Guru Nanak Institute of Technology

(NAAC 'A+' Accredited An Autonomous Institute)
(Affiliated to Maulana Abul Kalam Azad University of Technology)

R25
[M.Tech., Food Technology]

Curriculum and Syllabus for M.Tech. under Autonomy

(NEP-2020 implemented)

Dept. of Food Technology

(Effective from 2025-26 admission batch)

SEMESTER I

SL No.	Core/ Elective	Code	Subject Name	Contact Hours/Week				Credit
				L	T	P	Total	
THEORY								
1	PC1	MFT101	Applied Statistics for Food Technology	3	0	0	3	3
2	PC2	MFT102	Advanced Microbial Technology	4	0	0	4	4
3	PE1	MFT103	Program Specific Elective-I A. Advanced Fruit and Vegetable Processing Technology B. Lipid Science and Technology C. Advanced Baking, Confectionery and Extrusion Technology	3	0	0	3	3
4	PE2	MFT104	Program Specific Elective-II A. Advanced Food Technology and Nutrition B. Food Additives, Functional Foods and Nutraceuticals C. Food Rheology	3	0	0	3	3
5	MLC1	MLC101	Research Methodology and IPR	2	0	0	2	2
PRACTICAL								
6	LAB1	MFT 191	Advanced Microbial Technology Laboratory	0	0	3	3	1.5
7	LAB2	MFT192	Advanced Food Processing Laboratory	0	0	3	3	1.5
SESSIONAL								
8	Aud-I	MFT181	Audit Course-I A. Constitution of India B. Personality Development C. Stress Management by Yoga	2	0	0	0	0
Total Credit								**18**

**MLC – Mandatory Learning Course

SEMESTER II

SL No.	Core/ Elective	Code	Subject Name	Contact Hours/Week				Credit
				L	T	P	Total	
THEORY								
1	PC1	MFT 201	Food Safety and Quality Control	4	0	0	4	4
2	PC2	MFT 202	Food Packaging and Storage Engineering	3	1	0	4	4
3	PE3	MFT 203	Program Specific Elective-III A. Transport Phenomena in Food Processing B. Modern Separation and Purification Process C. Heat and Mass Transfer Operations in Food Processing	3	0	0	3	3
4	PE4	MFT 204	Program Specific Elective-IV A. Advanced Enzyme Engineering and Technology B. Advance Protein Technology C. Advanced Biochemical Engineering	3	0	0	3	3
5	PE5	MFT 205	Program Specific Elective-V A. Advanced Dairy Technology B. Technology of Meat Fish and Egg Processing C. Novel Technologies in Food Processing	3	0	0	3	3
PRACTICAL								
6	Mini project	MFT 281	Mini Project and Seminar I	0	0	4	4	2
7	LAB1	MFT 291	Innovative Food Product Development Lab	0	0	3	3	1.5
8	LAB2	MFT 292	Advanced Food Analysis and Quality Assessment Lab	0	0	3	3	1.5
SESSIONAL								
9	Aud-II	MFT 282	Audit Course-II A. English for Research Paper Writing B. Pedagogy Studies C. Disaster Management	2	0	0	0	0
Total Credit								**22**

SEMESTER III

SL No.	Core/ Elective	Code	Subject Name	Contact Hours/Week				Credit
				L	T	P	Total	
THEORY								
1	PE6	MFT 301	Program specific elective-VI A. Food Supply Chain Management B. Advanced Refrigeration and Cold Chain Management C. Food Process Plant Layout and Design	3	0	0	3	3
2	OE	MFT 302	Open elective A. Internet of Things in Food and Agriculture B. Design and Analysis of Experiments C. Operational Research	3	0	0	3	3
3	PC	MFT 303	Industrial Waste Management	3	1	0	3	4
PRACTICAL								
4	Major Project	MFT 381	DISSERTATION (PART-1)	0	0	12	12	6
Total Credit								**16**

SECOND YEAR SECOND SEMESTER
(4TH SEM)

SEMESTER IV:

SL No.	**Core/Elective**	**Code**	**Subject Name**	**Contact Hours/Week**				
				L	T	P	Total	Credit points
PRACTICAL								
1	Major Project	MFT481	DISSERTATION (COMPLETION)	0	0	24	24	12
Total Credit							**24**	**12**

TOTAL CREDIT: 68

SEMESTER I

SEMESTER I

SL No.	Core/ Elective	Code	Subject Name	Contact Hours/Week				Credit
				L	T	P	Total	
THEORY								
1	PC1	MFT101	Applied Statistics for Food Technology	3	0	0	3	3
2	PC2	MFT102	Advanced Microbial Technology	4	0	0	4	4
3	PE1	MFT103	Program Specific Elective-I D. Advanced Fruit and Vegetable Processing Technology E. Lipid Science and Technology F. Advanced Baking, Confectionery and Extrusion Technology	3	0	0	3	3
4	PE2	MFT104	Program Specific Elective-II D. Advanced Food Technology and Nutrition E. Food Additives, Functional Foods and Nutraceuticals F. Food Rheology	3	0	0	3	3
5	MLC1	MLC101	Research Methodology and IPR	2	0	0	2	2
PRACTICAL								
6	LAB1	MFT 191	Advanced Microbial Technology Laboratory	0	0	3	3	1.5
7	LAB2	MFT192	Advanced Food Processing Laboratory	0	0	3	3	1.5
SESSIONAL								
8	Aud-I	MFT181	Audit Course-I D. Constitution of India E. Personality Development F. Stress Management by Yoga	2	0	0	0	0
Total Credit								**18**

**MLC – Mandatory Learning Course

FIRST YEAR FIRST SEMESTER

Course Name: Applied Statistics for Food Technology

Course Code: MFT101

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Course Objective: 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.

Course Outcome(s):

After completion of the course students will be able to:

CO1: Remember the distinctive principles of applied statistics and time series.

CO2: Understand the theoretical workings of applied statistics and time series.

CO3: Apply the different testing tools like t-test, F-test, chi-square test, sign test, run test, etc for solving relevant real life problems.

CO4: Analyse experimental data using One way and Two-way ANOVA.

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	1	-	-	-	-	-	-	-	1	3	1	2
CO2	3	2	1	-	-	-	-	-	-	-	2	3	2	2
CO3	3	2	2	-	-	-	-	-	-	-	2	3	3	3
CO4	3	3	2	3	-	-	-	-	-	-	1	3	3	3

Course Contents:

Module I: **12 L**

Testing of Hypothesis: Sampling Distributions – Large sample tests – Testing the significance of 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 (χ^2 - test).

Module II: **9L**

Nonparametric Tests: Introduction – Sign test: One sample sign test – Sign test for paired samples – Signed rank test – Rank Sum test: Mann Whitney U test- Kruskal-Wallis test – One sample run test – Tests of randomness.

Module III:

6L

Design of Experiments: Analysis of variance – One-way classification – Completely Randomized Design – Two-way classification –Randomized block design – Latin Square Design.

Module IV:

9L

Time Series Analysis and Statistical Quality Control: 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. Introduction to Statistical quality control – Control charts.

Text and Reference Books:

1. N. G. Das: Statistical Methods, TMH.
2. *Sancheti , D. S. & Kapoor ,V.K. : Statistics Theory , Method & Application,* Sultan chand& sons , New Delhi
3. N.K.Dutta (2004). Fundamentals of Biostatistics, Kanishka Publishers.
4. Gurumani N. (2005) . An Introduction to Biostatistics, MJP Publishers
5. D.C. Montgomery(2001): Designs and Analysis of Experiments, John Wiley and Sons, New York
6. Chatfield C. (1980): The Analysis of Time Series –An Introduction, Chapman & Hall.
7. Bhuyan, KC., Multivariate Analysis and its Applications, New Central Book Agency (P) Limited

Course Name: Advanced Microbial Technology

Course Code: MFT102

Contact: 4:0:0

Total Contact Hours: 48

Credit: 4

Course Objective: To provide an opportunity for students to know about the pathogenic & nonpathogenic beneficial organisms and the use of beneficial organisms in food industry along with genetic engineering.

Course Outcomes: After successful completion of the course, student will be able to

CO1: **Use** of the idea of biotechnology and microbiological quality of food.

CO2: **Describe** the production method of fermented food materials.

CO3: **Apply** separation method to purify fermented products.

CO4: **Demonstrate** the basic knowledge on genetic engineering and genetically modified crop.

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	-	2	2	1	-	-	3	3	2	1
CO2	3	3	1	1	2	-	2	1	1	1	3	3	2	2
CO3	3	3	3	2	1	-	-	-	2	-	3	2	3	3
CO4	3	3	1	1	3	1	2	3	-	-	3	3	3	1

Course Content:

Module I: **11L**

Types of microorganism normally associated with food: mold, yeast, and bacteria; Physical and chemical factors influencing growth of microorganisms; Propagation and preservation of starter cultures with example; Application of biofilm formation in food; Biochemical changes caused by microorganisms; Food borne new emerging pathogens; Food allergy.

Module II: **11L**

Concept of bioprospecting, Bioreactor and Fermenter: design and control; Production technology of various products: Amylase, Citric acid, Whey protein etc.; Nutritional and therapeutic significance of fermented products; Food fortification & Probiotics; Importance of immobilization of enzymes in food product development.

Module III: **11L**

Microbial biomass removal and Disruption; Separation and purification: Centrifugation; Sedimentation; Flocculation; Filtration; Sonication; Homogenizers; Chemical Lysis; Enzymatic Lysis, Precipitation (Ammonium Sulfate), Extraction, Ultrafiltration, Nanofiltration, Reverse osmosis; Chromatography: Adsorption, Size Exclusion, HPLC, Electrophoresis, Drying and Crystallization; Problem solving.

Module IV: **11L**

Fundamental aspects of Genetic Engineering / recombinant DNA technology - Restriction enzymes, Plasmid Vectors (cloning as well as expression vectors), Application of PCR and Real Time PCR in strain identification, Application of genetic engineering in dairy and food industry and case studies. Metabolism of lactose by lac operon system; Use of animal models in food toxicity studies, GMO case studies.

Revision: **4L**

Text Book/References:

1. Essentials of Microbiology; K. S. Bilgrami; CBS Publishers, Delhi
2. Food Microbiology; WC Frazier; Tata McGraw Hill, Delhi
3. Modern Food Microbiology; James M Jay; CBS Publishers, Delhi
4. Microbiology; Pelczar, Chan and Krieg; Tata McGraw Hill, Delhi
5. Basic Food Microbiology; Bannett, Chapman and Hall
6. Food Microbiology; M. R. Adams
7. Hand Book of Microbiology; Bisen
8. Food Biotechnology,Vol 1 & 2; King RD &Cheetham PSJ; 1988, Elsevier App.Sci.
9. Food Biotechnology; Angold R, Buch G & Taggart J; 1989, Cambridge University Press.
10. Fermentation Biotechnology: Principles, Processes & Products; Ward OP; Open University press.

Course Name: Advanced Fruit and Vegetable Processing Technology

Course Code: MFT103A

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Course Objectives: To study about the advanced techniques in fruit and vegetable processing and its effects on quality of finished product

Course Outcomes (COs):

After completion of the course students will be able to:

CO1: Understand the sustainable Processing and effective storage of fruits and vegetables.

CO2: Identify suitable equipment for fruits and vegetables processing for effective use in society

CO3: Summarize the knowledge of processing methods in food and allied industries for fruits, vegetables, carbonated and non-carbonated non-alcoholic beverages

CO4: Develop ideas about innovative technologies for sustainable product development for daily life uses.

