying (K3)
CO3:	determine and quantify the component present in the food material by Chromatography Techniques	Evaluating (K5)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	3		1	1
CO2	3	3		1	1
CO3	3	3		1	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

18MFT21 ADVANCED REFRIGERATION AND COLD CHAIN MANAGEMENT				
	L	**T**	**P**	**Credit**
	3	**1**	**0**	**4**

Preamble	To impart the knowledge on concepts of refrigeration, cold and frozen storage and cold chain management
Prerequisites	Nil

UNIT – I **9**

Refrigeration System: Refrigeration, ton of refrigeration, refrigeration capacity, Single vapour compression and vapour absorption system, Refrigerants - characteristics of different refrigerants, ozone depletion potentials, pressure enthalpy charts.

UNIT – II **9**

Components of a Refrigeration System: Different types of Compressors - positive displacement and roto-dynamic type and performance, Evaporators and their functional aspects, Condensing units and cooling towers, expansion valves, humidifying systems, piping and different controls, Ice manufacture.

UNIT – III **9**

Cold and Frozen Storage: Types of storage rooms, Design and requirements of cold store and frozen store, maintenance, total refrigeration load calculation, Automated cold store, Frozen retail display – Classification and design, temperature requirements in frozen storage, packaging, energy conservation.

UNIT – IV **9**

Low Temperature Storage of Foods: Effect of temperature on food spoilage - Evaporative cooling and its applications, novel freezing methods and freezer types, Freezing rates, growth rate of ice crystals, crystal size and its effect of texture and quality of foods.

UNIT – V **9**

Cold Chain Management: Scope and importance of cold chain in food processing industry and retail chain, Cold chain – overview, planning and designing, transport of frozen foods – different modes, Time temperature indicators, safety aspects, Flexibility storage systems, cold chain transportation inland and export, retail and supermarket cold chain.

Lecture:45, Tutorial:15, Total: 60

REFERENCES:

1. Rajput R.K., "Refrigeration and Air-conditioning", S.K. Kataria & Sons, Delhi, 2012.
2. Dellino C.V.J., "Cold and Chilled Storage Technology", 2nd Edition, Springer, 2011.
3. Kennedy C.J., "Managing Frozen Foods", Woodhead Publishing Ltd., 2000.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	interpret the concepts and principles of refrigeration systems	Applying (K3)
CO2:	illustrate the working and function of various components of refrigeration systems	Understanding (K2)
CO3:	design a cold storage unit and classify its types	Applying (K3)
CO4:	inspect the quality aspects of frozen foods	Evaluating (K5)
CO5:	plan and design a cold chain system for transporting food products	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2		1	3
CO2	3	1			1
CO3	3	1			1
CO4	3	2		2	1
CO5	3	3		2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MFT22 NOVEL TECHNOLOGIES IN FOOD PROCESSING				
	L	**T**	**P**	**Credit**
	3	**0**	**0**	**3**

Preamble	To educate the students about recent and advanced processing techniques available in the field of food technology
Prerequisites	Nil

UNIT – I	**9**

Emerging Technologies: Emerging technologies in food processing – necessity and advantages –hurdle technology – concepts and applications - super critical fluid extraction processes in food materials. **High Pressure Processing of Foods:** High Pressure Processing – Principles – applications to food systems – effect on quality – High Pressure Freezing, High Pressure non-frozen storage.

UNIT – II	**9**

Pulsed Electric Field Processing: Principle - Mechanism of action. PEF treatment systems -processing parameters – applications. Equipment's – Mechanism of microbial and enzyme inactivation safety aspects.
High Intensity Pulsed Light Technology: Principles of pulsed light technology, Effect of pulsed light Technology on food products and food properties.

UNIT – III	**9**

Irradiation: Irradiation preservation of food- ionizing radiation- dosimetry- lethal effects on microorganisms
Ultrasound: Principle of ultrasound – Fundamentals – Ultrasound as a processing and preservation aid- Effects on food quality.

UNIT – IV	**9**

Ohmic Heating: Fundamentals of Ohmic Heating – Basic Principles, electrical heat generation -electrical conductivity. Generic Configurations - Product suitability for thermal treatments. **Cold Plasma:** Plasma Chemistry – Functionality - Limitations and Toxicology – Environment impact.

UNIT – V	**9**

Vacuum Cooling: Principles – Process – Equipment – Application – Fruits and Vegetables, Bakery, Fishery, Particulate foods, ready meals. Advantages and Disadvantages – Process Parameters. **Osmotic Membrane Distillation:** Fundamentals – OMD membranes – Process parameters – Osmotic agent, Concentration, Temperature, Membrane. Direct osmosis. Applications

Total: 45

REFERENCES:

1. Da-wen Sun, "Emerging Technologies for Food Processing", Elsevier Academic Press, 2005.
2. Howard Q. Zhang, Gustavo V. Barbosa-Canovas, Bala Balasubramaniam V.M., Patrick Dunne C., Daniel F. Farkas, James T.C. Yuan, "Non Thermal Processing Technologies for Food", Wiley-Blackwell IFT Press, 2011.
3. Tadeusz Kudra, Arun S. Mujumdar, "Advanced Drying Technologies", Eastern Hemisphere Distribution, New York, 2002.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	apply the concepts of hurdle technology, super critical fluid extraction and high pressure processing in food preservation	Applying (K3)
CO2:	outline the basics of pulsed electric field and light technology for food materials	Understanding (K2)
CO3:	demonstrate the concept of irradiation and ultrasound for food treatments	Understanding (K2)
CO4:	explain the concepts of ohmic heating and cold plasma techniques for food applications	Understanding (K2)
CO5:	apply the concepts of vacuum cooling and osmotic membrane distillation in food processing	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	1		1	2
CO2	2	1		1	2
CO3	2	1		1	2
CO4	2	1		1	2
CO5	3	1		1	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MFT23 FOOD SAFETY AND QUALITY CONTROL				
	L	**T**	**P**	**Credit**
	3	**0**	**0**	**3**
Preamble	This course delivers the knowledge of food hazards, food safety, quality control methods and audits to ensure food safety so that the product complies with national or international standards.			
Prerequisites	Nil			

UNIT – I	**9**

Contemporary Food Safety Strategies: Principles and need for quality control and safety, strategy and criteria for food safety. Consumer lifestyle and demand, issues in food safety, food traceability and recall, case against food biotechnology and irradiation. Case studies in food safety.

UNIT – II	**9**

Food Hazards and Contaminants: Characterization of food hazards. Food borne diseases and their control, food contaminants and their control. Naturally available toxins in foods, toxicants resulting from food processing. Management of food allergens. **Sampling:** Purpose of sampling, sampling plan, sample preparation, statistical design for sampling, sampling procedure.

UNIT – III	**9**

Integration of Food Process Engineering and Food Microbial Growth: Inactivation of microbial growth - thermal and non-thermal methods, process dependent microbial modeling, integration of process and microbial growth modeling. Applications of predictive microbial modeling. Advanced methods for rapid detection of food safety.

UNIT – IV	**9**

National and International Food Agencies and Quality Practices: BIS, AGMARK, FSSAI, Organizational structure and functions of United States Food and Drug Administration (USFDA), Global Food Safety Initiative (GFSI), International Consultative Group on Food Irradiation (ICGFI), European Food Safety Authority (EFSA), British Retail Consortium (BRC) global standards, Codex Alimentarius, Sanitary and Phyto-Sanitary measures (SPS), Plant Quarantine Act.

UNIT – V	**9**

Food Quality Management System: FSSAI functions, duties and responsibilities of food safety regulators, food safety and standards for food products, implementation, validation, verification and improvement of food safety management systems. Good Manufacturing Practices (GMP), Good Hygienic Practices (GHP), Good Laboratory Practices (GLP), ISO 22000, FSSC 22000, Food Safety Audit.

Total: 45

REFERENCES :

1.	Da-Wen Sun, "Handbook of Food Safety Engineering", John Wiley & Sons, New Jersey, 2012.
2.	Ronald H. Schmidt and Gary E. Rodrick, "Food Safety Handbook", John Wiley & Sons, New Jersey, 2005.
3.	Yasmine Motarjemi and Huub Lelieveld, "Food Safety Management - A Practical Guide For The Food Industry", Elsevier, New York, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	explain importance of food safety	Understanding (K2)
CO2:	classify food hazards and identify the risks associated with the processing of foods and their preventive measures	Applying (K3)
CO3:	apply food process engineering concepts on microbial growth modeling	Applying (K3)
CO4:	examine the functions of various National and International food agencies	Understanding (K2)
CO5:	apply food safety management system	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3			2	1
CO2	2	3		3	1
CO3	3	3			1
CO4	2			2	1
CO5	3	1		2	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MFL21 FOOD ANALYSIS AND QUALITY CONTROL LABORATORY

L	T	P	Credit
0	0	3	1

Preamble	This course imparts the technical knowledge on analysis of different food products.
Prerequisites	Food Chemistry

List of Experiments:

1. Detection of adulterants in food samples
2. Analysis of Tea/Coffee
3. Analysis of cereal and cereal products
4. Analysis of refined cane sugar / jaggery
5. Analysis of spices
6. Analysis of edible oil
7. Analysis of water
8. Analysis of dairy products
9. Analysis of non alcoholic beverages
10. Analysis of pasta
11. Sensory analysis of food products by difference tests
12. Analysis of Food Components by HPLC

Total: 45

REFERENCES / MANUALS / SOFTWARES:

1. FSSAI, "Food Safety and Standards Regulations – 2011", Ministry of the Health and Family Welfare, New Delhi, 2011.
2. Sadasivam, S., and Manickam, A., "Biochemical Methods", 3rd Edition, New Age International, Delhi, 1996.
3. "Manual of Methods for the Analysis of Foods", Ministry of Health and Family Welfare, Government of India, New Delhi, 2005.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	analyze different types of food products	Analyzing (K4)
CO2:	identify the adulterants present in the given food materials and also the food components by HPLC	Applying (K3)
CO3:	assess the sensory properties of food products	Evaluating (K5)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3		1	2	1
CO2	3	2	1	2	1
CO3	3	1	1		1

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MHE05 COMPUTATIONAL FLUID DYNAMICS

(Common to Chemical Engineering and Food Technology branches)

L	T	P	Credit
3	0	0	3

Preamble:	With the advent of high speed computing, CFD has become an integral part of engineering design, simulation and performance analysis. This course deals with the fundamentals of CFD, grid generation, meshing and solution techniques using Finite Volume Method.
Prerequisites:	Nil

UNIT – I **9**

Conservation Laws of Fluid Motion and Boundary Conditions: Governing equations of fluid flow and heat transfer, equations of state, Navier-Stokes equations for Newtonian fluid, conservative form of governing equations of flow, differential and integral forms of general transport equations, classification of physical behavior.

UNIT – II **9**

Finite Volume Method for Diffusion and Convective- Diffusion Problems: Finite volume method for one-dimensional, two-dimensional and three-dimensional steady state diffusion, steady one-dimensional convection and diffusion, the central differencing scheme. Properties of discretization schemes, assessment of the central differencing scheme for convection-diffusion problems, the upwind differencing scheme, the hybrid differencing scheme, the power-law scheme, higher order differencing schemes for convection-diffusion problems – QUICK scheme.

UNIT – III **9**

Solution Algorithms for Pressure-Velocity Coupling in Steady Flows: Staggered grid, momentum equations, SIMPLE algorithm, assembly of a complete method, SIMPLER, SIMPLEC, and PISO algorithms; Solution of discretised equations: tri-diagonal matrix algorithm, application of TDMA to two-dimensional and three-dimensional problems.

UNIT – IV **9**

Finite Volume Method for Unsteady Flows: One-dimensional unsteady state heat conduction, implicit method for two-and three-dimensional problems, discretisation of transient convection-diffusion equation, transient convection-diffusion using QUICK differencing scheme, solution procedures for unsteady flow calculations, steady state calculations using pseudo-transient approach.

UNIT – V **9**

Turbulence and its Modeling: Transition from laminar to turbulent flow, effect of turbulence on properties of the mean flow, Reynolds-averaged Navier-Stokes equations and classical turbulence models, mixing length model, k-ε model, Reynolds Stress model and Algebraic Stress model.

Total: 45

REFERENCES:

1. Versteeg H.K. and Malalasekara W., "An Introduction to Computational Fluid Dynamics: The Finite Volume Method", 2nd Edition, Pearson Education Ltd., 2007.
2. Anderson John D., "Computational Fluid Dynamics - The Basics with Applications", 1st Edition, Tata-McGraw Hill Publisher, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	apply the knowledge of C.F.D techniques in developing fluid flow models	Applying (K3)
CO2:	apply finite volume method for developing solution of steady state diffusion and convection diffusion problems	Applying (K3)
CO3:	demonstrate the application of SIMPLER, SIMPLEC and PISO algorithms for solution of industrial and R & D problems	Analyzing (K4)
CO4:	apply the knowledge of algorithms in solving unsteady flow heat conduction and convection diffusion processes	Applying (K3)
CO5:	demonstrate the application of turbulent flows and models in simulation packages	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	2		1	2	2
CO2	2		2	3	3
CO3	2		1	3	3
CO4	2		2	3	3
CO5	1		1	2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MFE01 ADVANCED FRUIT AND VEGETABLE PROCESSING TECHNOLOGY					
		L	**T**	**P**	**Credit**
		3	**0**	**0**	**3**
Preamble	To study about the recent techniques in fruit and vegetable processing and its effects on quality of finished products				
Prerequisites	Nil				
UNIT – I					**9**
Post-harvest Processing: Pre-harvest factors on postharvest life, Maturity index, Harvesting and handling methods, Precooling, Post-harvest treatments- curing, sprout suppressants, degreening. Storage – Refrigerated storage, Hypobaric storage. Controlled atmosphere stores. MAP. Fruit ripening – changes during ripening, ripening rooms. Ethylene – sources, alternatives.					
UNIT – II					**9**
Edible Coatings: Introduction, Principle, selection of edible coatings, Polysaccharide, protein and lipid based coatings. Gas permeation properties, Wettability, coating effectiveness, Diffusivities of fruits – determination. Measuring internal gas composition. Future trends. **Vacuum Technology:** introduction, principles – mass transfer and product behaviour. Applications and future trends.					
UNIT – III					**9**
Minimal Processing: introduction, quality changes, Processing – physiological and microbiological impacts, Fresh cut products – Fresh produces quality and safety. Strategies for minimizing quality loss improving quality, bio-control agents, browning inhibition. Storage and packaging. Fresh-cut chain – harvest to market. Equipment requirements. Traceability of fresh cut products. Layout of a fresh cut processing facility.					
UNIT – IV					**9**
Fruit and Vegetable Product Manufacturing: Jams and Jellies – Gelling agent, sweetening agent, acidulants, coloring and flavoring agents, method of manufacturing. Fruit Beverages – Classification, Production of filtered and cloudy fruit drinks – preparation steps, Juice extraction, clarification, concentrate production. Production of fruit nectars – preparation steps.					
UNIT – V					**9**
Ozone: Introduction, ozone properties, ozone generation methods – electrical, electrochemical, radiochemical and ultraviolet method. Ozone in fruit juice processing – gaseous and aqueous applications, factors affecting efficacy of ozone processing – Extrinsic and intrinsic parameters. Mechanism of microbial inactivation. Effect on food quality. Industrial health and safety.					
					Total: 45

REFERENCES:

1.	Jongen W., "Fruit and Vegetable Processing: Improving Quality", Woodhead Publishing Series in Food Science, Technology and Nutrition, 2002.
2.	Hui Y.H., József Barta, Pilar Cano M., Todd W. Gusek, Jiwan S. Sidhu and Nirmal K. Sinha, "Handbook of Fruits and Fruit Processing", Blackwell Publishing, 2006.
3..	Rodrigues Sueli, and Fabiano Andre Narciso Fernandes, (Eds), "Advances in Fruit Processing Technologies", 1st Edition, CRC Press, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	make use of suitable post-harvest processing methods for fresh produce	Understanding (K2)
CO2:	select suitable edible coatings for fruits and vegetables and outline the applications of vacuum technology on fruit processing	Applying (K3)
CO3:	apply minimal processing techniques for the production of fresh cut fruits and vegetables	Applying (K3)
CO4:	develop fruit and vegetable based jam, jelly and juice products	Applying (K3)
CO5:	interpret the usage and effect of ozone in fruit processing	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	1		2	1
CO2	3	2		2	1
CO3	3	2		2	1
CO4	3	3		2	1
CO5	3	2		2	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MFE02 ADVANCED FOOD PROCESSING TECHNOLOGY				
	L	**T**	**P**	**Credit**
	3	**0**	**0**	**3**
Preamble	To learn few selected food processes techniques such as extraction methods, encapsulation, instantization and agglomeration, cold plasma and 3d food printing.			
Prerequisites	Nil			

UNIT – I	**9**
Extraction Processes: Introduction, Extraction of bioactive compounds. Conventional extraction, Advanced extraction – enzyme assisted extraction, ultrasound assisted extraction, microwave assisted extraction, high pressure extraction, supercritical fluid extraction and pressurized liquid extraction. Challenges and future trends in extraction techniques	

UNIT – II	**9**
Encapsulation: Introduction, wall materials used for encapsulation, Methods of encapsulation process – nano and micro encapsulation – physical and chemical methods. Bioavailability. Controlled release techniques in food industry. Applications and current trends.	

UNIT – III	**9**
Instantization and Agglomeration: Introduction, Instantization and Agglomeration process, Methods - pressure, extrusion, tumbling of powders, straight through, spray bed dryer agglomeration, steam jet and agglomeration by heating. Characteristics of agglomerated products, Applications – instant food products.	

UNIT – IV	**9**
Cold Plasma: Plasma, properties of plasma, chemistry of plasma, plasma generation methods, Applications of plasma in food processing, Effect of plasma on microbial cells and enzymes, effect on starch, phenolic, antioxidant compounds, seed germination, packaging materials, Limitations and toxicology. Current research trends.	

UNIT – V	**9**
3D Food Printing: Introduction, Food printing platform, food printing materials – natively printable and non-printable foods, 3D food printing technologies - Selective Laser Sintering/Hot Air Sintering, Hot-Melt Extrusion/Room Temperature Extrusion, Binder Jetting, Inkjet Printing. Multi material and multi print head. Potential technologies Applicable to Food Printing, impacts from 3D Food Printing.	
	Total: 45

REFERENCES:

1. Sahu, Jatindra Kumar, (Eds), "Introduction to Advanced Food Process Engineering", CRC Press, 2014.
2. Bhattacharya, Suvendu, (Eds), "Conventional and Advanced Food Processing Technologies", John Wiley & Sons, 2014.
3. Misra N.N., Oliver Schlüter and Patrick J. Cullen, (Eds), "Cold plasma in Food and Agriculture: Fundamentals and Applications", Academic Press, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	select appropriate techniques for extraction of active components	Applying (K3)
CO2:	make use of suitable encapsulation techniques for food ingredients	Applying (K3)
CO3:	utilize agglomeration process for the production of instant food products	Applying (K3)
CO4:	summerize the effect of cold plasma on food products	Understanding (K2)
CO5:	outline the applications of 3D food printing	Understanding (K2)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2		2	1
CO2	3	2		2	1
CO3	3	2		2	1
CO4	3	2		2	1
CO5	3	2		2	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MFE03 ADVANCED SEPARATION TECHNIQUES IN FOOD PROCESSING				
	L	**T**	**P**	**Credit**
	3	**0**	**0**	**3**

Preamble	To impart knowledge of type of equipment's / separation methods that are required for a particular type of separation process in a food process industry
Prerequisites	Nil

UNIT – I **9**

Recent Advancements in Separation Techniques: Recent advances in separation techniques based on size, surface properties, ionic properties and other special characteristics of substances. Process concept, theory and equipment used in cross flow filtration, cross flow electro filtration and dual functional filter. Surface based solid – liquid separations involving a second liquid, Sirofloc filter.

UNIT – II **9**

Solid Separation Process: Concept of size, Shape, Magnetic separation, Eddy-current separation, Ballistic separation, Color separation, Wet Separation Process, liquid-solid and liquid- liquid separation by hydro cyclones, Surface velocity classifier, Elutriators, Impingement separator, Electrostatic precipitation membrane.

UNIT – III **9**

Adsorption based and other Separation Processes: Types and choice of adsorbents, Mechanisms of Affinity chromatography and immuno chromatography. Foam separation, Super critical fluid extraction - Food Application. **Powder Technology:** Classification of powder, separation of powder sieving, air classification and its factors affecting, air separation, Particle size distribution.

UNIT – IV **9**

Membrane Technology: Membrane modules, Mechanism and equipment's employed for micro-filtration, Ultrafiltration, Nanofiltration, Reverse osmosis, Concentration polarization, Pervaporation and Application of membrane technology in food industry.

UNIT – V **9**

Ionic Separation Processes: Working principle, controlling factors, equipment employed for electrophoresis, Dielectrophoresis, ion exchange chromatography, electrodialysis and permeation techniques for solids, liquids and gases.

Total: 45

REFERENCES:

1. Grandison A.S., and Lewis M.J., "Separation process in the food and biotechnology industries", Woodhead Pulication, England, 1996.
2. King C.J., "Separation Processes", 2nd Edition, Tata McGraw–Hill Publishers, New Delhi, 1982.
3. RonaldW. Rousseau, "Handbook of Separation Process Technology", Wiley India Pvt. Ltd., 2009.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	infer the concepts of separation techniques	Understanding (K2)
CO2:	choose different solid liquid separation process	Applying (K3)
CO3:	outline the adsorption and other separation process in food processing	Understanding (K2)
CO4:	categorize separation based on membranes	Analyzing (K4)
CO5:	apply the ionic separation and other commercial processes	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	1			1
CO2	3	2			1
CO3	3	2			1
CO4	3	2			1
CO5	3	1			1

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MFE04 ENZYME ENGINEERING AND TECHNOLOGY

L	T	P	Credit
3	0	0	3

Preamble	This course give an insight about the properties of enzymes, kinetics, production and purification, biosensors and application of enzymes in food industry
Prerequisites	Nil

UNIT – I **9**

Enzymes: Introduction, Classification and Nomenclature of enzymes according to IUB. Mechanisms of enzyme action, concept of active site and energetic of enzyme substrate complex formation, specificity of enzyme action, Mechanism of enzyme catalysis- electrostatic proximity and orientation effect, role of entropy in catalysis. Co-enzyme, cofactor and prosthetic group – reaction involving TPP, Pyridoxal phosphate, Nicotinamide, Flavin Nucleotides, Co-A, Biotin and Vitamin K dependent carboxylation. Isozymes, abzymes, synzymes.

UNIT – II **9**

Kinetics of Enzyme Action: Order of reaction, Activation energy, Kinetics of single substrate reactions, Estimation of Michelis-Menten parameters, Lineweaver Burk plot, multisubstrate reactions-mechanisms and kinetics, turn over number, pH and temperature effect on enzymes and deactivation kinetics.

UNIT – III **9**

Enzyme Inhibition: Reversible inhibition - Kinetics of competitive, non-competitive and uncompetitive inhibition. Irreversible inhibition – suicide inhibition. Allosteric regulation of enzymes, Monod changeuxwyman model. **Enzyme Immobilization** - Physical and chemical techniques for enzyme immobilization-adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding - examples, advantages and disadvantages.

UNIT – IV **9**

Application of Enzyme Extracts: Plant, animal and microbial sources, methods of characterization of enzymes, development of enzymatic assays. Enzyme application in food processing, meat industry, fruit and vegetable industry, dairy industry, health care and environment.