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	-	1	1	1	-	-	2	3	1	2
CO2	2	2	2	1	-	1	2	1	-	-	3	3	2	2
CO3	2	2	2	2	-	-	2	2	-	-	2	3	3	3
CO4	3	3	2	1	-	3	3	2	-	-	3	3	2	2

Course Content:

Module I: **8L**

Post-harvest Processing and Improving the shelf-life of vegetables by genetic modification: Pre-harvest factors on postharvest life, Maturity index, 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. Genetic control of leaf senescence and fruit ripening, future trends.

Module II: **8L**

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, freezes concentration.

Module III: **8L**

Edible Coatings and Vacuum Technology: 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. Introduction, principles – mass transfer and product behavior. Applications and future trends.

Module IV: **10L**

Minimal Processing and Enzyme Maceration: 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. Introduction, ozone properties, ozone generation methods – electrical, electrochemical, radiochemical and ultraviolet method.
Mechanism of microbial inactivation. Effect on food quality. Industrial health and safety. Introduction function of enzymes in fruit juice processing- Applications and future trends.

Revision **2L**

Text Book/References:

1. Jongen W., "Fruit and Vegetable Processing: Improving Quality", 1st Edition, Woodhead Publishing Series in Food
   Science, Technology and Nutrition, 2002
2. Nirmal Sinha, Jiwan Sidhu, JozsefBarta, James Wu, M.PilaCano, "Handbook of Fruits and Fruit Processing", 2nd Edition, Blackwell Publishing, 2012.
3. Srivastava R.P, Sanjeev Kumar, "Fruit and vegetable preservation: Principles and practices", 3rd Edition, CBS Publishers & Distributers, New Delhi, 2014.
4. Rodrigues Sueli, Fabiano Andre NarcisoFernandes, (Eds), "Advances in Fruit Processing Technologies", 1st Edition, CRC Press, 2012.

Course Name: Lipid Science and Technology

Course Code: MFT103B

Contact: 3:0:0

Credit: 3

Total Contact Hours: 36

Course Objectives: This course imparts an idea about the different techniques of lipid processing and its products.

Course Outcome: On completion of the course, the students will be able to

CO1: **Apply** suitable technology for processing of fats and oils

CO2: **Choose** appropriate techniques for modifying oil and fat

CO3: **Identify** the formulations for development of different lipid products

CO4: **Analyze** the changes during frying and storage of fats and oils

CO – PO-PSO Mapping

COs	Program Outcomes											Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	-	1	1	1	-	-	2	3	-	2
CO2	2	2	2	1	-	1	2	1	-	-	3	3	2	2
CO3	2	2	2	2	-	-	2	2	-	-	2	3	3	3
CO4	3	3	2	1	-	3	3	2	-	-	3	3	2	2

Course Content:

Module I **10L**

Extraction and refining of oils and fats - Traditional Method - Solvent Extraction - Mechanical Extraction - Modern trends in extraction of oils and fats - Supercritical technology – Cryogenic grinding - 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.

Module II **10L**

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 mimetic and substitutes - Dairy Imitation Products - Enzymatic Modification -Structured Lipids - Specialty fats - Lipid as micronutrients and nutraceuticals.

Module III **8L**

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**.**

Module IV **8L**

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. Measurement of lipid degradation parameters during storage. Quality standards of oil Cooking oils. Packaging standards and requirements of fats and oils.

Text/ Reference books:

1. Chakrabathy M.M., “Chemistry and Technology of Oils and Fats”, 1st Edition 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”, 2nd Edition Blackwell Science Ltd., 2013.
4. Richard D. O‟Brien., “Fats and Oils: Formulating and Processing for Application”, 3rd Edition CRC Press, 2009.

Course Name: Advanced Baking, Confectionery and Extrusion Technology

Course Code: MFT103C

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Course Objective:

To provide an optimum environment for students to gain knowledge on the different functional properties of the ingredients, processes and machinery involved in production of different bakery and confectionery products. Students can also get idea about the safety, hygiene and maintenance of different bakery industries.

Course outcome(s):

After completion of the course, the students will be able to

CO1: Explain the ingredients, process and machinery involved in bakery, and confectionery technology and extruded products.

CO2: Analyze the performance of the raw materials of the product

CO3: Demonstrate a detailed knowledge of law relating to assess product quality for industry and consumer requirements.

CO4: Remember the technical knowledge for the development of Bakery and Confectionary industry and Extruded products

CO – PO-PSO Mapping:

COs	Program Outcome											Program Specific Outcomes		
	PO 1	PO2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO1	PSO 2	PSO3
CO1	3	2	2	2	-	1	1	1	-	-	2	3	-	2
CO2	2	2	2	1	-	1	2	1	-	-	2	3	2	2
CO3	2	2	2	2	-	-	2	2	-	-	2	3	3	3
CO4	3	3	2	1	-	3	3	2	-	-	2	3	2	2

Course Contents:

Module I : **10L**

Essential bakery ingredients: Flour, yeast and sour dough, water, salt- Other ingredients: Sugar, color, flavor, fat, milk, bread improvers, leavening agents, shortenings, enzymes, emulsifiers and antioxidants. Role of fat and sugar replacers, clean label ingredients. Bulk handling of ingredients, dough mixers, dividers, rounders, sheeters, laminators, Fermentation enclosures and brew equipment, ovens and slicers.

Module II : **8L**

Rheological methods - Fundamental testing and Empirical methods, Rheological testing equipment, compression, penetration, modified penetrometers, transient tests, dynamic tests, extensional viscosity. Effect of ingredients, mixing, dosing and temperature on rheological properties, cake batter rheology and bread dough rheology.

Module III : **8L**

Various stages and methods, Formulation and production -frozen dough, refrigerated dough and partially baked bread. Types -Foam style and shortened style, industrial preparation and baking of cakes. Production process and quality control, healthy biscuit formulation. Manufacture of cookies, pretzels and pastries. Requirement of dietetic bakery. Packaging and shelf life of Confectionery products.

Module IV : **10L**

Different extruders, principles and types, Uses of extruders in the food industry, Pre conditioning of raw materials used in extrusion process, Extruder Selection, Design, and Operation for Different Food Applications**.** Recent Advances in extrusion technology: Carbon dioxide or Nitrogen assisted extrusion technology, Extrusion in confectionary technology, Non-thermal Extrusion of Protein Products.

Text books:

1. Bailey's Industrial Oil and Fat Products, Vol 1 & 2; Swern D; 4th ed, 1982, John Wiley & Sons.

2. The Chemistry & Technology of Edible Oils and Fats; Devine J & Williams PN; 1961, Pergamon Press.

Reference Books:

1. Up to-date Bread Making; Fance WJ &Wrogg BH; 1968, Maclasen& Sons Ltd.

2. Modern Cereal Chemistry; Kent-Jones DW & Amos AJ; 1967, Food Trade PressLtd.

Course Name: Advanced Food Technology and Nutrition

Course Code: MFT104A

Contacts: 3:0:0

Total Contact Hours: 36

Credit: 3

Course Objectives: This course provides in-depth knowledge on various food and nutrition preservation technique

Course Outcome:

On Completion of this course student will be able to

CO1: Classify various technology used in food preservation

CO 2: Interpret the importance of different new and emerging technology.

CO 3: Analyze the importance of nanotechnology principles and packaging techniques applied in food preservation

CO4: Determine the various biochemical pathways during food preservation.

CO-PO-PSO mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	2	2	1	1	1	2	-	1	1	3	2	2
CO2	2	3	3	3	3	2	1	-	2	2	1	3	2	3
CO3	3	3	3	3	3	3	1	-	1	2	1	3	2	3
CO4	1	2	2	3	2	3	-	-	-	1	1	3	3	3

Course Contents:

Module I: **8L**

Recent advances in food technology on different techniques of food preservation including non-thermal & thermal processing; Membrane technology - Introduction to pressure activated membrane processes, performance of RO/UF and NF in industrial process.

Module II: **8L**

New & emerging technology: HPP, Supercritical and Near Critical Fluid extraction, Ultrasound, Pulse electric field, Microwave Technology, Hurdle Technology.

Module III: **8L**

Ohmic heating, micro ionization in food processing and preservation, Nanotechnology principles, mechanism and applications in foods. Studies of various packaging materials - intelligent packaging, aseptic & shrink packaging.

Module IV: **8L**

Role of different constituents of food in human nutrition; determination of individuals in India: problems on human nutrition in India; different approaches towards solving nutritional problems.

Revision 4L

Text Book/References:

1. Minimally processed fruits & vegetable: S. M. Alzamora, M.S. Tapia, A. Lopez - Malo
2. Food Science by Norman N Potter and Joseph H. Hotchkiss
3. The Technology of Food Preservation by Norman W. Desrosier, James N. Desrosie

Course Name: Food Additives, Functional Foods and Nutraceuticals

Course Code: MFT104B

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Course Objectives: This course provides the knowledge about food additives, nutraceuticals and functional foods

Course Outcome: On Completion of this course student will be able to

CO1: Choose food additives for various food applications

CO2: select suitable therapeutic and nutraceutical ingredients

CO3: use of appropriate ingredients for promoting health

CO4: summarise various functional foods and dietary supplement available in the market and significance of functional foods.

CO-PO-PSO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	3	2	1	1	2	2	2	-	1	1	3	2	2
CO2	2	2	2	1	1	2	1	2	-	1	1	3	2	3
CO3	1	2	2	1	-	3	1	1	-	-	2	3	2	3
CO4	1	2	2	1	-	3	-	3	-	1	3	3	3	3

Course Contents:

Module I: **10L**

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.

Module II: **8L**

Sources, understanding benefits of nutraceuticals. Health ingredients–lutein, beta-carotene; - omega-3, omega-6, omega-9, betaglucan, phytosterols; prebiotics, probiotics, synbiotics, digestive enzymes. Scope of nutraceuticals involved in industry, Indian and global scenario.

Module III: **8L**

Fortifying agents - Vitamins, iron, Zinc, Iodine, calcium, soy isoflavones, folic acid, Prebiotic fiber, glucosamine, collagen peptide, olive polyphenols, protein isolates/concentrate and hydrolysates.

Module IV: **10L**

Introduction to dietary supplements, Dietary supplements (RDA) – Need for dietary supplements, supplements forms- tablets, capsules, powders, soft gels, gel caps, liquids. 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.

Text Book/References:

1. Wildman, RobertE.C.,Robert Wildman, Taylor C. Wallace(Eds)., “Handbook of Nutraceuticals and Functional Foods”, 2nd edition, CRC Press, New York, 2007.
2. Titus A. M. Msagati., “Chemistry of Food Additives and Preservatives”, 1st edition, Wiley-Blackwell, 2013.
3. John Shi, Chi-Tang Ho, Fereidoon Shahidi., “Asian Functional Foods”, 1st Edition, CRC Press, 2005.

Course Name: Food Rheology

Course Code: MFT104C

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Course Objective:

To be able to provide knowledge on concepts, models, and applications of rheology in food systems.