UNIT – V **9**

Enzyme Engineering and Biosensor: Enzyme engineering- design and construction of novel enzymes, site directed mutagenesis, artificial enzymes. Design of enzyme electrodes and their application as biosensors in industry.

Total: 45

REFERENCES:

1. Trevor Palmer, "Enzymes: Biochemistry, Biotechnology and Clinical Chemistry", Horwood Publishing**,** 2007.
2. Parmjit S. Panesar, Satwinder S. Marwaha, Harish K. Chopra, "Enzymes in Food Processing: Fundamentals & Potential Applications", I.K. International Publishing House, 2010.
3. Whitehurst R. and Law B., "Enzymes in Food Technology", Blackwell Publishing, 2002.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	outline enzyme classification and understand the influence of environmental factors on enzyme activity	Understanding (K2)
CO2:	interpret enzyme kinetics and enzyme inhibition	Understanding (K2)
CO3:	apply suitable methods for enzyme immobilization	Applying (K3)
CO4:	employ suitable enzymes in food processing	Applying (K3)
CO5:	understand the concepts of enzyme engineering and biosensor	Understanding (K2)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2		1
CO2	3	3	2		1
CO3	3	3	2		1
CO4	3	3	2		1
CO5	3	3	2		1

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MFE05 OPERATIONAL RESEARCH					
		L	**T**	**P**	**Credit**
		3	**0**	**0**	**3**
Preamble	Operation Research is a discipline to aid decision making and improving efficiency of the system by applying advanced analytical methods. It should offer a unique blend of traditional course work, practical skills and real-world problem-solving experience for student's success in today's competitive world				
Prerequisites	Nil				
UNIT – I					**9**
Introduction to Operation Research: History of Operations Research- Stages of Development of Operations Research- Relationship Between Manager and OR Specialist- OR Tools and Techniques- Scope and Applications of Operations Research- Limitations of Operations Research					
UNIT – II					**9**
Linear Programming: Introduction to Linear Programming. **Graphical Method:** Linear Programming Problem Formulation, Formulation with Different Types of Constraints, Graphical Analysis of Linear Programming, Graphical Linear Programming Solution, Multiple Optimal Solutions- Unbounded Solution, Infeasible Solution. **Simplex Method:** Basics of Simplex Method, Simplex Method Computation, Simplex Method with More Than Two Variables, Two Phase and M Method, Multiple Optimal Solutions- Unbounded Solution, Infeasible Solution					
UNIT – III					**9**
Non – Linear Programming: Constrained problems- Equality constraints- Lagrangean method- In equality Constraints- Karush- Kuhn- Tucker (KKT) Conditions- Quaradic Programming.					
UNIT – IV					**9**
Game Theory and Queuing Theory: Introduction to the theory of games- The definition of a game, Competitive game, Managerial applications of the theory of games, Key concepts in the theory of games, Types of games. Queuing Theory*:* Introduction, Mathematical Analysis of Queuing Process, Properties of Queuing System, Notations, Service System, Single Channel Models, Multiple Service Channels, Erlang Family of Distribution of Service Times, Applications of Queuing Theory, Limitations of Queuing Theory.					
UNIT – V					**9**
Simulation, Project Scheduling and PERT-CPM: Simulation: Basic Concepts, Simulation Procedure, Application of Simulation. Project Scheduling and PERT-CPM: Introduction, Basic Difference between PERT and CPM, PERT/CPM Network Components and Precedence Relationship, Project Management – PERT					
					Total: 45

REFERENCES:

1. Tiwari N.K., and Shishir K. Shandilya, "Operations Research", Prentice Hall, New Delhi, 2006.
2. Sharma, "Operations Research: Theory and Applications", Macmillan Publishers, New Delhi, 2009.
3. Gupta C.B., "Optimization Techniques In Operation Research", I.K. International Publishing House, New Delhi, 2008.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	outline the basics of operation research	Understanding (K2)
CO2:	develop a complete procedure for solving different kinds of programming problems	Applying (K3)
CO3:	apply non-linear programming for solving problems	Applying (K3)
CO4:	relate Game and Queuing Theory	Understanding (K2)
CO5:	analyze network scheduling using CPM and PERT	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1		3		1	1
CO2	2	3	2	1	1
CO3		3		1	1
CO4				1	1
CO5				1	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MFE06 HEAT AND MASS TRANSFER OPERATIONS IN FOOD PROCESSING					
		L	**T**	**P**	**Credit**
		3	**0**	**0**	**3**
Preamble	This course provides in-depth knowledge on selected heat transfer operations like condensation, boiling, evaporation, distillation, extraction and leaching. Performance analysis / design aspects / Equipment for the above mentioned operations are also included.				
Prerequisites	Nil				
UNIT – I					**9**
Condensation and Boiling: Condensation number – Film condensation – Boiling heat transfer - Simplified relations. **Evaporators:** Single and multiple effect evaporators – Performance of evaporators and boiling point elevation – capacity – economy and heat balance - Types of evaporators.					
UNIT – II					**9**
Heat Exchangers: Overall heat transfer coefficients – Fouling factor - Types of Heat Exchanger- - LMTD - Heat exchanger effectiveness by NTU method- Compact Heat Exchangers – Analysis for variable Properties					
UNIT – III					**9**
Distillation: Batch Distillation **–** Flash Vaporization – Continuous fractionation- Design of multistage tray towers for binary systems: McCabe Thiele method and Panchon Savorit method. Introduction to multicomponent distillation					
UNIT – IV					**9**
Extraction: Single stage, multistage cross current and multi stage counter current operations - Introduction to newer extraction techniques: Super critical extraction, pulsed electric field extraction, microwave extraction, ultrasound assisted extraction, subcritical water extraction, High pressure assisted extraction.					
UNIT – V					**9**
Leaching: Solid liquid equilibria, single stage leaching, multistage crosscurrent and counter current leaching, Calculations for number of stages - leaching equipment. Batch percolators – Fixed bed multistage systems – continuous contactors.					
					Total: 45
REFERENCES:					
1.	Holman J.P., "Heat Transfer", 6th Edition , McGraw-Hill, New York, 1986.				
2.	Treybal R.E., "Mass Transfer Operations", 3rd Edition, McGraw-Hill, New York, 1981.				
3.	Albert Ibarz, "Unit Operations in Food Engineering", CRC Press, 2003.				

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	explain condensation and evaporative heat transfer phenomena	Understanding (K2)
CO2:	analyze the heat exchanger performance	Analyzing (K4)
CO3:	design multistage distillation towers	Creating (K6)
CO4:	choose and apply extraction techniques	Applying (K3)
CO5:	explain leaching process and estimate number of stages	Understanding (K2)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2			1
CO2	3	2			1
CO3	3	2			1
CO4	3	2			1
CO5	3	2			1

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MFE07 FOOD ADDITIVES, NUTRACEUTICALS AND FUNCTIONAL FOODS				
L	**T**	**P**	**Credit**	
3	**0**	**0**	**3**	
Preamble	This course provides the availability of food additives, various nutraceuticals and functional foods and their health benefits			
Prerequisites	Nil			
UNIT – I				**9**
Food Additives: Introduction, classification and functions; Role of additives in foods - preservatives, antioxidants, sequestrants, emulsifiers -selection of emulsifier based on Hydrophilic and Lipophilic balance (HLB) and its application, stabilizers and thickeners, bleaching and maturing agents, starch modifiers, food colourants and colour retention agents, sweeteners, humectants, flavorants and flavor enhancers, leavening agents, pH control agents, fat substitutes and replacers, anti-foaming agents. International Product Code.				
UNIT – II				**9**
Nutraceuticals: Introduction, sources, understanding benefits of nutraceuticals. Scope involved in industry, Indian and global scenario. **Eye, Heart and Digestive Health Ingredients:** Eye health ingredients – lutein, zeaxanthin, astaxanthin, beta-carotene, bilberry extracts; Heart health ingredients - omega-3, omega-6, omega-9, beta-glucan, soy protein, phytosterols; Digestive Health Ingredients – prebiotics, probiotics, synbiotics, digestive enzymes, zinc carnosine.				
UNIT – III				**9**
Women and Bone and Joint Health Ingredients: Women health ingredients - Vitamin D, iron, calcium, soy isoflavones, folic acid, cranberry extract, lycopene, phytoestrogens; Bone and Joint health ingredients - prebiotic fiber, glucosamine, chondroitin, collagen peptide, hyaluronic acid, devils claw, olive polyphenols, Boswelia Serrata, horsetail extract.				
UNIT – IV				**9**
Dietary Supplements: Introduction to dietary supplements, functional food and beverages; Agnuscastus, Aloe vera, Bee products, Chitosan, Echinacea, Garlic, Ginger, Ginkgo biloba, Ginseng, Guarana, Kelp, Milk thistle, Saw palmetto, Spirulina, Chlorella, Hypericumperforatum, Tea extracts. Dietary supplements – Need for dietary supplements, supplements forms-tablets, capsules, powders, softgels, gelcaps, liquids.				
UNIT – V				**9**
Asian Functional Food: Functional Foods from Meat, Fruit, Fermented Vegetable Products: Kimchi, Sugarcane, Garlic, Onion, Date Fruits, Japanese Green Tea, Miso, Fermented Soybean Products. Cereal based Functional food and their health effects.				
				Total: 45
REFERENCES:				
1.	Belitz H. D., Grosch W., Schieberle P., "Food Chemistry", 3rd Edition, Springer-Verley, Berlin, 2004.			
2.	John Shi, Chi-Tang Ho and Fereidoon Shahidi, "Asian Functional Foods", 1st Edition, CRC Press, 2005.			
3.	Wildman, Robert E.C., "Handbook of Nutraceuticals and Functional Foods", CRC Press, New York, 2001.			

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	classify and choose various food additives	Applying (K3)
CO2:	appraise the different types of eye, heart and digestive health ingredients	Applying (K3)
CO3:	examine the types of women and bone and joint health ingredients	Evaluating (K5)
CO4:	outline various functional foods and nutraceuticals in the market	Understanding (K2)
CO5:	infer the significance of Asian functional foods	Understanding (K2)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	3	1
CO2	3	3	2	3	1
CO3	3	3	2	3	1
CO4	3	3	2	3	1
CO5	3	3	2	3	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MFE08 FOOD PACKAGING AND STORAGE ENGINEERING

L	T	P	Credit
3	0	0	3

Preamble	The knowledge about packaging and storage materials and methods will be delivered by this course. The recent developments and trends in labelling and packaging are also covered in the subject.
Prerequisites	Nil

UNIT – I **9**

Packaging Materials and Selection of Package: Functions of packaging, Type of packaging materials, Selection of packaging materials and methods for different foods solid, semi–solid and liquid food. Optimizing packaging. advances in sealing, seaming and methods to detect defects, improving the performance of retortable pouches, testing consumer responses to new packaging concepts.

UNIT – II **9**

Developments in Active Packaging: Controlled release packaging – process, structure, property and food variables, target release rate, active antimicrobial packaging – manufacturing, measurement of antimicrobial activity, active nanocomposites packaging – free radical scavenging nanocomposites, oxygen scavenging nanocomposites, antimicrobial nanocomposites, edible chitosan coatings – properties of chitosan, application of chitosan based coatings, flavor-release packaging – mechanism of flavor release, practical applications.

UNIT – III **9**

Trends in Packaging, Labelling and Shelf life Studies: MAP - novel gases, high oxygen MAP, applications, Natural non-toxic insect repellent packaging materials, Interactive packaging using internet, Smart Labelling - Labelling to detect changes in temperature, monitor freshness, detect changes in oxygen and carbon dioxide concentration. Shelf life studies - Testing under normal and accelerated conditions, Shelf life models – constant H_2O and O_2 driving forces, variable H_2O driving force, variable O_2 driving force.

UNIT – IV **9**

Storage Engineering: Storage of grains–biochemical changes during storage– production, distribution and storage capacity estimate models–storage capacity models–ecology, storage factors affecting losses, storage requirements, bag and bulk storage– pressure distribution– theories–rodent control– method of stacking–preventive method, function structural and thermal design of structures.

UNIT – V **9**

Grain Storage and Handling: Bag Storage - Advantages and Disadvantages - Bag Storage structure design. Parameters of good storage structure, Controlled atmospheric storage. Cover Plinth Storage Structures, CAP storage (Ceiling and Plinth Storage), Plans for Bag storage, layouts, Dunnage, Materials for Dunnage, Protection against Rodents, Fungi, Pests and Mites, Bulk Storage in silos and large bins - Physical load and mechanical strength of Silos, Silo flow problems.

Total: 45

REFERENCES:

1. Dong Sun Lee, Kit L. Yam and Luciano Piergiovanni, "Food Packaging Science and Technology", 1st Edition, CRC Press, USA, 2008.
2. Raia Ahvenainen, "Novel Food Packaging Techniques", 1st Edition, CRC Press, UK, 2003.
3. Jerry Heeps, "Insect Management for Food Storage and Processing", 2nd Edition, Elsevier, USA, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	select appropriate packaging materials based on the need	Applying (K3)
CO2:	make use of suitable novel packaging technique for the product	Applying (K3)
CO3:	apply the knowledge to design new labels and predict shelf life	Applying (K3)
CO4:	summarize the concepts in food storage	Understanding (K2)
CO5:	develop plans for grain storage and handling	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	2		1	2	1
CO2	2	2	1		1
CO3	3	3	1	2	1
CO4			1	1	1
CO5	1	1	1		1

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MFE09 INDUSTRIAL WASTE MANAGEMENT				
	L	**T**	**P**	**Credit**
	3	**0**	**0**	**3**

Preamble	To educate the students on complete management principles related to waste water and solid waste, starting from source identification up to reuse concepts.
Prerequisites	Nil

UNIT – I **9**

Industries and Environment: Industrial scenario in India – Industrial activity and Environment – Uses of water by industry – Sources and types of industrial wastewater – Industrial wastewater and environmental impacts – Regulatory requirements for treatment of industrial wastewater – Industrial waste survey – Industrial wastewater generation rates, characterization and variables – Population equivalent – Toxicity of industrial effluents and Bioassay tests.

UNIT – II **9**

Management of Industrial Waste Water: Treatments: Aerobic and anaerobic biological treatment – batch and high rate reactors – Chemical oxidation –Ozonation – Photo catalysis – Wet Air Oxidation – Evaporation – Ion Exchange – Membrane Technologies. **Treatment Plants:** Individual and common Effluent Treatment plants – Joint treatment of industrial wastewater – Zero effluent discharge systems – Quality requirements for wastewater reuse – Industrial reuse – Disposal on water and land – Residuals of Industrial wastewater treatment.

UNIT – III **9**

Solid Waste Sources and Segregation: Sources: Types and Sources of solid wastes – Need for solid waste management – Elements of integrated waste management and roles of stakeholders – Salient features of Indian legislations on management and handling of municipal solid wastes, plastics and fly ash. **Segregation:** Handling and segregation of wastes at sources – storage and collection of municipal solid wastes – Analysis of collection systems – Need for transfer and transport – Transfer stations - Optimizing waste allocation – compatibility, storage, labeling wastes

UNIT – IV **9**

Energy Recovery and Disposal: Energy Recovery: Objectives of waste processing – material separation and processing technologies – biological and chemical conversion technologies – methods and controls of composting – energy recovery and other modern techniques in managing solid waste – case studies. **Disposal:** Waste disposal options – Disposal in landfills – Landfill classification, types and methods – site selection – design and operation of sanitary landfills, secure landfills – leachate and landfill gas management – landfill closure of landfills – landfill remediation

UNIT – V **9**

Practical Applications in Industries: Industrial manufacturing process description, wastewater and solid waste characteristics, source reduction options and waste treatment flow sheet for Textiles – Tanneries – pulp and paper – petroleum refining – pharmaceuticals – sugar and distilleries – Food processing – fertilizers – Thermal power plants and Industrial Estates.

Total: 45

REFERENCES:

1.	Eckenfelder W.W., "Industrial Water Pollution Control", McGraw-Hill, 2001.
2.	Arceivals S.J., "Wastewater Treatment for Pollution Control", Tata McGraw-Hill, 2008.
3.	Landreth R.E. and Rebers P.A., "Municipal Solid Wastes - Problems and Solutions", Lewis Publishers, 2002.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	summarize the present industrial impact on environment	Understanding (K2)
CO2:	identify the waste water management and reuse	Applying (K3)
CO3:	outline the sources of solid waste and segregation	Understanding (K2)
CO4:	utilize of solid waste and disposal	Applying (K3)
CO5:	apply the waste management in industries	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	3		3	1
CO2	3	3		2	2
CO3	2	2		2	1
CO4	3	3		3	2
CO5	3	3		2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MFE10 ADVANCED BAKING AND CONFECTIONERY TECHNOLOGY

L	T	P	Credit
3	0	0	3

Preamble	This course will help students to get well equipped with science and technology of bakery and confectionery products, ingredient functionality, and significance of analytical techniques in product development. In depth knowledge of engineering principles, equipments and machinery as well as new technology used in bakery and confectionery industries is also obtained.
Prerequisites	Nil

UNIT – I **9**

Bakery Ingredients and Equipments: Essential bakery ingredients: Flour, yeast and sour dough, water, salt- Other ingredients: Sugar, color, flavor, fat, milk, milk powder and bread improvers. Leaveners and yeast foods. Shortenings, Emulsifiers and Antioxidants. Equipments- Introduction to utensils and equipments used in bakery industry with their purpose. Bulk handling of ingredients- Dough mixing and mixers, Dividing, rounding, sheeting, and laminating- Fermentation enclosures and brew equipment - Ovens and Slicers.

UNIT – II **9**

Rheological Properties of Dough and Batter: Rheological methods, Fundamental testing – Empirical methods, Dough testing equipments – Farinograph, Amylograph. Alveograph and Extensiograph. Texture profile analysis, compression, penetration, modified penetrometers, transient tests, dynamic tests, extensional viscosity, Effect of ingredients, mixing, dosing and temperature on rheological properties of dough and batter.

UNIT – III **9**

Technology of Bakery Products: Bread: Stages in processing of bread. Bread making methods - Advantages and disadvantages of various methods of bread-making – update on frozen dough and partially baked bread. Biscuits: Types of biscuit dough - hard and soft dough. Hard dough - Fermented dough, Puff dough and Semi sweet dough. Soft dough – Creaming and all in one method. Cookies: batter and foam type. Methods of mixing cookies – single stage, creaming and blending methods. Center filled cookies. Technology of manufacture. Cakes: Formulation and mixing methods - Baking of cake - Cake characteristics. Basic concepts of heat and mass transfer mechanism in bakery products.

UNIT – IV **9**

Technical Faults in Bakery Products: Foam to sponge conversion and the collapse of bakery products, Effect of ingredient, recipe and product interactions. **Confectionery:** Classification, ingredients and their role: Sugar boiled Confectionery – Candies – Liquid and Powder center filled, Toffee chews – plain and milk based, Jellies. Chewing and Bubble Gum, Compressed Tablets. Chocolate Confectionery – Cocoa Products. Sugar Free Confectionery – Candies – Chewing Gum

UNIT – V **9**

Confectionery Technology: Technology for manufacture of Candies, Toffee chews and Jelly Confectionery – Batch and continuous process for production of plain and center filled candies – Toffee chew processing – Jelly processing. Chocolate confectionery - cocoa bean processing, Chocolate manufacture – mixing, refining, conching, tempering, molding and enrobing. Chewing and Bubble Gum – Ingredients and processing. Sugar free candies and chewing gum – Ingredients and processing. Sugar free chewing gum - Quality standards of confectionery products. Packaging and shelf life of Confectionery products.

Total: 45

REFERENCES:

1. Samuel A. Matz, "Bakery Technology and Engineering", 3rd Edition, Chapman and Hall, London, 2005.
2. Cauvain Stanley P. and Young Linda S., "Technology of Bread Making", 2nd Edition, Aspen Publication, Maryland, 1999.
3. Servet Gulum Sumnu and Serpil Sahin, "Food Engineering Aspects of Baking Sweet Goods", CRC Press, USA, 2008.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	summarize the function of ingredients in bakery products	Understanding (K2)
CO2:	analyse and interpret the results of various testing methods in bakery products	Analyzing (K4)
CO3:	apply the knowledge of ingredients in new product development	Applying (K3)
CO4:	outline the technical defects observed in bakery products and the types of confectionery products including the role of raw materials	Understanding (K2)
CO5:	apply the process technology for development of confectionery products	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	1	1
CO2	3	2	2	1	1
CO3	3	3	3	2	1
CO4	3	3	3	2	2
CO5	3	2	3	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MFE11 ADVANCED GRAIN SCIENCE AND TECHNOLOGY				
	L	**T**	**P**	**Credit**
	3	**0**	**0**	**3**

Preamble	To learn about the milling of various cereals along with the recent advancements in milling and various cereal based products
Prerequisites	Nil

UNIT – I	**9**

Grains: Introduction, structural components of cereal grains, physical properties. Harvesting, Threshing, grain cleaning, grading, drying, storage, aeration and stored grain management, control of insects, microorganisms and rodents during storage.

UNIT – II	**9**

Rice Milling: Structure. Rice milling - flowsheet. Improving nutritional properties of rice by different methods. Changes in physico-chemical, pasting and milling properties during aging of rice. Water mist polishing, rice moisture conditioning, Instruments for rice quality control – rice analyzer, broken rice analyzer, FWM analyzer, rice taste analyzer.

UNIT – III	**9**

Wheat Milling: Morphology of wheat. Classification. Wheat milling - Flow sheet. Turbo milling, air classifiers. Criteria of wheat and flour quality, structure and functional properties of gluten, wheat grain protein, starch, phytochemcials, dough chemistry, rheology, evaluation of flour quality by Farinograph, Mixograph, Extensogram, rapid visco analyzer, dynamic rheometry.

UNIT – IV	**9**

Speciality Milling: Barley – Processing, finishes products and end uses. Corn – wet and dry milling, Manufacture of value added products such as zein from corn. Oat milling and flaking. Dietary fibre from barley and oats: β glucan structure, extraction, physiological effects and functional properties

UNIT – V	**9**

Cereal Products: Rice snack foods, Rice noodles, quick cooking rice, canned and frozen rice, Baby foods, extruded rice, puffed rice cake, pasta, instant noodles, breakfast cereals, cereal enrichment, malted cereals, special food ingredients from cereals, future trends.