Course Outcome(s):

After Completion of the course students will be able to:

CO1: explain the fundamentals of food rheology

CO2: interpret the different rheological models

CO3: analyze the rheological behavior of processed fluids and semi-solid foods

CO4: evaluate the rheological behavior of food gels

CO – PO-PSO Mapping:

COs	Program Outcomes											Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	2	2	2	1	-	-	-	1	2	3	2	1
CO2	3	3	2	2	-	-	-	-	-	1	2	3	2	3
CO3	3	3	2	2	3	2	-	1	-	1	1	3	2	1
CO4	3	3	3	2	2	-	-	1	-	1	2	3	3	2

Course Contents:

Module I: 8L

Stress and strain tensors, viscometric properties, shear stress-shear rate relationships, units in rheological measurements, types of fluid flow behavior, apparent viscosity, intrinsic viscosity, stress-strain behavior of solid foods, linear viscoelasticity, phase transitions in foods. Time-Independent Flow Behaviour - Newtonian Model, Power Law Model, Herschel–Bulkley Model, Quemada Model. Time- Dependent Flow Behaviour - Weltman Model, Tiu–Boger Model. Shear Thinning Foods - Cross and Carreau Models. Effect of Temperature on Viscosity, Peclet Number of Dispersions.

Module II: 8L

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 Analysis of Food Dispersions

Module III: 8L

Rheological Tests to Evaluate Properties of Gel Systems, Mechanisms of Gelation, Classification of Gels. Theoretical Treatment of Gels - Rubber Elasticity, Percolation Theory, Cascade Theory. Gel Point and Sol-Gel Transition by Rheological Measurements. Mixed Polymer Gels, Starch Gels

Module IV: 8L

Velocity Profiles in Tubes, Pump Selection and Pipe Sizing, Energy Requirements for Pumping, Power Consumption in Agitation, Residence Time Distribution in Aseptic Processing Systems, Role of Rheology in Thermal Processing of Canned Foods, Continuous Flow Sterilization

Revision: 4L

Text Books:

1. Mass Transfer Operations: Robert E. Treybal, MGH, International studentEdition.
2. Transport process and Unit Operations: Geankoplis. 3rd Edn.,PHI.
3. Unit Operations in Chemical Engfueering : McCabe, Smith, and Harriot. MGH, SthEdn.
4. Multicomponent Distillation: Holland, C. D.,PHI.

Reference books:

1. The Elements of Fractional Distillation: Robinson, C. S. and Gilliland, E. R. MGH.

2. Mass Transfer: Sherwood, Pigford, and Wilke, MGH.

3. Separation Processes: King, C. J.MGH.

4. Design of Equilibrium Stage Processes: Smith, B. D.MGH.

Course Name: Research Methodology and IPR

Course Code: MLC101

Contact: 2:0:0

Credit: 2

Total Contact Hours: 24

Course objective: This course will familiarize the fundamental concepts/techniques adopted in research, problem formulation and patenting. Also will disseminate the process involved in collection, consolidation of published literature and rewriting them in a presentable form using latest tools.

Course Outcomes:

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

CO1: Understand research problem formulation

CO2: Analyze research related information

CO3: Follow research ethics and understand the ultimate importance of ideas, concept and creativity

CO4: Appreciate that IPR protection provides incentive to inventors for further research work

CO-PO-PSO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	-	-	1	2	2	-	1	3	3	2	2
CO2	3	3	3	2	2	2	3	3	2	2	3	3	2	3
CO3	2	3	3	3	2	3	3	3	3	3	3	3	2	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Course Contents:

Module I **(6L)**

Meaning of research problem, Sources of research problem, Criteria and characteristics of a good research problem,Scope and objectives of research problem.

Module II **(6L)**

Effective literature studies approaches and analysis Plagiarism, Research ethics. Approaches for data collection, analysis, interpretation, necessary analytical instrumentations.

Module III **(6L)**

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

Module IV **(6L)**

Nature of Intellectual Property: Patents, Design, Trade and Copyright, Process of Patenting and Development: technological research, innovation, patenting, and development. International Scenario: International cooperation on Intellectual property. Procedure for grants of patents.

Text/ Reference books:

1.. Ranjit Kumar, Research Methodology- A step by step guide for beginners, Pearson Education, Australia, 2005.
2. Ann M. Korner, Guide to Publishing a Scientific paper, Bioscript Press 2004.
3. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008
4. Kothari, C. R. Research Methodology - Methods and Techniques, New Age International publishers, New Delhi, 2004.
5. Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & engineering students’, Juta & Company, 1996.
6. Robert P. Merges, Peter S. Menell and Mark A. Lemley, “Intellectual Property in New Technological Age”, Aspen Publishers, 2016.
7. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007.
8. Mayall , “Industrial Design”, McGraw Hill, 1992.
9. Niebel , “Product Design”, McGraw Hill, 1974.
10. Asimov , “Introduction to Design”, Prentice Hall, 1962.

Course Name: Advanced Microbial Technology Laboratory

Course Code: MFT191

Contact: 0:0:3

Credit: 1.5

Course Objective:

To help the students understand various methods of isolation, characterization and screening of bacteria, fungi and other related organisms and apply different preservation and fermented food productions techniques relative to food safety and spoilage.

Course outcome:

After the completion of this course students will be able to:

CO1: Understand biotechnological processing/engineering principles to variety of fermented products.
CO2: Develop new fermented products.
CO3: Interpret the data in scientific format.
CO4: Identify new development in this field with analytical thinking of the various aspects ofthe new technology.

CO-PO-PSO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	2	1	-	2	3	2	-	2	3	3	2	2
CO2	2	2	1	1	1	2	2	-	-	1	2	3	2	3
CO3	2	1	1	1	-	2	3	-	-	-	2	3	2	3
CO4	3	2	2	2	1	-	-	-	3	-	2	3	3	3

List of Experiments:

1. Preparation of alginate beads for phytochemical/enzyme/cell entrapment and immobilization.
2. Production of fortified edible agar/pectin based standard hydrogel.
3. Preparation of fortified cottage/fermented cheese and sensory analysis.
4. Study of antimicrobial property by agar well/paper diffusion test.
5. Liquid-Liquid solvent extraction of hydrophobic compound.
6. Preparation of emulsified/colloid system by using emulsifier.
7. Food allergy test by inhibition of protein denaturation.
8. Pectin/chitosan extraction from natural source.
9. Inactivation of microbial growth of a given food sample.
10. Innovative: Alcohol fermentation, mushroom production etc.

Text and Reference Book:

1. Fundamental Principles of Bacteriology – A. J. Salle
2. Food Microbiology – M. R. Adams, M. O. Moss.

Course Name: Advanced Food Processing Laboratory
Course Code: MFT192
Contact: 0:0:3
Credit: 1.5

Course Objectives:

To assist the students in using laboratory techniques common to basic Food Processing and to provide an opportunity to the students to evaluate the effective test methods used in sensory evaluation and analyze the resulting information.

Course Outcome(s):

After Completion of the course students will be able to:

CO1: Apply the principles that make a food product safe for consumption.

CO2: Use laboratory techniques common to basic Food Processing.

CO3: Interpret government regulations pertaining to food manufacturing.

CO4: Interpret the effective test methods used in sensory evaluation and analyze the resulting information.

CO-PO-PSO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	2	-	-	2	3	2	-	2	3	3	2	2
CO2	2	2	1	1	3	2	2	-	-	1	2	3	2	3
CO3	2	1	1	-	-	2	3	-	-	-	3	3	2	3
CO4	3	2	2	2	2	-	-	-	3	-	3	3	3	3

List of Experiments:

1. Preparation of lactose-free milk
2. Preparation of soya based product (Fermented and Non-fermented)
3. Preparation of Carrot powder
4. Preparation of protein isolate.
5. Preparation of ready-to eat fish/ meat based product.
6. Preparation of canned Rasogolla.
7. Preparation of Nutritional/Energy bar.
8. Preparation of fortified carbonated non alcoholic beverage
9. Preparation of probiotic diary product
10. Preparation of value added Bakery products.
11. Innovative experiment.

Text Books and Reference Books:

1. Food Science by B. Srilakhsmi
2. Essentials of Food & Nutrition by Swaminathan, Vol. 1 &2
3. Hand Book of Analysis of fruits & vegetables by S. Ranganna

Course Name: Constitution of India
Course Code: MFT181A
Contact: 2-0-0
Total Contact Hours: 24

Course Outcome:

On Completion of this course student will be able to

CO1: Identify and explore the basic features and modalities of Indian constitution.

CO2: Differentiate and relate the functioning of Indian parliamentary system at the center and state level.

CO3: Differentiate the various aspects of Indian Legal System and its related bodies.

CO4: Understand the role of municipalities, panchayat and election commission.

Course Content:

Module 1: Introduction: 4L

"Constitution"- Historical Background of the Constituent Assembly, Indian Constitution and its Salient Features, the Preamble of the Constitution.

Module 2: Fundamental Rights, Fundamental Duties, Directive Principles of State Policy: 4L

The Right to Equality
The Right to Freedom: I (Article 19)
The Right to Freedom: II (Articles 20, 21 and 22)The Right against Exploitation
The Right to freedom of ReligionCultural and Educational rights The Right to Property
The Right to Constitutional RemediesThe Directive Principles Fundamental Duties

Module 3: Union Government and its Administration 4L

Structure of the Indian Union, Parliamentary System, Federal System, Centre-State Relations, Amendment of the Constitutional Powers and Procedure, The historical perspectives of the constitutional amendments in India, Emergency Provisions: National Emergency, President Rule, Financial Emergency,and Local Self Government – Constitutional Scheme in India.

Module 4: The Machinery of Government in the State **4L**

Powers of Indian Parliament Functions of Rajya Sabha, Functions of Lok Sabha, Powers and Functions ofthe President, Comparison of powers of Indian President with the United States, Powers and Functions of the Prime Minister, Judiciary – The Independence of the Supreme Court, Appointment of Judges

State Executives – Powers and Functions of the Governor, Powers and Functions of the Chief Minister, Functions of State Cabinet, Functions of State Legislature, Functions of High Court and Subordinate Courts.

Module 5: The Machinery of Municipalities and Panchayat **4L**

Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation, Pachayati raj: Introduction, PRI: Zila Pachayat, Elected officials and their roles, CEO Zila Pachayat: Position and role, Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy

Module 6: Election Commission **4L**

Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

Text / Reference Books:

1) Indian Constitution by D.D.Basu, The Publisher, LexisNexis

2) Constitution of India by Subhas C Kasyap, Vitasta Publishing

3) The Constitution of India, P.M Bakshi, Universal Law Publishing Co.Ltd, New Delhi, 2003.

4) Indian Constitution Text Book - Avasthi, Avasthi,Publisher: LAKSHMI NARAIN AGARWAL

Course Name: Personality Development
Course Code: MFT181B
Contact: 2-0-0
Total Contact Hours: 24

Course Objective:
To provide students to develop their personality

COURSE OUTCOME:
On Completion of this course student will be able to

CO1: Understanding the concepts of personality and self esteem
CO2: Basic knowledge of attitude and motivation
CO3: Basic skill development for stress management
CO4: Development of leadership quality and positive attitude

MODULE 1 Introduction to Personality Development (5L)

The concept of personality - Dimensions of personality – Theories of Freud & Erickson- Significance of personality development. The concept of success and failure: What is success? - Hurdles in achieving success - Overcoming hurdles - Factors responsible for success – What is failure - Causes of failure. SWOT analysis.