Total: 45

REFERENCES:

1.	KarelKulp, "Handbook of Cereal Science and Technology", 2nd Edition, CRC Press, 2000.
2.	Amalendu Chakraverty, Arun S. Mujumdar, Hosahalli S. Ramaswamy, "Handbook of Postharvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices", CRC Press, 2003.
3.	Serna-Saldivar, Sergio O., "Cereal grains: Properties, Processing and Nutritional Attributes", CRC Press, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	outline the grain properties and preprocessing operations of grains	Understanding (K2)
CO2:	make use of suitable milling technologies for rice processing	Applying (K3)
CO3:	outline wheat milling process and suggest suitable flour treatment methods and byproduct utilization	Understanding (K2)
CO4:	recommend various milling method suitable for different cereals	Evaluating (K5)
CO5:	develop different cereal based products	Creating (K6)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3				1
CO2	3	1		2	1
CO3	3	2		2	1
CO4	3	2		2	1
CO5	3	3		3	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MFE12 TRANSPORT PHENOMENA IN FOOD PROCESSING					
		L	**T**	**P**	**Credit**
		3	**0**	**0**	**3**
Preamble	This course deals with the movement of different physical quantities in any process and describes the basic principles and laws of transport. It also describes the relations and similarities among different types of transport (Momentum, Energy, Mass) that may occur in any system.				
Prerequisites	Fluid Mechanics, Heat Transfer, Mass Transfer				
UNIT – I					**9**
Momentum Transport: Phenomenological laws of transport properties, Newtonian and non-Newtonian fluids, rheological models, theories of transport properties of low density gases and liquids, effect of pressure and temperature. Shell momentum balances – boundary conditions and flow of falling film.					
UNIT – II					**9**
Interphase Transport in Isothermal System: Friction factor, Fluid–Fluid systems, Flow patterns in vertical and horizontal pipes, Formulation of bubbles and drops and their size distribution, Solid – fluid systems, Forces acting on stagnant and moving solids, Flow through porous medium, Capillary tube model and its applications.					
UNIT – III					**9**
Energy Transport: Fourier's law of heat conduction, theory of thermal conductivity of liquids and solids, shell energy balances- boundary conditions, heat conduction with an electrical heat source, composite walls, viscous heat source.					
UNIT – IV					**9**
Interphase Transport in Non-Isothermal System: Heat Transfer coefficient, Forced convection in tubes, around submerged objects, Heat Transfer by free convection, film type and drop wise condensation and equations for heat transfer, Heat transfer in boiling liquids.					
UNIT – V					**9**
Mass Transport and Interphase Mass Transfer: Ficks law of diffusion, Theories of ordinary diffusion in gases and liquids, shell mass balances- boundary conditions, diffusion with heterogeneous and homogeneous reaction – effectiveness factor. Mass Transfer co-efficient in single and multiple phases at low and high mass transfer rates. Macroscopic balance to solve steady and Unsteady state problems.					
					Total: 45

REFERENCES:

1. Bird R.B., Stewart W.E. and Lightfoot E.N., "Transport Phenomena", 2nd Edition, John Wiley and Sons, 2002.
2. Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, and David P. DeWitt, "Fundamentals of Heat and Mass Transfer", 7th Edition, John Wiley and Sons, 2011.
3. Jorge WeltiChanes, Jorge Vélez-Ruiz, Gustavo V. Barbosa-Cánovas, "Transport Phenomena in Food Processing", CRC Press, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	explain the phenomena behind the transport of momentum, mass and energy	Understanding (K2)
CO2:	make use of the shell balance approach to solve momentum, mass and energy transport problems	Applying (K3)
CO3:	explain and apply the concept of interphase transport in isothermal systems	Applying (K3)
CO4:	explain and apply the concept of interphase transport in non-isothermal systems	Applying (K3)
CO5:	analyze unsteady state problems	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	2	2			1
CO2	3	3			1
CO3	3	2			1
CO4	3	2			1
CO5	3	2			1

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MFE13 INDUSTRIAL ENGINEERING					
		L	**T**	**P**	**Credit**
		3	**0**	**0**	**3**
Preamble	This course gives deep insight in Industrial Engineering, productivity as well as significance of forecasting and planning. This in turn helps them to apply the principles in layout and design of facility and understanding on the importance of cost analysis in Industrial engineering.				
Prerequisites	Nil				
UNIT – I					**9**
Productivity: Industrial Engineering–Role of Industrial Engineering - System concept of production-Types of production system-flow, job, batch and project- Productivity-Factors affecting productivity-Productivity measures-Productivity improvement techniques-Business Process Reengineering (BPR).					
UNIT – II					**9**
Work Study: Method, basic procedure-Selection-Recording of process -Critical analysis, Development - Implementation -Micro motion and memo motion study –Principles of motion economy-Work measurement - Techniques of work measurement -Time study –computation of standard time-Work sampling -Synthetic data -Predetermined motion time standards-Job Evaluation, Merit Rating-Ergonomics and Safety.					
UNIT – III					**9**
Forecasting: Need for forecasting -demand patterns-Forecasting models -Judgmental Techniques, Time series analysis, moving average, exponential smoothing, Regression and correlation method-Forecast error-costs and accuracy of forecasts.					
UNIT – IV					**9**
Facility Planning: Facility location-factors influencing plant location-single and multi facility location problems-Minimax, Gravity and Euclidean –Distance location problem. Capacity planning, Plant layout-Layout classification-Layout Design Procedures-CRAFT, ALDEP, CORELAP-Material handling systems-unit load concept-material handling principles- Types of material handling equipments and its selection.					
UNIT – V					**9**
Value Engineering: Value engineering–Function, aims, procedure. Make or buy decision, Interest formulae and their applications –Time value of money, Single payment compound amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series payment Present worth factor-equal payment series capital recovery factor-Uniform gradient series annual equivalent factor, Effective interest rate, Methods of comparison of alternatives –present worth method, Future worth method, Annual equivalent method, rate of return method.					
					Total: 45
REFERENCES:					
1.	Telsang M., "Industrial Engineering and Production Management", S. Chand and Company, New Delhi, 2006.				
2.	Panneerselvam R., "Production and Operations Management", Prentice Hall of India, 2007.				
3.	Buffa Elwood S. and Sarin Rakesh K., "Modern Production and Operations Management", 8th Edition, John Wiley and Sons, New York, 2003.				

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	relate Industrial Engineering with production and productivity	Remembering (K1)
CO2:	interpret the concepts of work study	Understanding (K2)
CO3:	explain the significance of forecasting & various models	Understanding (K2)
CO4:	apply the knowledge of facility planning and layout design procedures design of a facility	Applying (K3)
CO5:	identify the importance of Industrial Engineering in cost analysis	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	1
CO2	3	2	3	2	1
CO3	2	2	3	2	1
CO4	3	3	2	3	2
CO5	3	2	3	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

18MFE14 FOOD PRODUCT DESIGN AND DEVELOPMENT

L	T	P	Credit
3	0	0	3

Preamble	To understand the process involved in idea generation, development of new food products, quality control and market study
Prerequisites	Nil

UNIT – I **9**

Food Needs and Consumer Preference: Market survey and its importance - designing a questionnaire to find consumer needs for a product or a concept - advantages of processed foods in urbanized Modern Society, Product development to meet the requirements, Generation of new product ideas, Product concepts, Product design.

UNIT – II **9**

Designing New Products: New Food Product Development (NPD) process and activities - food innovation case studies, market-oriented NPD methodologies - organization for successful NPD, Recipe development - involvement of consumers, chefs and recipe experts, selection of materials/ingredients –meat replacers – fat replacers – gluten free ingredients - cost effectiveness - nutritional needs or uniqueness.

UNIT – III **9**

Standardization and Large Scale Production: 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 **9**

Quality, Safety and Regulatory Aspects: Product Stability, evaluation of shelf life- accelerated shelf life determination - changes in sensory attributes and effects of environmental conditions, developing packaging systems for maximum stability and cost effectiveness - interaction of package with food, clean labelling, Regulatory aspects - Approval for proprietary product.

UNIT – V **9**

Advertisement, Marketing and Case Studies: Product performance testing - consumer testing - market positioning -Marketing - developing test market strategies, 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 - integration of technological and marketing approaches to NPD, food choice models and new product trends.

Total: 45

REFERENCES:

1. Brody A.L., and John B.L., "Developing New Food Products for a Changing Marketplace", 2nd Edition, CRC / Taylor and Francis, 2008.
2. Fuller G.W., "New Food Product Development: From Concept to Marketplace", CRC, 2004.
3. Gupta R., "Food Retailing: Emerging Trends", ICFAI University, Press, 2005.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	apply the concepts of consumer preference and idea generation for developing new product	Applying (K3)
CO2:	categorize the different stages in new product development and able to design new food product	Creating (K6)
CO3:	apply the knowledge of standardization and large scale production of new food products	Applying (K3)
CO4:	infer the quality, safety and regulatory aspects for new food product development	Applying (K3)
CO5:	analyze the marketing strategies of new food products	Evaluating (K5)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	2	2
CO2	3	3			1
CO3	3	3			2
CO4	3	2		2	2
CO5	3	3		1	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MHE18 DESIGN AND ANALYSIS OF EXPERIMENTS

(Common to Chemical and Food Technology branches)

Category	L	T	P	Credit
PC	3	0	0	3

Preamble:	This course highlights various techniques for designing and optimizing engineering experiments
Prerequisites:	Nil

UNIT – I **9**

Introduction to Experimental Design: Introduction – Principles and applications of Design of Experiments, Design of a process and product, Guidelines for designing experiments, Using statistical techniques for experimentation, Case studies

UNIT – II **9**

Foundations of Statistics: Sampling and Sampling Distributions, Inferences on Randomized and paired comparison designs, Analysis of Variables, Regression Analysis – Linear, Multiple regression, Testing for lack of fit

UNIT – III **9**

Randomized Complete Block Design: Framing RCBD experiments, Latin Square Desing, Graeco-Latin Square Design,Central Composite Design, Balanced Incomplete Block Design, Model adequacy checking, Leas Square estimation, regression, Case Studies in Chemical Engineering

UNIT – IV **9**

Factorial Experiments: Principles and Merits of Factorial design, Analysis of two factorial experiments, Analysis of two level Fractional factorial experiments, Three level Factorial experiments, Introduction to mixed and non regular factorial designs, Case Studies in Chemical Engineering

UNIT – V **9**

Response Surface Methodology using Software Tools: Introduction to RSM, Steepest Ascent method, Analysis of Second order response surface, Designs for Fitting Response surfaces, Mixture experiments, Case Studies in Chemical Engineering Introduction to software tools – Minitab

Total: 45

REFERENCES:

1. Douglas C. Montgomery, "Design and Analysis of Experiments", 8th Edition, Wiley, 2017.
2. Angela Dean and Daniel Voss, "Design and Analysis of Experiments", Springer, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	apply the basic principles and strategies of experimental design to real time experimental data	Applying (K3)
CO2:	apply fundamental concepts of statistics for testing a hypothesis	Applying (K3)
CO3:	formulate and analyze Randomized complete block experiments	Analyzing (K4)
CO4:	analyze Factorial experiments for deriving conclusions	Analyzing (K4)
CO5:	perform response surface analysis using software tools and interpret the results	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	2		2	2	1
CO2	2		2	2	1
CO3	1		2	2	1
CO4	1		2	2	1
CO5	2		2	2	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MFE15 PROJECT ENGINEERING AND MANAGEMENT				
	L	**T**	**P**	**Credit**
	3	**0**	**0**	**3**

Preamble	This course is useful to students to have knowledge of management principles followed in Industrial establishments, as well as in integrating the process engineering principles with management principles. Significance of financial management as well as marketing or sales is also dealt in depth.
Prerequisites	Nil

UNIT – I **9**

Principles of Management: Management, functions of management: Planning, organizing, coordination and control, Human relations and performance in organization, Human and cultural variables in global organizations. Industrial relations and disputes. **Legal Aspects of Business Enterprise:** Importance and necessity of industrial legislation, Export – Import regulations. Labour laws, Social welfare legal measurements, Factory Act.

UNIT – II **9**

Project Identification and Process Planning: Project definition, Project Profile and standards, Feedback information (MIS), Evaluation and Modification, Selection, Criteria. Planning the process, Strategic and Managerial Planning, Organizing the process planning.

UNIT – III **9**

Project Engineering: Economic Balancing, Network Planning, Methods (PERT/CPM), Engineering Flow Diagrams, Cost requirements, Analysis and Estimation of Process Feasibilities (Technical/Economical) Analysis, Application of reliability theory.

UNIT – IV **9**

Engineering Management: Plant Engineering Management, Objectives, Programme, Control, Plant Location and Site Selection, Layout diagrams, Selection and procurement of equipment and machineries, Installation, Recommissioning, Commissioning and performance appraisal, Strategies choice and Influence, Product planning and development, Provision and maintenance of service facilities.

UNIT – V **9**

Financial Management: Finance: Important, ledger, Journal, Profit and Loss Account, Balance Sheet, Interpretation of Statements, Ration Analysis, Project financing, Project appraisal, return on investments. **Marketing and Sales:** New Issues in Marketing : Basic information on Globalization, Consumerization, Green Marketing and Event Marketing-Sellers and Buyers markets, monopoly, oligraphy, perfect competition, Cost - Elements of Cost, Contribution, Break even analysis, Budgets, Pricing Policies.

Total: 45

REFERENCES:

1. Banga T.R., Agarwal N.K., and Sharma S.C., "Industrial Engineering and Management Science", Khanna Publishers, New Delhi, 2007.
2. Bagad V.S., "Industrial Management", Technical Publications, Pune, 2008.
3. Pathi P.K., "Labour and Industrial Laws", 2nd Edition, Prentice Hall India, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	summarize the functions of management related to industrial organization and apply the legal aspects of business enterprises	Understanding (K2)
CO2:	identify the projects and meticulously plan the process	Applying (K3)
CO3:	explain the significance of forecasting and various models	Understanding (K2)
CO4:	outline the importance of project engineering and management	Understanding (K2)
CO5:	apply the basic knowledge of financial, marketing and sales in their carrier	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	2	1	3	3	3
CO2	3	3	3	2	2
CO3	3	3	3	2	3
CO4	3	3	3	2	3
CO5	3	2	3	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MFE16 SENSORY EVALUATION OF FOODS

L	T	P	Credit
3	0	0	3

Preamble	This course aims at enriching the knowledge of planning and executing a sensory evaluation by adopting discriminative, descriptive and other rapid test methods.
Prerequisites	Nil

UNIT – I **9**

Introduction to Sensory Evaluation: Sensory evaluation – definition, Sensory perception – vision, Gustation, olfaction, touch, audition, multimodal perception, Factors affecting sensory measurements, Role of sensory evaluation, Factors contributing to successful sensory evaluation

UNIT – II **9**

Planning a Sensory Project: Requirements for sensory testing - Professional conduct in sensory testing: health, safety, ethical and legal considerations, Good working and laboratory practices, Setting objectives, Resources needed for sensory testing, Product type, Assessors, Budget, Timings, Selecting the test method, Setting action standards, Experimental design, Data analysis

UNIT – III **9**

Discriminative Test Methods: Overall Difference tests - Triangle test, Duo-trio test, Difference from control test, Same and different test, 'A' 'not A' test, Attribute specific test - Paired comparison, Alternative forced choice, Ranking test, Similarity test - The power of the test, Proportion of true discriminators

UNIT – IV **9**

Descriptive and Affirmative Tests: Descriptive analysis tests - Consensus profiling, Flavor Profiling, Texture Profiling, Quantitative Descriptive Analysis, Spectrum method, Free choice profiling, Flash profiling. Affective tests - Focus groups, Preference tests, Acceptance tests, Attribute diagnostics

UNIT – V **9**

Rapid Sensory Profiling Methods: Ranking descriptive analysis, Free multiple sorting, projective mapping, rapid profiling using references, check all that apply, open ended questions, temporal dominance of sensations, ideal profiling, just above right scales.

Total: 45

REFERENCES:

1. Harry T. Lawless and Hildegarde Heymann, "Sensory Evaluation of Food: Principle and Practices", 2nd Edition, Springer, UK, 2010.
2. Morten C. Meilgaard, Gail Vance Civille and B. Thomas Carr, "Sensory Evaluation Techniques", 4th Edition, CRC Press, USA, 2010.
3. Sarah Kemp, Tracey Hollowood, and Joanne Hort, "Sensory Evaluation: A Practical Handbook", 1st Edition, Wiley-Blackwell Publishers, UK, 2009.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	interpret the concepts in sensory evaluation	Understanding (K2)
CO2:	plan a sensory evaluation session	Applying (K3)
CO3:	recommend suitable discriminative test method for sensory evaluation	Evaluating (K5)
CO4:	select suitable descriptive and affirmative tests for sensory evaluation	Applying (K3)
CO5:	choose and use appropriate rapid sensory profiling methods depending on the product	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	1	1			1
CO2	1	3	3	2	1
CO3	2	2	1		1
CO4	2	2	1		1
CO5	2	2	1		1

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MFE17 FOOD SUPPLY CHAIN MANAGEMENT

L	T	P	Credit
3	0	0	3

Preamble	This course aims at enriching the minds of those students who have interest in addressing transportation and logistics within the company and learning the optimized transportation and logistics activities with the vendors and buyers
Prerequisites	Nil

UNIT – I **9**

Introduction to Food Supply Chain: Types of food chain, Decision Phases in Supply Chain, Food consumer and supply chain, International Food Supply Chains, Impact of Globalization on Supply Chain Networks, Food supply chain in India, Factors affecting food supply chain, Managing challenges in international food supply chains, Temperature-controlled supply chains.

UNIT – II **9**

Collaboration within Food Supply Chain: Current relationship models within food sector, Current practices in food and drinks supply chain, Perceived risk and product safety in food supply chains, Food packaging and supply chain management, Food inventory management, Designing food supply chains, Building blocks of Food Supply Chain Management, Future of Food Supply Chain Management.

UNIT – III **9**

Operational Challenges: Food retail environment, Food routes to consumer, Impact of expanding consumer choice, Online grocery retailing, Future of food retailing. **Food Sourcing and Procurement:** Sourcing models, Purchasing models, Supplier segmentation, Supplier development, Strategic sourcing, Sustainable procurement.

UNIT – IV **9**

Development in Food Supply Chains: Traceability - legislations and standards, Use of traceability technology in food supply chains, Design of Traceability systems, Product development in food supply chains, Innovations within food supply chains. **Risk Management:** Risk management and uncertainty, Risks in food supply chain, Managing risks in food supply chains.

UNIT – V **9**

Sustainability Challenges in Food Supply Chains: Sustainable food supply chains, Measuring sustainability within food supply chains, Developing sustainability within food supply chains, Information Technology in food supply chain, Carbon Footprint of food supply chains, Quality Management Schemes in food supply chain.

Total: 45

REFERENCES:

1. Iakovou E., Bochtis D., Vlachos D. and Aidonis D., "Supply Chain Management for Sustainable Food Networks", John Wiley and Sons, 2016.
2. Chopra S. and Meindl P., "Supply Chain Management Strategy, Planning and Operation", Pearson Education, 2015.
3. Bourlakis M.A. and Weightman P.W.H., "Food Supply Chain Management", John Wiley and Sons, 2008.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	explain the process view of supply chain and identify the challenges in food supply chain	Understanding (K2)
CO2:	utilize the appropriate collaborative tool to balance supply-side inventory to consumer demand	Applying (K3)
CO3:	assess beliefs held by consumers about internet grocery shopping and explain sourcing process in relation to procurement	Evaluating (K5)
CO4:	appraise overview on international legislations and standards regulating food traceability and to identify the risks and determine its interaction in food supply chain	Analyzing (K4)
CO5:	identify sustainability performance expected from sustainability practices implemented in different supply chain stages	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	2	1	1		1
CO2	1	2	1		1
CO3	1	1			1
CO4	1	1		1	1
CO5	1				1

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MFE18 FOOD PROCESS PLANT LAYOUT AND DESIGN

L	T	P	Credit
3	0	0	3

Preamble	To impart knowledge on designing the food process and plant and to enhance the knowledge of designing food processing equipments.
Prerequisites	Nil

UNIT – I **9**

Process and Plant Design: Overview of plant design- Process Flow sheets, Types of process design, Material and energy balances, Design of equipment, plant layout and buildings, Economic analysis in process/plant design, Manufacturing cost and profitability, Computer aided process/plant design.

UNIT – II **9**

Food Plant Design: Elements of Food Plant Design- General aspects, new food plants, plant improvement, plant expansion, mobile food plants, advanced food plants. Good Manufacturing Practices, Food Plant Economics

UNIT – III **9**

Selection of Food Processing Equipment: Construction characteristics. Operational characteristics- reliability, convenience, safety, instrumentation, ergonomics, efficiency, accuracy, environmental impact. Testing of equipments. Equipment specifications.

UNIT – IV **9**

Design of Food Processing Equipment: Sizing and costing of Equipment, materials of construction, Fabrication of equipment- Strength of Construction, Fabrication and Installation of Equipment, Hygienic Design of Food Processing Equipment.

UNIT – V **9**

Heat Transfer Equipment: Heat exchangers- Heat transfer factor. Baking Oven- Load of baking chamber, Load by products, Load by heat loss, Total thermal load, types of heating source. **Mass Transfer Equipment:** Reactors- process operation, design considerations, location, support and elevation, nozzle location, platform and piping arrangements.

Total: 45

REFERENCES:

1. George D. Saravacos and Athanasios E. Kostaropoulos, "Handbook of Food Processing Equipment", Springer Science & Business Media, New York, 2002.
2. Georgina Calderón-Domínguez, Gustavo F. Gutiérrez-López, and Keshavan Niranjan, "Advances in Heat Transfer Unit Operations", CRC/Taylor & Francis, 2016.
3. Ed Bausbacher and Roger Hunt, "Process plant layout and piping design", P T R Prentice Hall, Englewood Cliffs, New Jersey, 1993.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	explain process and plant design	Understanding (K2)
CO2:	construct food plant design	Evaluating (K5)
CO3:	identify and interpret different material characteristics of equipments	Applying (K3)
CO4:	select suitable criteria for food process equipments	Analyzing (K4)
CO5:	design heat and mass transfer equipments	Evaluating (K5)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1	1	1
CO2	3	1	1		
CO3	2	1	1	1	1
CO4	2	1	1		
CO5	3	2	1	1	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MFE19 SCALE UP METHODS IN PROCESS ENGINEERING

L	T	P	Credit
3	0	0	3

Preamble	This course introduces the aspects of taking the process from bench scale to industrial scale. Similarity criterion, pilot plant models and Dimensional analysis are dealt. Scale up of Heat and Mass transfer equipments, Mixers and other selected equipments useful in food processing are covered.
Prerequisites	Fluid Mechanics, Heat Transfer, Mass Transfer

UNIT – I **9**

Food Product Scale Up: Need and challenges - Scale up of formulations - Product and package information matrix- Batch versus continuous processing - Product transfers and facility scale up. **Principals of Similarity, Pilot Plants and Models:** Introduction to scale–up methods, pilot and models and principles of similarity

UNIT – II **9**

Dimensional Analysis and Scale–Up Criterion: Dimensional analysis, regime concept, similarity criterion and scale up methods used in process Engineering.

UNIT – III **9**

Scale-Up of Mixing and Heat Transfer Equipment: Typical problems in scale–up of mixers, Heat Exchangers and Evaporators.

UNIT – IV **9**

Scale-Up of Mass Transfer Equipments: Scale-up of distillation columns and packed towers for continuous and batch processes.

UNIT – V **9**

Scale up of other Selected Processes: Supercritical Fluid Extraction - Screw Extruders - Spray driers - Ball Mill - Furnaces and Kilns . Limitations of scale up techniques.

Total: 45

REFERENCES:

1. Kenneth J. Valentas, J. Peter Clark, Leon Levin, "Food Processing Operations and Scale-up", CRC Press, 1991.
2. Marko Zlokarnik, "Dimensional Analysis and Scale-Up in Chemical Engineering", Springer–Verlag, Berlin, Germany, 1986.
3. Donald G. Jordan, "Chemical Process Development" (Part 1 and 2), Intersciences Publishers, 1988.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	infer the importance and aspects of food product scale up	Understanding (K2)
CO2:	recall fundamentals of scale up, dimensional analysis and scale up criterion	Remembering (K1)
CO3:	apply the similarity and scale up principles in the scale-up of mixing and heat transfer equipments	Applying (K3)
CO4:	apply acquire knowledge in the scale-up of mass transfer equipments	Applying (K3)
CO5:	understand the scale up of miscellaneous equipment and limitations of scale up techniques	Understanding (K2)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	2	1			
CO2	2	2			
CO3	3	2			1
CO4	3	2			1
CO5	3	2			1

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MFE20 FOOD RHEOLOGY

L	T	P	Credit
3	0	0	3

Preamble	This course explains the basics of food rheology and to familiarize the students with rheological instruments and their use in relation to food products.
Prerequisites	Nil

UNIT – I **9**

Food Rheology and Structure: Stress and Strain tensors, viscometric properties, shear stress-shear rate relationships, units in rheological measurements, types of fluid flow behaviour, apparent viscosity, intrinsic viscosity, stress-strain behaviour of solid foods, linear viscoelasticity, phase transitions in foods.