MODULE 2: Attitude & Motivation Attitude (5L)

Concept - Significance - Factors affecting attitudes - Positive attitude – Advantages –Negative attitude- Disadvantages - Ways to develop positive attitude - Differences between personalities having positive and negative attitude. Concept of motivation - Significance – Internal and external motives - Importance of self- motivation- Factors leading to de-motivation

MODULE 3: Self-esteem (5L)

Term self-esteem - Symptoms - Advantages - Do's and Don’ts to develop positive self-esteem – Low self-esteem - Symptoms - Personality having low self-esteem - Positive and negative self-esteem. Interpersonal Relationships – Defining the difference between aggressive, submissive and assertive behaviors - Lateral thinking.

MODULE 4: Other Aspects of Personality Development (5L)

Body language - Problem-solving - Conflict and Stress Management - Decision-making skills - Leadership and qualities of a successful leader – Character building -Team-work – Time management - Work ethics –Good manners and etiquette

MODULE 5: Employability Quotient (4L)

Resume building- The art of participating in Group Discussion – Facing the Personal (HR & Technical) Interview - Frequently Asked Questions - Psychometric Analysis - Mock Interview Sessions.

Text Books/ Reference Books:

1. Hurlock, E.B (2006). Personality Development, 28th Reprint. New Delhi: Tata McGraw Hill.
2. Stephen P. Robbins and Timothy A. Judge (2014), Organizational Behavior 16th Edition: Prentice Hall.
3. Andrews, Sudhir. How to Succeed at Interviews. 21st (rep.) New Delhi.Tata McGraw-Hill 1988.
4. Heller, Robert.Effective leadership. Essential Manager series. Dk Publishing, 2002
5. Hindle, Tim. Reducing Stress. Essential Manager series. Dk Publishing, 2003
6. Lucas, Stephen. Art of Public Speaking. New Delhi. Tata - Mc-Graw Hill. 2001
7. Mile, D.J Power of positive thinking. Delhi. Rohan Book Company, (2004).
8. Pravesh Kumar. All about Self- Motivation. New Delhi. Goodwill Publishing House. 2005.
9. Smith, B . Body Language. Delhi: Rohan Book Company. 2004

Course Name: Stress Management by Yoga
Course Code: MFT181C
Contact: 2-0-0
Total Contact Hours: 24

Course Objective:
To provide students to achieve overall health of body and mind and to overcome stress.

Course Outcome:

CO1: Develop healthy mind in a healthy body thus improving social health also

CO2: Improve efficiency.

Course Content:

Module1:

Definitions of Eight parts of yog. (Ashtanga) – aims & objectives of yoga – misconception about yoga. Historical perceptive on yoga

Module2:

Yam and Niyam; Do`s and Don'ts in life.

Ahinsa, satya, astheya, bramhacharya and aparigraha, Shaucha, santosh, tapa, swadhyay, ishwarpranidhan Asan and Pranayam

Module3: Various yog poses and their benefits for mind & body

Module4: Regularization of breathing techniques and its effects-Types of pranayam

Module5: Yoga and development of Social qualities of personality – Co-operation – Simplicity – Tolerance – Social adjustments – Yoga and personal efficiency. Improvement of personal efficiency through yoga.

References

1. 'Yogic Asanas for Group Tarining-Part-I" :Janardan Swami Yogabhyasi Mandal, Nagpur
2. Rajayoga or conquering the Internal Nature" by Swami Vivekananda, AdvaitaAshrama (PublicationDepartment), Kolkata

SEMESTER II

SEMESTER II

SL No.	Core/ Elective	Code	Subject Name	Contact Hours/Week				Credit
				L	T	P	Total	
THEORY								
1	PC1	MFT 201	Food Safety and Quality Control	4	0	0	4	4
2	PC2	MFT 202	Food Packaging and Storage Engineering	3	1	0	4	4
3	PE3	MFT 203	Program Specific Elective-III D. Transport Phenomena in Food Processing E. Modern Separation and Purification Process F. Heat and Mass Transfer Operations in Food Processing	3	0	0	3	3
4	PE4	MFT 204	Program Specific Elective-IV D. Advanced Enzyme Engineering and Technology E. Advance Protein Technology F. Advanced Biochemical Engineering	3	0	0	3	3
5	PE5	MFT 205	Program Specific Elective-V D. Advanced Dairy Technology E. Technology of Meat Fish and Egg Processing F. Novel Technologies in Food Processing	3	0	0	3	3
PRACTICAL								
6	Mini project	MFT 281	Mini Project and Seminar I	0	0	4	4	2
7	LAB1	MFT 291	Innovative Food Product Development Lab	0	0	3	3	1.5
8	LAB2	MFT 292	Advanced Food Analysis and Quality Assessment Lab	0	0	3	3	1.5
SESSIONAL								
9	Aud-II	MFT 282	Audit Course-II D. English for Research Paper Writing E. Pedagogy Studies F. Disaster Management	2	0	0	0	0
Total Credit								**22**

FIRST YEAR SECOND SEMESTER

Course Name: Food Safety and Quality Control

Course Code: MFT201

Contact: 4:0:0

Total Contact Hours: 48

Credit: 4

Course Objectives:

1. To develop the knowledge of students regarding quality control and management principles, tools and their application

2. To enable the students to be aware of the voluntary and mandatory food standards and certifications in place- globally and nationally

Course Outcome: On Completion of this course student will be able to

CO1: Interpret principles of natural, biological science, and engineering fundamentals with basics food safety and quality management.

CO2: Apply food safety management principles with an understanding of the limitations in application of the same in food quality and safety maintenance in a food industry.

CO3: Analyze existing food laws and quality management techniques in relation to follow legal limits and supply safe food to consumers.

CO4: Develop system tools to meet specific needs of food safety and maintain the effective quality of food during processing taking into consideration public health and safety, cultural, societal and environmental issues.

CO-PO-PSO Mapping:

CO(s)	Program Outcomes											Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	2	3	3	-	2	1	-	2	2	3	3	3	1
CO 2	3	3	3	3	3	2	2	2	1	2	3	3	2	2
CO 3	2	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Course Contents:

Module I: **11L**

Definition of quality, Quality specifications and quality attributes of different foods,

Statistical quality control, Quality control programs: History and development, Biosafety levels, Total quality management (TQM), Quality assurance, Management Principles, ISO 9000 Family (QMS), principles and requirements

Module II: **11L**

Food Safety Management System ISO-22000 – Family, Key role, Principles of FSMS and requirements, HACCP- Prerequisites; GMP/C-GMP, GHP, GLP, Cleaning and Sanitation, Safety practices in the production areas, Pest Control, Withdrawal and Recall Procedures, traceability system, Principles and steps of HACCP Plan, Hazard Identification, Risk assessment, CCP Decision Tree, CAPA Plan, document and records,

Module III: **11L**

Mandatory and voluntary regulations world-wide, CODEX, FDA, WHO, EFSA, WTO, (TBT, SPSs), GATT. Role of regulatory authorities in India - functioning, legal acts and their enforcements- FSSAI , BIS, AGMARK, Legal Metrology Act, Industry Specific Regulations, ASCI, EPA, Export Quality Control and Inspection Act

Module IV: **11L**

Certification, Certification procedures, Certifying bodies, Accrediting bodies, International bodies. GFSI benchmarking, FSSC 22000, BRC, SQF, IFS, FSMA, OSHA, Auditing procedures- types of audit, Surveillance; Mock audit, third party quality certifying audit, Auditors and Lead auditors.

Revision: 4L

Text Books:

1. Total Quality Management, M.P. Poonia & S.C. Sharma, Khanna Publishing House

(AICTE Recommended Textbook - 2018)

2. Total Quality Management, Poornima M. Charantimath, Pearson Education India

3. Total Quality Management for the Food Industries. WA Gould, Woodhead Publishing

4. Management and control of quality. James R Evans, William M Lindsey. Thomson

Southwestern

5. Bioethics and Biosafety, M. K. Sateesh, I. K. International Pvt Ltd.

Course Name: Food Packaging and Storage Engineering

Course Code: MFT202

Contact: 3:1:0

Total Contact Hours: 48

Credits: 4

Course Objective:

To help the students identify the importance of packaging and storage engineering in the food industry and understand the recent developments in food packaging.

Course outcome(s):

After completion of the course students will be able to:

CO1: Define food packaging and storage phenomenon and explain their function for different food packaging materials.

CO2: Identify potential use of different packaging materials in context to industry and environment.

CO3: Perceive knowledge of bio composite and biodegradable materials for safe food packaging including active and intelligent packaging.

CO4: Adapt rules of different statutory and regulatory bodies in food packaging and storage systems and disposal protocols for food packaging material.

CO-PO-PSO Mapping:

COs	Program Outcomes											Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	1	1	2	2	2	1	3	3	2	2
CO2	3	3	3	3	3	2	3	3	2	2	3	3	2	3
CO3	3	1	2	3	3	3	3	3	3	3	3	3	2	3
CO4	3	3	2	3	3	3	3	3	3	3	3	3	3	3

Course Contents:

Module I: **11L**

Functions of packaging; Type of packaging materials; Selection of packaging material for different foods; Selective properties of packaging film; Methods of packaging and packaging equipment; concept of tetrapack.

Module II: **11L**

Mechanical strength of different packaging materials; Printing of packages; Barcodes & other marking; Interactions between packaging material and foods; Environmental and cost consideration in selecting packaging materials.

Module III: **11L**

Manufacture of packaging materials; Potential of biocomposite materials for food packaging; Packaging regulations; Packaging and food preservation; Disposal of packaging materials.

Module IV: **11L**

Testing of packaging; Rigid and semi rigid containers; Flexible containers; Sealing equipment; Labelling; Aseptic and shrink packaging; Secondary and transport packaging. Advances in Packaging Technologies; MAP, CAP, Active packaging, Intelligent Packaging, Nano-Packaging, Irradiated food Packaging.

Revision: 4L

Text Books:

1. Food Packaging: Principles and Practice by G. L. Robertson. Taylor & FrancisInc.

2. Food Packaging Technology by Richard Coles, Derek MC Dowell and Mark J. Kirwan.Blackwell Publishing, CRCpress.

3. Food and Packaging Interactions by Joseph H. Hotchkiss, (ACS symposium series -365, April 5-10, 1987, American chemical society, Washington DC,1988.)

Reference Books:

1. Food and Packaging Interactions by Joseph H. Hotchkiss, (ACS symposium series -365, April 5-10, 1987, American chemical society, Washington DC,1988.)

2. Packaging foods with plastics by winter A. Jenkins & James P Harrington – Technomic publishing co. Inc, Lancaster.Basel.

3. Flexible food packaging (Question & Answers) by Arthur Hirsch VNB – Van Nostrand Reinhold, New York (An AVI Book), ISBN0-442-00609-8.

4. Food Packaging and Preservation (theory & practice) by M.Mathlouthi-Elsevier Applied science publisher, London and NewYork.

5. Food Packaging Materials (Aspect of Analysis & Migration of contaminants) by N.T.crosby applied science publishers LTD.London.

6. Plastics in Packaging by A.S Athlye, TMGH, New Delhi.

7. Packaging (specifications, purchasing & Quality Control) 3rd edition by Edmond A Leonard- Marcel Dekker, INC- Newyork &Basel.

8. Plastics in packaging by forwarded by H.B Ajmera & M.R Subramanium – Indian institute of packaging. Published by A.P.Vaidya, Secretary II, E2, MIDC, Industrial Area (Andheri (East),Bombay-400093.

9. Food Packaging- Stanley Sacharois & Roger C. Griffin- The AVI Publishing company Inc. 1970.

10. Principles of packaging development- Griffin & Sacharow. (The AVI Publishing company, Inc. 1972).

Course Name: Transport Phenomena in Food Processing

Course Code: MFT203A

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Course Objective:

To be able to analyze various transport processes with understanding of solution approximation methods and their limitations.

Course Outcome(s):

After Completion of the course students will be able to:

CO1: Understand the chemical and physical transport processes and their mechanism

CO2: Apply heat, mass and momentum transfer analysis

CO3: Analyze industrial problems along with appropriate approximations and boundary conditions

CO4: Develop steady and time dependent solutions along with their limitations

CO – PO-PSO Mapping:

COs	Program Outcomes											Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	1	-	-	-	-	3	3	2	1
CO2	3	3	2	2	-	-	-	2	-	-	3	3	2	3
CO3	3	3	2	-	3	2	-	-	-	-	3	3	2	1
CO4	3	3	3	2	2	-	-	1	2	-	3	3	3	2

Course Contents:

Module I: **8L**

Introduction to heat and mass transfer and their analogous behaviour, steady and unsteady state heat conduction, analytical and numerical solution of unsteady state heat conduction equations, use of Gurnie-Lurie and Heisler Charts in solving heat conduction problems

Module II: **8L**

Applications in food processing including freezing and thawing of foods. Convective heat transfer in food processing systems involving laminar and turbulent flow heat transfer in boiling liquids, heat transfer between fluids and solid foods.

Module III: **6L**

Functional design of heat exchangers: Shell and tube, plate and scraped surface heat exchangers, jacketed vessels. Radiation heat transfer and its governing laws, its applications in food processing.

Module IV: **10L**

Molecular diffusion in gases, liquids and solids; molecular diffusion in biological solutions and suspensions molecular diffusion in solids, unsteady state mass transfer and mass transfer coefficients, molecular diffusion with convection and chemical reaction, diffusion of gases in porous solids and capillaries, mass transfer applications in food processing.

Revision: 4L

Text Books:

1. Mass Transfer Operations: Robert E. Treybal, MGH, International studentEdition.
2. Transport process and Unit Operations: Geankoplis. 3rd Edn., PHI.
3. Unit Operations in Chemical Engineering : McCabe, Smith, and Harriot. MGH, 5th Edn.
4. Multicomponent Distillation: Holland, C. D.,PHI.

Reference books:

1. The Elements of Fractional Distillation: Robinson, C. S. and Gilliland, E. R. MGH.
2. Mass Transfer: Sherwood, Pigford, and Wilke, MGH.
3. Separation Processes: King, C. J.MGH.
4. Design of Equilibrium Stage Processes: Smith, B. D.MGH.

Course Name: Modern Separation and Purification Process

Course Code: MFT203B

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Course Objective:

To learn conceptual design of separation processes and design of equipment involved.

Course Outcome(s):

After Completion of the course students will be able to:

CO1: **Understand** the principles of molecular diffusion and basic laws of mass transfer.

CO 2: **Study** the characteristic of packed bed absorption column

CO3: Understand the basics of distillation process for separation

CO4: Solve the problems of separation by diffusion, absorption and distillation

CO – PO-PSO Mapping:

COs	**Program Outcomes**											**Program Specific Outcomes**		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	2	2	1	-	-	-	-	3	3	2	1
CO2	3	3	2	2	-	-	-	1	-	-	3	3	2	1
CO3	3	3	2	-	3	2	-	-	-	-	3	3	2	3
CO4	3	3	3	2	2	-	-	1	2	-	3	3	3	2

Course Contents:

Module I: 8L

Fixed bed processes- ion exchange (principle & procedure, anion and cation exchanger resin), molecular sieve (principle & procedure, common column materials).

Module II: 8L

Membrane separations techniques- classification, reverse osmosis, ultrafiltration, diafiltration, electrodialysis. Cross flow filtration, application of van't Hoff equation, concentration polarization, rejection ratio, Types of devices, design- batch & continuous.

Module III: 10L

Definition of chromatography, Process based on chromatography- partition chromatography, Comparison of paper and thin layer chromatography, Asscending and descending Chromatography, Structure and reactions of ninhydrin, Adsorption chromatography (Freundlich & Langmuir adsorption isotherm), ion exchange chromatography, affinity chromatography.

Module IV: 6L

Electrophoresis, capillary electrophoresis, iso-electric focusing, gel filtration, solvent extraction, supercritical fluid extraction, Green technologies.

Revision: 4L

Text Books:

1. Mass Transfer Operations: Robert E. Treybal, MGH, International student Edition.

2. Transport process and Unit Operations: Geankoplis. 3rd Edn., PHI.

3. Unit Operations in Chemical Engineering : McCabe, Smith, and Harriot. MGH, Sth Edn.

Reference books:

1. Multicomponent Distillation: Holland, C. D., PHI.

2. The Elements of Fractional Distillation: Robinson, C. S. and Gilliland, E. R. MGH.

3. Mass Transfer: Sherwood, Pigford, and Wilke, MGH.

4. Separation Processes: King, C. J. MGH.

5. Design of Equilibrium Stage Processes: Smith, B. D. MGH.

6. Distillation: van Winkle, M., MGH.

Course Name: Heat and Mass Transfer Operations in Food Processing

Course Code: MFT203C
Contacts: 3:0:0
Total Contact Hours: 36
Credit: 3

Course Objectives: This course provides in-depth knowledge on selected heat and mass transfer operations.

Course Outcomes:

After completion of the course students will be able to:

CO1: Explain condensation and evaporative heat transfer phenomena
CO2: Analyse the heat exchanger performance
CO3: **Explain** distillation process and estimate number of stages
CO4: Choose and apply extraction techniques and estimate number of stages

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	-	-	-	-	-	-	3	3	2	2
CO2	3	3	3	2	2	1	2	1	2	2	3	3	2	3
CO3	3	3	3	2	1	2	2	2	2	2	3	3	2	3
CO4	3	3	3	1	3	1	1	-	-	-	3	3	3	3

Course Content:

Module I: **10L**
Thermal Operations: Emerging Technologies like infrared, microwave heating, ohmic heating, radiofrequency, dielectric, instant and high heat infusion and their current status. Recent trends in retort technology & continuous heat processing. Advances in evaporation – multi effect evaporation (DSE, MVR & TVR), recent trends and design calculations, centrifugal evaporation, freeze concentration.

Module II: **10L**
Non Thermal Operations: Recent trends in High pressure processing, high voltage pulsed electric field, high intensity pulsed light technology, oscillating magnetic field, cold plasma, ozone and ultrasonic technology, Osmotic dehydration. Membrane concentration – mechanisms of membrane transport, transport models, equipment – fluid & membrane movement modules.

Module III: **12L**

Mass Transfer Operations Novel drying technologies like microwave drying, radio frequency drying, infrared drying, airless drying, heat pump assisted drying and pulse combustion drying. Extraction – Different types of commercial extraction systems used in processing (tea & coffee extraction, solvent extraction) – Super critical fluid extractions and its application. Recent trends in distillation, absorption and crystallization

Revision **4L**

Text Book/References:

1. McCabe W. L., Smith J. C., Harriott P., "Unit Operations of Chemical Engineering", 5th Edition, McGraw Hill Education, 2010.

2. Holman J.P., "Heat Transfer", 10th Edition, McGraw-Hill, New York, 2012.

3. Treybal R.E., "Mass Transfer Operations", 3rd Edition, McGraw-Hill, New York, 2012.

4. Albert Ibarz, "Unit Operations in Food Engineering", 1st Edition, CRC Press, 2003.

Course Name: Advanced Enzyme Engineering and Technology

Course Code: MFT204A

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Course Objective:

To help student to gain knowledge about different enzyme production, purification and isolation process as well as the use of enzymes in food technology.

Course outcome(s):

After completion of the course students will be able to:

CO1: Outline enzyme classification and understand the influence of environmental factors on enzyme activity

CO2: Interpret enzyme kinetics.

CO3: Identify suitable enzymes for processing and development of food products

CO4: Apply use of concepts of enzyme engineering and biosensors

CO – PO-PSO Mapping:

COs	Program Outcomes											Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO1 1	PSO1	PSO2	PSO3
CO1	3	2	2	2	-	-	-	-	-	-	3	3	2	3
CO2	3	3	3	2	2	1	2	1	2	2	3	2	1	2
CO 3	3	3	3	2	1	2	2	2	2	2	3	1	2	3
CO 4	3	3	3	1	3	1	1	-	-	-	3	3	2	3

Course Contents:

Module I: **8L**

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.

Module II: **10L**

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.

Module III: **7L**

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

Module IV: **7L**

Application of enzymes in food processing industries; Application of immobilized enzymes and cells. Production of Commercial Enzymes. Design of enzyme electrodes and their application as biosensors in industry

Revision: **4L**

Text Book:

1. Biochemical Engg. Fundamentals-Baily, Ollis.MGH
2. Bioprocess Engineering by Michael L. Shuler and FikretKargi
3. Bioprocess Engineering Principles, Pauline M.Doran

Reference Books:

1.Prescott & Dunn’s Industrial MicrobiologyMacmiller

2.Principles of Fermentation Technology-Wittaker and Stanby

3.Methods in Enzymology, Edited by Dan S. Tawfik,Science Direct

Course Name: Advance Protein Technology

Course Code: MFT204B

Contact: 3:0:0

Total Contact Hours: 36

Credits: 3

Course Objective:

To help the students develop an advanced idea about protein utilization in food and its importance in our daily diet.

Course outcome(s):

After Completion of the course students will be able to:

CO1: Define protein structure and properties and to analyze different sources of protein.
CO2: Describe protein concentrate and isolate and their functions.
CO3: Interpret manufacturing of protein hydrolysates and to develop textured protein.
CO4: Apply different technique to detect and estimate protein.

CO-PO-PSO Mapping:

COs	Program Outcomes											Program Specific Outcomes		
	PO 1	PO 2	PO3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9	PO10	PO1 1	PSO1	PSO2	PSO 3
CO1	3	2	2	2	-	-	-	-	-	-	3	3	2	3
CO2	3	3	3	2	2	1	2	1	2	2	3	2	1	2
CO3	3	3	3	2	1	2	2	2	2	2	3	1	2	3
CO4	3	3	3	1	3	1	1	-	-	-	3	3	2	3

Course Contents:

Module I: 8L

Introduction, structure, functional diversity, modification, analytical tools to identify protein modifications;

Module II: 8L

Protein Separation Techniques: Basic principle of chromatography, instrumentation, ion-exchange, size-exclusion and affinity chromatography techniques; Analysis of protein sample: Basic principle of electrophoresis, instrumentation

Module III: 8L

Methods of manufacturing protein hydrolysates; Factors affecting quality of hydrolysates; Food uses of hydrolysates; Fiber spinning process of proteins; Textured protein gels and expanded products; Simulated milk products; Restructured protein; Nonconventional sources of protein.

Module IV: 8L

Centrifugation; Cell disruption; Protein precipitation and its recovery; Aqueous two-phase separation; Ion exchange chromatography; Gel filtration; Affinity chromatography; Electrophoresis; Cross filtration; Ultra filtration.

Revision: 4L

Text Books:

1. Altschul, A.M and Wilcke, , H.L Ed 1978. new protein Foods. Vol III. Academic Press, NewYork

2. Bodwell, C.E.Ed. 1977. evaluation of proteins for Humans. AVI,Westport

3. Milner,M., Scrimshaw, N.S and Wang, D.I.C.Ed. 1978. Protein Resources and Technology. AVI,Westport

4. Salunkhe, O.K and Kadam, S.S Eds. 1999. Handbook of world legumes; Nutritional Chemistry, Processing Technology and Utilization. Volume I to III, CRC Press,Florida

5. Salunkhe, D.K. Chavan, J.K.,Adsule, R.N Kadam, S.S 1992. World Oilseeds: Chemistry, Technology and Utilization, Van Nostrand Reinhold, NewYork

Reference Books:

1. Bioseparation Engineering: Principles, Practise and Economics, M.Ladish; Wiley Inter science

2. Proteolytic enzymes: a practical approach, Beynon, R.J and Bond, J.S; IRL Press, Oxford

Protein Biotechnology, Franks, F.; Humana Press

Course Name: Advanced Biochemical Engineering

Course Code: MFT204C

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Course Objective: To help the students understand the basic principles of various biochemical processes and realize the importance of different design parameters in bioreactor operation

Course outcome(s):

After completion of the course, the students will be able to
CO1: Recognize the basic principles of biochemical engineering and microbial growth kinetics

CO2: Interpret the design aspects of bioreactor including the upstream and downstream processing

CO3: Understand the applications of microbial technology in food processing

CO4: Illustrate the biotechnological concept in the production of biologicals

CO – PO-PSO Mapping:

COs	Program Outcomes											Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	-	-	-	-	-	-	3	3	2	3
CO2	3	3	3	2	2	1	2	1	2	2	3	2	1	2
CO3	3	3	3	2	1	2	2	2	2	2	3	1	2	3
CO4	3	3	3	1	3	1	1	-	-	-	3	3	2	3

Course Contents:

Module I (8L):

Isolation, screening and maintenance of industrially important microbes; microbial growth and death kinetics (an example from each group, particularly with reference to industrially useful microorganisms); strain improvement for increased yield and other desirable characteristics.

Module II (8L):

Elemental balance equations; yield coefficients; unstructured models of microbial growth; structured models of microbial growth,

Module III (8L):

Batch and continuous fermenters; modifying batch and continuous reactors: chemostat with recycle, multistage chemostat systems, fed-batch operations; conventional fermentation v/s biotransformations; immobilized cell systems upstream processing: media formulation and optimization; sterilization; aeration, agitation and heat transfer in bioprocess; scale up and scale down

Module IV (8L):

Separation of insoluble products - filtration, centrifugation, sedimentation, flocculation; Cell disruption; separation of soluble products: liquid-liquid extraction, precipitation, chromatographic techniques, reverse osmosis, ultra and micro filtration, electrophoresis; final purification: drying; crystallization; storage and packaging; recovery costs; water usage and recycling; effluent treatment and disposal.

Revision: 4L

Text Books:

1. Biochemical Engineering Fundamentals: J.E Bailey, D F Olli,MGH
2. Biochemical Engineering: Aiba S; Academia press,NY
3. Michael L. Shuler and Fikret Kargi: Bioprocess Engineering: Basic Concepts, 2nd Edition

Reference Books:

1. Bioprocess Engineering Principles, Pauline M.Doran
2. Principles of Bioseparation Engineering, Raja Ghosh

Course Name: Advanced Dairy Technology

Course Code: MFT205A

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Course Objective:

To provide an opportunity for students to classify different processing techniques required for preservation of milk and classify the different by products related to this industry.

Course outcome(s):

After completion of the course, the students will be able to

CO1: Define milk, its composition, variety and different testing methods to detect adulterant in milk

CO2: Develop understanding about thermal processing of milk and milk products and discuss cleaning and sanitization of different milk industry

CO3: Solve simple problems based on milk drying and to categorize different dried milk products

CO4: Formulate different milk based products and to prepare different traditional Indian dairy products.

CO – PO-PSO Mapping:

COs	Program Outcomes											Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO1 1	PSO1	PSO2	PS03
CO1	3	2	2	2	-	-	3	-	-	-	3	3	-	3
CO2	3	2	2	1	-	1	2	1	-	-	3	3	2	3
CO3	3	3	2	2	-	-	2	-	-	-	3	3	3	2
CO4	3	3	2	1	-	3	3	2	-	-	3	3	2	2

Course Content:

Module I **(10 L)**

Definition of milk, Composition of milk, Varieties of milk, Nutritional values, Checks for purity of milk and adulteration in milk, Cleaning and sanitization, HACCP of processing unit.

Module II **(10 L)**

Thermal processing of fluid milk – Pasteurization (LTLT,HTST & UHT), Packaging of fluid milk, Fermentation of milk and fermented milk products – Cheese, Yogurt, Curd, Kefir, Kumis, Flavored yogurt, Therapeutic value of Fermented Products, concept of Probiotics, prebiotics and probiotics dairy products

Module III **(8 L)**

Processing of evaporated and dried milk products – Milk powder, Malted milk and Infant formulae. Manufacturing and standardization of Cream, butter/butter oil, ghee, Ice-cream, Cheese, Simple problem based on milk drying, standardization, etc.

Module IV **(4 L)**

Traditional Indian sweets- Kheer, Paneer, Channa, Srikhand, Dairy processing by-products: and Production of lactose and protein from whey. Application of technologies in dairy industry

Revision: 4L

Text Books:

1. Outlines of Dairy Technology, Dukumar De; Oxford.

2. Milk & Milk Processing; Herrington BL; 1948, McGraw-Hill Book Company.

Reference Books:

2. Modern Dairy Products, Lampert LH; 1970, Chemical Publishing Company.

3. Developments in Dairy Chemistry – Vol 1 & 2; Fox PF; Applied Science Pub Ltd.

4. Robinson RK; 1996; Modern Dairy Technology, Vol 1 & 2; Elsevier Applied Science Pub.

Course Name: Technology of Meat Fish and Egg Processing

Course Code: MFT205B

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Course Objective:

To provide an opportunity for students to classify different processing techniques required for preservation of fish, meat, poultry and classify the different by products related to these industries.

Course outcome(s):

After completion of the course, the students will be able to

CO1: Identify the significance different processing techniques required for preservation of fish.

CO2: Classify the different by products related to fish processing industries and describe their use.

CO3: Compare the various components of the meat muscle with special focus on slaughtering and post mortem changes in meat, preservation and to recognize the different processing techniques related to meat processing industry and use of meat byproducts

CO4: Develop a general understanding on the structure, composition, nutritional values and effective preservation methods of eggs.

CO – PO-PSO Mapping:

COs	**Program Outcomes**											**Program Specific Outcomes**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO1 1**	**PSO1**	**PSO2**	**PS03**
CO1	2	3	3	3	-	3	3	3	3	3	3	2	3	3
CO2	2	3	3	3	2	3	3	3	3	3	3	2	3	3
CO3	3	3	3	3	2	3	3	3	3	3	3	2	2	3
CO4	2	3	3	3	2	3	3	3	3	3	3	2	3	3

Course Contents:

Module I (10L):

Classification of fresh water fish and marine fish; Commercial handling, storage and transport of fish; proximate composition and nutritive value of fish; Indices of freshness and its quality assessment, contaminants and toxicants in fish- both endogenous and exogenous,; Spoilage of fish; Methods of Preservation of fish and fish products: Canning, Freezing, Drying, Curing, Smoking, Fermentation (fish sauce) marinating and pickling, irradiation; effect of processing and storage on nutritive value; packaging.

Module II (5L)

Fish byproducts - production of fish meal, fish protein concentrate, and fish protein hydrolysate fish liver oil and fish silage; Production of chitin, chitosan; Production of non- food items from fish; Processing of fish wastes.

Module III (12L)

Slaughtering of animals; Classification, composition and nutritive value of poultry meat; Post mortem changes of meat; Curing and smoking of meat; Fermented meat products (sausages and sauces); frozen meat & meat storage; By-products from slaughter houses and meat processing industries and their utilization.

Module IV (5L)

Structure, composition and nutritive values of eggs; Quality assessment (defects) of eggs; Processing of eggs; Byproduct Utilization, Utilization of egg- derived products as food ingredients.

Revision: 4L

Text Books:

1. Processed Meats; Pearson AM & Gillett TA; 1996, CBSPublishers.
2. Food Science by B.Srilakhsmi

Reference Books:

1. Meat Science and Applications - Y H. Hu., Wai-Kit Nip, Robert W. Rogers& Owen A. Young, Marcel Dekker,2001.
2. Advanced Technologies for Meat Processing - Leo M. L. Nollet& Fidel

Toldrá, CRC Press, 2006.

3. Meat; Cole DJA &Lawrie RA; 1975, AVIPub.

4. Egg and poultry meat processing; Stadelman WJ, Olson VM, Shemwell GA &Pasch S; 1988, Elliswood Ltd.

5. Developments in Meat Science – I & II, Lawrie R; Applied Science Pub.Ltd.

6. Fish & Fisheries of India; Jhingram VG; 1983, Hindustan PubCorp

7. Fish as Food, Vol. I-IV; George Borgstrom, Academic Press

8. Fish Processing Technology ,Rogestein & Rogestein

9. Fish as Food; Vol 1 & 2; Bremner HA; 2002, CRCPress.

10. Egg Science & Technology; Stadelman WJ & Cotterill OJ; 1973, AVIPub.

Course Name: Novel Technologies in Food Processing

Course Code: MFT205C

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Course Objectives: To impart knowledge on novel processing techniques in the field of food technology

Course Outcomes:

By pursuing this course the students shall be able to

CO1: apply the concepts of hurdle technology along with various novel thermal and non-thermal technologies resulting in chemical and nutritional changes in food during processing

CO2: demonstrate the concept of novel extraction and purification methods

CO3: Understand the novel, recent advances and innovative food packaging for shelf life extension of products.

CO4: explain the concepts of vacuum frying, microencapsulation and computer vision technology for preparation of functional foods and nutraceuticals

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
CO1	3	2	2	2	-	-	-	-	-	-	3	3	2	2
CO2	3	3	3	2	2	1	2	1	2	2	3	3	2	3
CO3	3	3	3	2	1	2	2	2	2	2	3	3	2	3
CO4	3	3	3	1	3	1	1	-	-	-	3	3	3	3

Course Content:

Module I: 8L

Hurdle Technology, High Pressure Processing of Foods; Vacuum Cooling: Emerging technologies in food processing – necessity and advantages. Hurdle technology – concepts, applications – non thermal processing methods as hurdles. High Pressure Processing – Principles – applications to food systems – effect on food quality. Vacuum Cooling - Principles – Process – Equipment – Application –Advantages and
Disadvantages

Module II: 8L

Pulsed Electric Field Processing, Microwave Processing and Irradiation, Pulsed Electric Field Processing – Effect of pulsed light Technology on food products and food properties. - Equipment and mechanisms – microbial and enzyme inactivation – PEF enhanced drying, marinating. Microwave processing of fluid foods – principle – processing – factors influencing dielectric processing properties of foods – interaction of microwave with food components – equipment – challenges. Irradiation – types of radiations used for food preservation - lethal effects on microorganisms and food constituents – dosimetry and applications.

Module III: 6L

Novel extraction and separation processes - Super Critical Fluid Extraction, Ultrasound Processing, ion exchange and Osmotic Membrane Distillation Super critical and sub critical extraction of functional ingredients in food materials. Ultrasound: Principles – Ultrasound assisted extraction, decontamination, preservation, freezing, thawing and drying – parameters influencing ultrasound processing. Exchange
equilibrium – affinity selectivity and kinetics of ion exchange –Design of ion exchange systems and their uses in removal of ionic impurities from effluents. Osmotic Membrane Distillation: Fundamentals – OMD membranes – Process parameters – Osmotic agent, Concentration, Temperature.