UNIT – II **9**

Flow and Functional Models for Rheological Properties of Fluid Foods: Time independent flow behaviour, Models for time dependent flow behavior- Newtonion model, Power law model, Herschel-Bulkley Model, Casson Model, Quemada Model. Apparent viscosity- shear rate relationships of shear- thinning foods, Role of solids fraction in rheology of dispersions, Effect of soluble and Insoluble solids concentration on Apparent viscosity, Effect of temperature on viscosity, Mixing rules for two components blends, Treatment of rheological data using models.

UNIT – III **9**

Measurement of Flow and Viscoelastic Properties: Rotational Viscometers, Torsion Gelometer for Solid Foods, Pressure-Driven Flow Viscometers, Extensional flow Viscometry, Measurement of viscoelastic behavior of Fluid Foods, Viscosity measurement at high temperature, In-Plant measurement of Flow behavior.

UNIT – IV **9**

Rheology of Food Gum and Starch Dispersions: Rheology of Food Gum Dispersions, Rheology of Heated Starch Dispersions, Dynamic Rheological Behavior of Starch Dispersions, Role of Continuous and Dispersed Phases on Viscoelastic Properties of Starch Dispersions, Effect of Sugar on Rheology of Starch Dispersions, Rheological Behavior of Starch-Protein Dispersions, Rheology of Starch-Gum Dispersions

UNIT – V **9**

Rheological Behavior of Processed Fluid and Semi solid Foods: Fruit Juices and Purees: Role of Soluble and Insoluble Solids, Rheological Properties of Chocolate, Rheology of Milk and Milk Concentrate, Rheology of Mayonnaise, Salad Dressing, and Margarine, Rheology of Salad Dressings, Structural Analyses of Food Dispersions

Total: 45

REFERENCES:

1. Rao M.A., "Rheology of Fluid and Semi solid Foods: Principles and Applications", 2nd Edition, Springer, 2007.
2. Bourne M.C., "Food Texture and Viscosity: Concept and Measurement", Academic Press, 2002.
3. Steffe J.F., "Rheological Methods in Food Process Engineering", 2nd Edition, Freeman Press, USA, 1992.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	explain the fundamentals of food rheology	Understanding (K2)
CO2:	interpret the flow behavior and functional models	Understanding (K2)
CO3:	illustrate the principle of working of various flow and viscoelastic measurement devices	Understanding (K2)
CO4:	evaluate the behavior of food gum and starch dispersions	Analyzing (K4)
CO5:	infer the rheological behavior of processed fluids and semi-solid foods	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1		3	1	1	1
CO2		3	1	1	1
CO3		3	1	1	1
CO4		3	1	1	1
CO5		3	1	1	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MFE21 PLANTATION CROPS AND SPICES TECHNOLOGY					
		L	**T**	**P**	**Credit**
		3	**0**	**0**	**3**
Preamble	To educate the students about processing of plantation crops and spices products manufacturing				
Prerequisites	Nil				
UNIT – I					**9**
Plantation Crops: Description of various types of Plantation crops. Processing of tea – Manufacturing of black tea, CTC tea Green tea, Oolong tea, flavoured tea. Grading of Tea. Coffee – Occurrence, Manufacturing of coffee powder, instant coffee. Cocoa Processing – Cocoa liquor, cocoa powder manufacturing. Coconut – Processing and by products. Cashew nut and Oil palm Processing. **Processing of tuber crops:** tapioca. Processing of potatoes- processed potato products.					
UNIT – II					**9**
Spices and Condiments: Description of various types of spices and condiments, their composition, functional properties, flavoring agents. Nutritive value of spices and their health benefits. Importance in culinary preparations.					
UNIT – III					**9**
Processing of Spices: Processing of spices – Pepper, Chilli, Turmeric, Cardamom, Cinnamon, Clove, Vanilla and Ginger. Spices Products – Liquid products and Solid Products. Importance of Cryogenic grinding of spices. Spice Oils – Concept and importance. Extraction methods - Solvent extraction, Steam distillation.					
UNIT – IV					**9**
Herbs and Flavour: Description of various types of herbs. Basil, Cilantro, Dill, Coriander, Mint, Oregano, Borage, Thyme, bilva leaves, Safflower. Nutritive value and health benefits. Processing and post - harvest handling.					
UNIT – V					**9**
Flavoring Materials of Natural Origin: Natural flavors, sources of natural flavoring materials – Herbs and spices. Microbiology of spices, gas sterilization of spices, gamma irradiation, Heat treatment, Distillation, Extraction. Distillation of volatile oils, Application of spice essential oils. Oleoresins - Extraction, Quality and Application of oleoresins. Biosynthesis of flavours – Microorganisms, Enzymes, Plant suspension cultures.					
					Total: 45

REFERENCES:

1. Peter K.V., "Handbook of Herbs and Spices", 2nd Edition, Woodhead Publishing, 2012.
2. Kumar N., "Introduction to spices, plantation crops, medicinal and aromatic plants", 2nd Edition, Oxford and IBH Publishing, 2006.
3. Panda H., "Handbook on Spices and Condiments (Cultivation, Processing and Extraction)", National Institute of Industrial Research, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	explain the processing stages involved in plantation processing	Understanding (K2)
CO2:	utilize functional properties of spices and herbs in product development	Applying (K3)
CO3:	select processing steps required for spices processing	Applying (K3)
CO4:	select processing steps required for herbs processing	Applying (K3)
CO5:	apply technologies for essential oil and oleoresin extraction	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	1			1
CO2	3	2		1	2
CO3	3	1			1
CO4	3	1			1
CO5	3	2			2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MFE22 INDUSTRIAL PROCESS AUTOMATION					
		L	**T**	**P**	**Credit**
		3	**0**	**0**	**3**
Preamble	To have thorough knowledge on data acquisition, data analysis, modeling and computer based automation in process industries				
Prerequisites	Nil				
UNIT – I					**9**
Introduction: Food quality, automated evaluation of food quality, food quality quantization and process control, problems associated in food quality evaluation					
UNIT – II					**9**
Data Acquisition: Sampling, concepts and systems for data acquisition: Ultrasonic A mode, electronic nose, data acquisition for food quality process control, Image acquisition: Ultrasonic B mode, Elastography.					
UNIT – III					**9**
Data Analysis: Data pre-processing, Static data analysis, Dynamic data analysis, Image processing: Image segmentation, Image feature extraction. **Modeling:** Modeling strategies: Theoretical and empirical modeling, Static and dynamic modeling, Linear statistical modeling, ANN modeling					
UNIT – IV					**9**
Computer Based Controls: Computer based measurement and control system- role, basic components, architecture- Human machine Interface, Hardware for computer based process control system, Interface computer system with process, Industrial Applications.					
UNIT – V					**9**
Automation in Food Processing: General considerations, Packaging, palletizing, and mixed pallet automation, raw product handling and assembly, Decorative product finishing, integrated automation.					
					Total: 45
REFERENCES:					
1.	Nof Y.S., "Handbook of Automation", Springer Publications, New York, 2009.				
2.	Huang Y., Whittaker A.D. and Lacey R.E., "Automation for Food Engineering - Food Quality Quantization and Process Control", CRC Press, Florida, 2000.				
3.	Mittal G.S., "Computerized Control Systems in Food Industry", Marcel Dekker Inc., New York, USA, 1997.				

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	explain the fundamental concepts used in automation in food processing	Understanding (K2)
CO2:	outline the importance of Data acquisition in quality process control	Understanding (K2)
CO3:	interpret the data analysis and modeling in automation	Evaluating (K5)
CO4:	summarize the concept of computer based controls in automation	Understanding (K2)
CO5:	examine the role of automation in food processing	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	3			1
CO2	3	2			1
CO3	3	3			1
CO4	3	2			1
CO5	3	1			1

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MFE23 ADVANCED MEAT PROCESSING TECHNOLOGY				
	L	**T**	**P**	**Credit**
	3	**0**	**0**	**3**
Preamble	This course educates the student about the advances in processing, preservation and product development of meat, fish and poultry. The course also provides insight into detection of meat quality and originality.			
Prerequisites	Nil			

UNIT – I	**9**
Meat: Chemical composition and structure of meat, Scientific slaughter – Stunning techniques - mechanical, electrical, chemical methods; Pre- and post-slaughter operations, Factors affecting post-mortem changes, Meat tenderization by high hydrostatic pressure, high hydrodynamic pressure, Gene technology for meat traceability and safety, Online monitoring of meat quality by NIR spectroscopy and Fluorescence spectroscopy, New sources of animal protein – cultured meat, edible insect.	

UNIT – II	**9**
Poultry Meat: Pre-slaughter care and handling, Dressing of poultry birds, Grading of dressed chicken, Edible co-products. **Egg:** Structure, composition, Measures of egg quality, Preservation methods of eggs, Designer eggs, Speciality egg products, Egg pasteurization by microwave, gas plasma and pulsed light.	

UNIT – III	**9**
Fish: Marine processing industries in India, Types and composition of fish, On board processing and its advantages, Handling and transportation of fish, Individual quick freezing; Retort pouch processing of fish; Food utilization of by-catch and underutilized species; Quality Assurance of Seafood; Advances in fishery by-products technology - Productions of fish protein concentrate, fish liver oil, fish sauce and insulin.	

UNIT – IV	**9**
Advances in Meat Processing Operations: Microbial decontamination by irradiation; Automation for lamb carcass production; Refrigerated poultry handling; New developments in freezing of meat – high pressure shift freezing, ultrasonic freezing; Generation of peptides from meat proteins; Ohmic heating of meat products; Microwave in fish handling and processing; Meat calculations for QUID (Quantitative Ingredient Declarations); Drug residues in meat; Meat fraud detection; Advances in bulk packaging for the transport of fresh fish.	

UNIT – V	**9**
Advances in Meat, Poultry and Fish Processing: Mechanically recovered meat; Hot boning of meat, brine vacuum impregnation in ham salting; Applications of bacteriocins in meat products; Processing strategies for developing functional meat products; Shockwave processing of meat; Tailor designing nitrite free meat products; Enhancement and control of proteolysis in dry cured meats; Probiotic cultures; HACCP for poultry industry.	
	Total: 45

REFERENCES:

1. George M. Hall, "Fish Processing: Sustainability and New Opportunities", 1st Edition, Wiley Blackwell Publications, USA, 2011.
2. Isabel Guerrero-Legarreta, "Handbook of Poultry Science and Technology: Secondary Processing", 1st Edition, John Wiley and Sons Publications, UK, 2010.
3. Hui Y. H., "Handbook of Meat and Meat Processing", 2nd Edition, CRC Press, USA, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	classify meat and evaluate its quality	Analyzing (K4)
CO2:	apply various methods to preserve poultry co-products and eggs	Applying (K3)
CO3:	select suitable method for fish preservation	Applying (K3)
CO4:	explain the advances in meat processing operations	Understanding (K2)
CO5:	make use of advance technologies in meat and fish processing	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	1		1	1	1
CO2	2	1		1	1
CO3	2	1		1	1
CO4	2		1		1
CO5	2	1		1	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MFE24 ADVANCED DAIRY TECHNOLOGY				
	L	**T**	**P**	**Credit**
	3	**0**	**0**	**3**
Preamble	This course aims at enriching the minds of those students who have interest in learning the advances in dairy technology and milk preservation in the broader context of dairy science and food safety.			
Prerequisites	Nil			

UNIT – I	**9**
Milk Constituents and Its Properties: Constituents of milk, Factors affecting milk composition, Properties of milk - Thermal, Optical, Electrical and Rheological properties, Refractive Index, Effects of high-pressure treatment on constituents and properties of milk, Bioactive compounds from milk.	