Module IV: 8L

Novel technologies for storage & packaging: Antimicrobial food packaging, Non Migrating Bioactive Polymers (NMBP), Time-Temperature Indicators (TTIs), Freshness indicators , Green Plastics for Food Packaging Antimicrobial food packaging- Antimicrobial Agents – Factors affecting effectiveness of antimicrobial packaging. Non-Migrating Bioactive Polymers (NMBP) in Food Packaging – Applications of polymers with immobilized bioactive compounds. Defining and classifying TTIs – Requirements for TTIs – Using TTIs to monitor shelf-life. Use of freshness indicators in packaging– Compounds indicating the quality of packaged food products. Problem of

plastic packaging waste – the range of edible and biopolymers – developing novel biodegradable materials.

Module V: **6L**

Other Novel Food Processing Methods and products: Microencapsulation of bioactive compounds. Food extrusion technology- Principles – applications to food systems – effect on food quality-RTE Foods-TVP. Vacuum frying – effect on food quality – combination with microwave drying. Computer vision technology to prevent quality loss of products.

Text Book/References:

1. Da-wen Sun, "Emerging Technologies for Food Processing", 2nd Edition, Elsevier Academic Press, USA, 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", 1st edition, Wiley- Blackwell, IFT Press, 2011

Course Name: Innovative Food Product Development Lab

Course Code: MFT291

Contact: 0:0:3

Credit: 1.5

Pre requisites: Principles of Food Preservation, Unit Operation, Food Microbiology, Food Processing Lab

Course Objective:

To help the students understand various methods of product development, idea of selection of raw material and establishment of defined protocol.

Course outcome:

After the completion of this course students will be able to:

CO1:. **Identify** new development in food sector

CO2: Develop new products.

CO3: Interpret the data in scientific format.

CO4: Analysis of the various aspects of the new technology.

CO-PO-PSO Mapping:

COs	Program Outcomes											Program Specific Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9	PO10	PO1 1	PSO 1	PS O2	PS0 3
CO1	3	-	-	-	-	2	2	-	2	-	3	3	2	2
CO2	3	2	2	-	-	-	1	-	2	2	3	3	2	3
CO3	3	3	2	2	-	-	-	2	1	2	3	3	2	3
CO4	3	2	-	-	2	2	-	1	1	-	3	2	3	1

Course content:

- Development of a food product prototype including product formulation and specifications
- Intensive literature review
- Plan generation
- Selection of raw materials
- Establishment of suitable process flow-diagram for the developed protocol
- Process optimization on nutritional quality.
- Sensory analysis
- Cost analysis

Course Name: Advanced Food Analysis and Quality Assessment Lab

Course Code: MFT 292

Contact: 0:0:3

Credit: 1.5

Course Objectives:

To assist the students in using laboratory techniques common to basic Food analysis and to provide an opportunity to the students to evaluate the effective test methods and assess the quality of the food product.

Course Outcome(s):

After Completion of the course students will be able to:

CO1: Determine the methods of selecting appropriate techniques for analysis of food products.

CO2: Analyze different components present in developed food material.

CO3: Interpret government regulations pertaining to food manufacturing.

CO4: Evaluate the effective methods assess the quality of the food product

CO – PO-PSO Mapping:

COs	Program Outcomes											Program Specific Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9	PO10	PO1 1	PS O1	PS O2	PS O3
CO1	2	2	2	-	-	2	3	2	-	2	3	1	1	3
CO2	2	2	1	1	3	2	2	-	-	1	2	1	2	2
CO 3	2	1	1	-	-	2	3	-	-	-	3	1	1	3
CO 4	3	2	2	2	2	-	-	-	3	-	3	2	2	2

Course Content:

1. Raw material and its testing.
2. Inspection of food spoilage.
3. Establishment of quality assurance protocol
4. Product testing (including sensory analyses), characterization and shelf-life study.

Course name: English For Research Paper Writing

Course Code: MCE 282A

Contacts: 2:0:0

Total Contact Hours: 24L

Course Outcomes:

Students will be able to:

CO1. **Understand** that how to improve your writing skills and level of readability.

CO2. Learn about what to write in each section.

CO3. Learn how to summarize the whole work, contributes to the overall field of study.

CO4. Understand the skills needed when writing a Title Ensure the good quality of paper at very first time submission.

Module 1: [5L]

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding doubts and Imprecision, Jargons.

Module 2: [7L]

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Forming compact title and keywords,

Learn to write summary of the project as abstracts, collect related information, Introduction, Review of the Literature,

Module 3:[6L]

Methods, Results, Discussion, Conclusions, Introduce figures and tables or charts, The Final Check, Proofing

Module 4: [6L]

Key skills are needed when writing a Title, an Abstract, an Introduction, the Literature Review

Module 5: [6L]

Skills are needed when writing the Methods, able to explain Results and Discussion briefly, sort out the major points of discussion when writing the Conclusions

Module 6: [6L]

Useful phrases, how to ensure paper is as good as it could possibly be the first-time submission

Reference Studies:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)

2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press

3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM.

4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

Course name: Pedagogy Studies

Course Code: MFT 282B

Contacts: 2:0:0

Total Contact Hour/Week: 2L

CO1: **Learn** that how pedagogic practices support most effectively support all students to learn at primary and secondary levels in developing countries.

CO2: **Learn** that how can teacher education and guidance materials best support effective pedagogy

CO3: **Learn** the relation between pedagogy, curriculum and teacher education that support maximum change in teachers' practices and which are more likely to lead to increases in student learning attainment

Module 1: Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Meaning of Teacher Education, Teaching skills. Professional skills, Theoretical and conceptual framework in research. Overview of methodology and Searching.

Module 2: Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries: Overview and aims, Pedagogy, Curriculum, Teacher education.

Module 3: Evidence on the effectiveness of pedagogical practices, Methodology for the in depth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches, Teachers' attitudes and beliefs and Pedagogic strategies.

Module 4: Professional development: alignment with classroom practices and follow-up support, Peer support, Support from the head teacher and the community, Curriculum and assessment,

Barriers to learning: limited resources and large class sizes

Module 5: Research gaps and future directions, Research design, Contexts, Pedagogy, Teacher education Curriculum and assessment, Dissemination and research impact.

Course name: Disaster Management

Course Code: MFT 282C

Contacts: 2:0:0

Total Contact Hours: 24L

Course Outcomes:

Students will be able to:

CO1. **Learn** to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO2. Evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO3. **Develop** an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO4. **Understand** the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

Module 1: [5L]

Disaster: Definition, difference, nature and magnitude, Types of Disaster, Natural (Flood, Cyclone, Earthquakes, Landslides etc) & Man-made Disaster (Fire, Industrial Pollution, Nuclear Disaster, Biological Disasters, Air, Sea, Rail & Road accidents, Structural failures (Building and Bridge), War & Terrorism etc, Factors Contributing to Disaster Impact and Severity

Module 2: [5L]

Repercussions of various types of Disasters, Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem, Outbreaks of Disease and Epidemics, Natural Disaster-prone areas in INDIA, Areas prone to o Earthquake, Floods and Droughts, Landslides and Avalanches, Cyclonic And Coastal Hazards such as Tsunami, Trends of major Disasters and their Impact on India

Module 3: [5L]

Disaster Preparedness and Management, Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness

Module 4: [5L]

Risk Assessment, Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment And Warning, Tracking of disaster, Warning mechanisms, People's Participation in Risk Assessment, Strategies for Survival.

Module 5: [4L]

Rehabilitation, Reconstructions and Recovery Reconstruction and Rehabilitation as a Means of Development, Post Disaster effects and Remedial Measures, Disaster Mitigation Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-

Structural Mitigation, Programs of Disaster Mitigation in India.

SUGGESTED READINGS:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies", New Royal book Company.

2. Sahni, Pardeep et.al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall of India, New Delhi.

3. Goel S. L., Disaster Administration And Management Text And Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi.

SEMESTER III

SEMESTER III

SL No.	Core/ Elective	Code	Subject Name	Contact Hours/Week				Credit
				L	T	P	Total	
THEORY								
1	PE6	MFT 301	Program specific elective-VI D. Food Supply Chain Management E. Advanced Refrigeration and Cold Chain Management F. Food Process Plant Layout and Design	3	0	0	3	3
2	OE	MFT 302	Open elective D. Internet of Things in Food and Agriculture E. Design and Analysis of Experiments F. Operational Research	3	0	0	3	3
3	PC	MFT 303	Industrial Waste Management	3	1	0	3	4
PRACTICAL								
4	Major Project	MFT 381	DISSERTATION (PART-1)	0	0	12	12	6
Total Credit								**16**

SECOND YEAR FIRST SEMESTER

(3RD SEM)

Course Name: Food Supply Chain Management

Course Code: MFT 301A

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Course Objective: This course imparts knowledge in various components, future and challenges involved in food supply chain.

Course outcome(s):

After completion of the course students will be able to:

CO1: explain the various food supply chain models in India and in global perspective

CO2: translate collaborative approach to balance supply-side inventory to consumer demand

CO3: outline the operational challenges in food retailing, logistics, sourcing and procurement

CO4: summarize the concepts of traceability, innovation and risk management in food supply chain and sustainability performance in different stages of supply chain

CO-PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PS O1	PS O2	PS O3
CO 1	3	3	2	2	1	1	2	2	2	1	3	3	2	2
CO 2	3	3	3	3	3	2	3	3	2	2	3	3	2	3
CO 3	3	3	2	3	3	3	3	3	3	3	3	3	3	3
CO 4	3	3	3	3	2	3	2	3	3	3	3	3	3	3

Course Contents:

Module I: **8L**

Introduction to Food Supply Chain: Types of food chain, Decision Phases in Supply Chain, Food consumer and supply chain, International Food Supply Chains – factors affecting and challenges, Impact of Globalization on Supply Chain Networks, Food supply chain in India, Entities in the agriculture supply chain and case examples.

Module II: **8L**

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

Module III: **8L**

Operational Challenges: Food retail environment, Food routes to consumer, Impact of expanding consumer choice, Online grocery retailing, Future of food retailing – Challenges and case examples. Food logistics – packaging in logistics, temperature- controlled supply chains, case examples. Supply chain collaboration and relationship. Food Sourcing and Procurement: Sourcing models, Purchasing models, Supplier segmentation, Supplier development, Strategic sourcing, Sustainable procurement

Module IV: **8L**

Development in Food Supply Chains and Risk Management and Sustainability Challenges 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 and uncertainty, Risks in food supply chain, Managing risks in food supply chains. Sustainable food supply chains, Measuring sustainability within food supply chains, Developing sustainability within food supply chains – case examples, Food hubs, Information Technology in food supply chain, Carbon Footprint of food supply chains, Quality Management Schemes in food supply chain.

Revision: **4L**

Text and Reference Books:

1. Samir Dani., “Food Supply Chain Management and Logistics: From farm to fork”, 2nd Edition, Kogan Page, New Delhi,

2. Bourlakis M.A. and Weightman P.W.H., “Food Supply Chain Management”,1st Edition, John Wiley and Sons, UK, 2008.

3. Iakovou E., Bochtis D., Vlachos D. and Aidonis D., “Supply Chain Management for Sustainable Food Networks”, 1st

Course Name: Advanced Refrigeration and Cold Chain Management

Course Code: MFT 301B

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Course Objective: To impart the knowledge on concepts of refrigeration and cold chain management.

Course Outcomes: After successful completion of the course, student will be able to

CO1: apply the concepts of refrigeration systems and determine COP

CO2: illustrate the working and function of various components of refrigeration systems

CO3: examine the effect of low temperature storage on product quality

CO4: classify and construct cold storage unit and calculate cooling loads and develop cold chain system for transporting food products

CO-PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PS O1	PS O2	PS O3
CO 1	3	3	2	2	1	1	2	2	2	1	3	3	2	2
CO 2	3	3	3	3	3	2	3	3	2	2	3	3	2	3
CO 3	3	3	2	3	3	3	3	3	3	3	3	3	3	3
CO 4	3	3	3	3	2	3	2	3	3	3	3	3	3	3

Course Content:

Module I: Introduction to Refrigeration:

8L

Refrigeration, Ton of refrigeration, refrigeration capacity calculations, Single vapour compression and vapour absorption systems - COP determinations and calculations. Refrigerants - characteristics of different refrigerants, ozone depletion potentials, pressure enthalpy charts.

Module II:

Components of Refrigeration System:

8L

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.

Module III: Low Temperature Storage of Foods:

8L

Effect of temperature on food spoilage, Low temperature storage Methods-Chilling, Freezing, Evaporative cooling and its applications. Novel freezing methods and freezer types, Freezing rates, growth rate of ice crystals, crystal size and its effect on texture and quality of foods

Module IV: Cold and Frozen Storage and Cold Chain Management:

8L

Construction, Operation – Insulation, Types of storage rooms, Design and requirements of cold store and frozen store, total refrigeration load calculations, Automated cold store, temperature requirements in frozen storage, maintenance, packaging, energy conservation. 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 - data loggers, safety aspects, Flexibility storage systems, cold chain transportation inland and export, retail and supermarket cold chain- Retail display cabinets.

Revision: **4L**

Text Book/References:

1. Rajput R.K., “Refrigeration and Air-conditioning”, 3rd Edition, S.K. Kataria& Sons, Delhi, 2013.

2. Dellino C.V.J., “Cold and Chilled Storage Technology”, 2nd Edition, Springer, 2012.

3. Kennedy C.J., “Managing Frozen Foods”, 1st Edition, Woodhead Publishing Ltd.,2000.

4. Fellows P J “Food Processing Technology: Principles and Practice” 3rd Edition, Woodhead Publishing Ltd.,2009.

Course Name: Food Process Plant Layout and Design

Course Code: MFT 301C

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Course Objectives: To impart knowledge on designing the food process, equipment and plant layout.

Course Outcomes (COs)

After completion of the course students will be able to:

CO1: explain process design and plant layout

CO2: apply process layout concepts to construct food plant

CO3: select food process equipment based on constructional and operational characteristics

CO4: make use of sizing, construction and costing of food process equipment and appraise the criteria for design of food process equipment

CO-PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PS O1	PS O2	PS O3
CO 1	3	2	2	2	1	2	1	1	1	1	3	3	2	2
CO 2	3	3	3	3	3	2	2	2	1	2	3	3	2	3
CO 3	3	2	3	3	3	3	3	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	2	3	3	3	3	3	3	3	3

Course Content:

Module I: **8L**

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

Module II: **8L**

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.

Module III: **8L**

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

Module IV: **8L**

Sizing, construction and costing of Equipment and Design of food process 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. 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. Reactors- process operation, design considerations, location, support and elevation, nozzle location, platform, piping arrangements. Design of equipment for industrial food processing such as evaporation, dehydration, refrigeration, freezing, thermal processing, and dehydration.

Revision: **4L**

Text Book/References:

1. George D. Saravacos ,Athanasios E. Kostaropoulos, “Handbook of Food Processing Equipment”, 2nd Edition,Science, Technology and Nutrition, 2002
2. Ed Bausbacher , Roger Hunt, “Process plant layout and piping design”,1st Edition, P T R Prentice Hall, Englewood Cliffs,
3. Georgina Calderón-Domínguez, Gustavo F. Gutiérrez-López, and Keshavan Niranjan, “Advances in Heat Transfer Unit Operations”, 1st Edition, CRC/Taylor & Francis, 2016..
4. Teixeira, Arthur A., Shoemaker, Charles F. “Computerized Food Processing Operations” 1st Edition, Springer, 1989.

Course Name: Internet of Things in Food and Agriculture

Course Code: MFT 302A

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Course Objectives: This course aims to deliver knowledge about concepts of IoT and its applications in food and agriculture.

Course Outcomes (COs)

After completion of the course students will be able to:

CO1: outline the basic concepts of IoT

CO2: summarize the fundamental concepts of Internet-connected product

CO3: apply the concept of IoT for management of agriculture and supply chain

CO4: make use of appropriate IoT concepts for rapid detection of food spoilage and utilize IoT methods to solve food traceability and food waste management problems

CO-PO- PSO Mapping:

CO(s)	Program Outcomes											Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	2	2	2	-	2	1	-	1	1	3	3	3	1
CO 2	3	3	3	3	3	2	2	2	1	2	3	3	2	1
CO 3	2	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	2	3	2	2	3	3	3	3

Course Content:

Module I: **8L**

Introduction to Internet of Things (IoT): Definition and Characteristics of IoT, Physical Design of IoT – IoT Protocols, IoT Communication Models - IoT Communication application programing interfaces – IoT enabled technologies – Wireless Sensor Networks - Cloud Computing – Big data analytics – Communication Protocols, Embedded Systems – IoT Levels and Templates- organizational implementation and management challenges.

Module II: **8L**

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, Serial Peripheral Index (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.

Module III: **8L**

IoT in Agriculture, IoT in Food and in Food Waste Management: Smart agriculture, type of IoT sensors for agriculture – monitoring of climate conditions, Greenhouse automation, crop management, cattle monitoring and management, End-to-End farm management systems. Benefits and applications of smart farming, Issues and challenges in food and agriculture- efficient routing protocols and ambient energy harvesting for IoT. 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.

Need of new technologies in food traceability systems. Architecture traceability system- ICT & Electronic Product Code (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.

Module IV: **8L**

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. IoT linked wearable devices for managing food safety in the healthcare sector.

Revision: **4L**

Text Book/References:

1. Qusay F. Hassan, Attaur Rehman Khan, Sajjad A. Madani., "Internet of Things Challenges, Advances and Applications", 1st Edition, 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", 1st Edition, John Wiley & Sons, UK, 2016.
3. Montserrat Espiñeira, Francisco J. Santaclara., "Advances in Food Traceability Techniques and Technologies - Improving Quality Throughout the Food Chain", 1st Edition, Wood head Publishing, 2016.

Course Name: Design and Analysis of Experiments

Course Code: MFT 302B

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Course Objectives: This course highlights different techniques for designing and optimizing experimental data.

Course Outcomes:

After completion of the course students will be able to:

CO1: apply the basic principles and strategies of experimental design to real time experimental data

CO2: apply fundamental concepts of statistics for testing a hypothesis

CO3: analyze randomized complete block experiments

CO4: analyze factorial experiments for deriving conclusions and perform response surface analysis using software tools and interpret the results

CO-PO- PSO Mapping:

CO(s)	Program Outcomes											Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	2	2	2	-	2	1	-	1	1	3	3	3	1
CO 2	3	3	3	3	3	2	2	2	1	2	3	3	2	1
CO 3	2	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	2	3	2	2	3	3	3	3

Course Content:

Module I: **8L**

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.

Module II: **8L**

Statistical Analysis: Sampling and Sampling Distributions, Inferences on Randomized and paired comparison designs, Analysis of Variances, Regression Analysis – Linear, Multiple regressions, Testing for lack of fit.

Module III:

8L

Randomized Complete Block Design and Factorial Design: Framing RCBD experiments, Latin Square Design, Graeco-Latin Square Design, Central Composite Design, Box Behnken Design, Balanced Incomplete Block Design, Model adequacy checking, Least Square estimation, regression, Contour profile of response surface plot, Case Studies.

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.

Module IV: **8L**

Software Tools and their Applications in data processing: Introduction to RSM, Steepest Ascent method, Analysis of Second order response surface, Designs for Fitting Response surfaces, Mixture experiments. Curve fitting tools -OriginPro, Spread sheet, Matlab. Statistical analysis of data – Design Expert and Minitab.

Revision: **4L**

Text Book/References:

1. Douglas C. Montgomery., “Design and Analysis of Experiments”, 8thEdition, Wiley, USA, 2017.

2. Hoshmand A.R., “Design of Experiments for Agriculture and the Natural Sciences”, 2nd Edition, CRC Press, USA, 2018.

3. Castillo E.D., “Process Optimization – A Statistical Approach”, 2nd Edition, Springer Science Business Media, USA, 2007.

4. Angela Dean , Daniel Voss., “Design and Analysis of Experiments”, 1st Edition, Springer, USA, 2013.

Course Name: Operational Research

Course Code: MFT 302C

Contact: 3:0:0

Total Contact Hours: 36

Credit: 3

Course Objectives: This course delivers the knowledge of operational research methods to improve operational efficiency and decision making.

Course Outcome:

On Completion of this course student will be able to

CO1: outline the basics of operation research

CO 2: solve different kinds of linear programming problems

CO 3: apply non-linear programming for solving problems

CO4: make use of Game and Queuing theory concepts in food processing and apply forecasting methods in food production planning and sales

CO-PO-PSO mapping:

CO(s)	Program Outcomes											Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	2	2	2	-	2	1	-	1	1	3	3	3	1
CO 2	3	3	3	3	3	2	2	2	1	2	3	3	2	1
CO 3	2	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	2	3	2	2	3	3	3	3

Course Contents:

Module I:

Introduction to Operation Research (OR): 8L

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

Module II:

Linear Programming: 8L

Introduction to Linear Programming, Graphical Method, Minimization case, Mixed constraint linear programing problem, special cases, Simplex method, Big M method, Two phase method, Types of linear programming solutions, Product Formulation and Process Optimization Using Linear Programming

Module III:

Non – Linear Programming: 8L

Constrained problems- Equality constraints- Lagrangean method- In equality Constraints- Karush-Kuhn- Tucker (KKT) Conditions- Quaradic Programming. Applications of non - linear programming in food processing.

Module IV:

Game Theory and Queuing Theory: 8L

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. 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, Food processing plant applications of queueing equations, Limitations of Queueing Theory.

Revision: 4L

Text Book/References:

1. Tiwari N.K., Shishir K. Shandilya, “Operations Research”, 1st Edition, Prentice Hall, New Delhi, 2006.

2. Sharma J. K., “Operations Research: Theory and Applications”, 5th Edition, Macmillan Publishers, New Delhi,2012.

3. Ferruh Erdogdu., “Optimization in Food Engineering”, 1st Edition, CRC Press, USA, 2008.

4. SerafimBakalis, Kai Knorzer, Peter J. Fryer., “Modelling Food Processing Operations”, 1st Edition, Woodhead Publishing, UK, 2015.

Course Name: Industrial Waste Management

Course Code: MFT303

Contact: 4:0:0

Total Contact Hours: 48

Credit: 4

Course Objective: To educate the students on management of waste water and solid waste, starting from source identification to reuse concepts.

Course outcome(s):

After completion of the course students will be able to:

CO1: Classify different industrial waste, nature of the waste and its characteristics.

CO2: Identify different treatment methods for liquid/solid