UNIT – II	**9**
Heat-induced Changes: Chemical and physical changes in Ultra Heat Temperature treatment, Heat-induced reactions in milk – surface reactions. **Biotech Approaches in Dairy Products:** Genetically Modified Cheese: A Novel Biotechnological Development, Recent Biotechnological Approaches in Dairy and Food Industry, Bio-Functional Whey Based Beverages, Production and enrichment of bioactive peptides derived from milk proteins.	

UNIT – III	**9**
Advanced Dairy Processing: Microwave processing, High Pressure processing, Pulsed Electric Field processing, Ultrasound processing, Advanced heating processes - extended shelf-life, Innovative steam injection, Modern approaches to lactose production.	

UNIT – IV	**9**
Dairy Products Manufacture: Liquid infant formulae, Anhydrous Milk Fat, Frozen cream, Dried cream, Processed Cheese, Dairy protein products, Blends and blended spreads – production and quality aspects, Glycosylated whey proteins, Milk imitations.	

UNIT – V	**9**
Operational Considerations and Limitations: Fouling - types, mechanisms, factors affecting fouling, Biofilm - formation, detection, control. **Automation in Dairy Industry:** Factors contributing to automation, Stages in automation in dairy, Automation at enterprise level - Enterprise Resource Planning.	
	Total: 45

REFERENCES:

1. Spreer E., "Milk and Dairy Product Technology", Routlege, 2017.
2. Datta N., Tomasula P.M., "Emerging Dairy Processing Technologies: Opportunities for the Dairy Industry", John Wiley & Sons, 2015.
3. Burton H., "Ultra-High-Temperature Processing of Milk and Milk Products", Springer Science & Business Media, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	outline the basic constituents of milk and its characteristics	Understanding (K2)
CO2:	assess changes occurring in milk due to heat induced processes	Applying (K3)
CO3:	appraise the advances of technology in the area of milk processing	Applying (K3)
CO4:	analyze the advances in processing operations of dairy products	Analyzing (K4)
CO5:	examine the fouling in dairy equipments and illustrate the automation in dairy industry	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	2	2			1
CO2	2	2			1
CO3	2	2			1
CO4	2	2			1
CO5	1	2			1

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MFE25 TECHNOLOGY OF FOOD COLOURS AND FLAVOURS

L	T	P	Credit
3	0	0	3

Preamble	This course will help students to understand the chemistry and technology of food flavours and colours, regulatory aspects, analytical techniques used in flavor isolation, application of flavours and colours in food product development.
Prerequisites	Nil

UNIT – I **9**

Basics of Flavours and Colours: Olfactory perception of flavour and taste–Theories of olfaction -Molecular structure and activity relationships of taste – Sweet, bitter, acid and salt, Chemicals causing pungency, astringency, cooling effect – properties. Classification of flavours – Natural, Nature identical and synthetic – Flavor potentiators. Basics of colour – Hue, chroma, brightness. Regulations regarding additions – Toxicology and safety aspects.

UNIT – II **9**

Food Colours: Chlorophyll and chlorophyll derivatives, Haems and bilins, Carotenoids, annatto, saffron, turmeric, Caramel colour, Anthocyanins and betalains, Monascus, cochineal and related pigments, Stability to pH, temperature and other processing conditions. Technology for the production of dried colourants. Microbial and cell suspensions in the synthesis of colours.

UNIT – III **9**

Technology of Flavours: Classification–Alliaceous flavours–Bittering agents, Coffee and Cocoa, Fruit flavours. Evolution of flavours during processing –enzymatic development, effect of roasting, cooking, frying on flavour developments- Essential oils and oleoresins –Extraction – Super critical fluid extraction - Continuous and semi continuous methods- Effect of types of solvents used. Liquid and dry flavour production. Encapsulated flavours – techniques and applications in food industry. Microbial synthesis of flavours.

UNIT – IV **9**

Flavour Analysis: Introduction, Aroma Compounds - Sample Selection/Preparation, Principles of Aroma Isolation – Solubility, Sorptive Extraction, Volatility. Methods of Aroma Isolation – Static Headspace, Headspace Concentration Methods (Dynamic Headspace) - Distillation Methods – Solvent Extraction, Sorptive Extraction - Concentration for Analysis, Aroma Isolation Summary. Analysis of Aroma Isolates, Prefractionation - Gas Chromatography, GC/Olfactometry (GC/O) GC- MS/Olfactometry (GC-MS/O), Mass Spectrometry.

UNIT – V **9**

Flavour Applications: Culinary and Meat Products - Soups and Stocks, Sauces, Seasonings, and Marinades, Meat Products. Baked Goods and Bakery Products, Snack Foods, Sugar-Based Confectionery Products and Chewing Gum - Hard Candies, Caramels (Toffees), Pressed Tablets, Starch-Deposited Chews, Chewing Gum. Dairy Products - Flavored Milks, Flavored Yogurts, Flavored Dairy Desserts. Soft Drinks - Carbonated Beverages.

Total: 45

REFERENCES:

1. Reineccius G. and Heath H.B., "Flavor Chemistry and Technology", 2nd Edition, CRC Press, 2006.
2. Rowe D.J., "Chemistry and Technology of Flavors and Fragrances", Blackwell Publishing Ltd., 2005.
3. Eiri Board, "Hand Book of Flavours Technology", Engineers India Research Institute, 2007.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	summarize the fundamental concepts related to flavours and colours	Understanding (K2)
CO2:	apply the technological aspects of colours in food product development	Applying (K3)
CO3:	outline the techniques of flavor analysis and interpret the results	Understanding (K2)
CO4:	classify flavours and illustrate various technologies used in flavor production	Understanding (K2)
CO5:	select and apply appropriate flavours/seasonings across the entire food category	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	2	3	2	3	1
CO2	2	3	2	3	1
CO3	3	2	3	2	2
CO4	3	2	2	2	1
CO5	3	2	3	2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MFE26 INTERNET OF THINGS IN FOOD AND AGRICULTURE

L	T	P	Credit
3	0	0	3

Preamble	Course is designed to develop certain tools using the concepts of IOT required in field of Food and Agriculture
Prerequisites	Nil

UNIT – I **9**

Introduction to Internet of Things (IoT): Definition and Characteristics of IoT, Physical Design of IoT – IoT Protocols, IoT Communication Models - IoT Communication APIs – IoT enabled Technologies – Wireless Sensor Networks - Cloud Computing – Big data analytics – Communication Protocols, Embedded Systems – IoT Levels and Templates.

UNIT – II **9**

Python, Physical Devices and Endpoints for IoT: Language features of Python, Data types, data structures, Control of flow, functions, modules, packaging, classes, exception handling. Python packages – HTTPLib, URLLib, SMTPLib.: Introduction to Raspberry PI – Interfaces (serial, SPI, 12C) Programming – Python program with Raspberry PI with focus of interfacing external gadgets – controlling output – reading input from pins – connecting IoT to Cloud – Xively.

UNIT – III **9**

IoT in Food and Agriculture: Issues and challenges in food and agriculture-RFID and sensor network integration in food industry-RFID in food production, food supply chain, retailing and sustainability. RFID in sensor network and food processing-Case studies-Big data analytics in food industries-Food supply chain visibility, Intelligent food supply chain. Block chain-Concepts-Potential Applications in Food Industry.

UNIT – IV **9**

IoT in Food Spoilage and Safety: Importance of IoT concerning food quality, safety and security. Biosensors for detection of food borne pathogens – prevention & retardation of food spoilage. Microbial detection, GIS, Sensor Networks. Case study on ensuring safety by enhanced IoT's.

UNIT – V **9**

IOT in Traceability and Waste Management: Food Traceability: Need of new technologies in food traceability systems. Architecture of traceability system- ICT & EPC enabled systems. Real time tracking and remote monitoring – Wireless sensing technologies, remote communications and Intelligent traceability. Food Waste Management: Scope and significance of IoT in food waste management. Smart Garbage System (SGS) - components, design, architecture of SGS, implementation and efficiency, real-time application in food waste minimization.

Total: 45

REFERENCES:

1. Qusay F. Hassan, Attaur Rehman Khan, Sajjad A. Madani, "Internet of Things Challenges, Advances and Applications - First Series", CRC Press, Taylor and Francis Group, 2017.
2. Selwyn Piramuthu, Weibiao Zhou, "RFID and Sensor Network Automation in the Food Industry: Ensuring Quality and Safety through Supply Chain Visibility", John Wiley & Sons, UK, 2016.
3. Montserrat Espiñeira, Francisco J. Santaclara, "Advances in Food Traceability Techniques and Technologies - Improving Quality Throughout the Food Chain", Woodhead Publishing, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	identify architecture, infrastructure and constraints of Internet of Things	Applying (K3)
CO2:	summarize the fundamental concepts of Internet-connected product	Understanding (K2)
CO3:	apply concept of IoT's in food and agriculture	Applying (K3)
CO4:	recommend appropriate IoT' s for food spoilage detection and ensuring safety	Evaluating (K5)
CO5:	categorize the IoT's available in food traceability and waste management system	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1	1	1
CO2	3	2	1		1
CO3	3	2	1	1	2
CO4	3	3	1	2	1
CO5	3	2	1	3	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MFE27 MACHINE VISION FOR FOOD TECHNOLOGY

L	T	P	Credit
3	0	0	3

Preamble	To educate the students about image acquisition, object classification and various image processing technology used in food technology
Prerequisites	Nil

UNIT – I **9**

Image Acquisition Systems: Electromagnetic spectrum - Image acquisition system – Computer vision, ultrasound, Infrared, Tomographic imaging. **Image Segmentation Techniques:** Pre-processing Techniques - Noise Removal - Contrast Enhancing. Segmentation Techniques – Thresholding - Based Segmentation - Edge-Based Segmentation - Region-Based Segmentation - Gradient-Based Segmentation - Classification-Based Segmentation - Other Segmentation Techniques.

UNIT – II **9**

Object Measurement System: Size – Shape – Size dependent and independent - Colour – Human and Hardware oriented, Instrumental – Texture – Structural, Statistical, Transform and model based. **Object Classification Methods:** Artificial neural network – Statistical classification – Fuzzy logic – Decision tree – Support vector machine.

UNIT – III **9**

Hyperspectral Imaging Technology: Fundamentals – Multivariate data analysis - Spectral Preprocessing, Development of Multivariate Calibration, Model Validation and Evaluation, Selection of Important Wavelengths, Multivariate Image Analysis. Application for muscle foods.

UNIT – IV **9**

Raman Chemical Imaging Technology: Principles – Raman spectroscopy techniques –Raman imaging instruments – Raman image analysis techniques – Image preprocessing, target identification, Mapping and quantitative analysis. Application.

UNIT – V **9**

Quality Evaluation of Foods: Meat, poultry carcass, sea foods, fruits and vegetables, Grains, Other foods.

Total: 45

REFERENCES:

1. Da-Wen Sun, "Computer Vision Technology for Food Quality Evaluation", 2nd Edition, Academic Press, London, 2008.
2. Davis E.R., "Image Processing for the Food Industry", World Scientific, Singapore, 2000.
3. Da-Wen Sun, "Hyperspectral Imaging for Food Quality Analysis and Control", 1st Edition, Academic Press, London, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	select image acquisition and segmentation techniques for food	Applying (K3)
CO2:	measure and classify the objects using machine vision technology	Applying (K3)
CO3:	explain hyperspectral imaging technology	Understanding (K2)
CO4:	explain Raman chemical imaging technology for food materials	Understanding (K2)
CO5:	select machine vision technology for food materials	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	1			1
CO2	3	1			1
CO3	2	1			1
CO4	2	1			1
CO5	3	1			1

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy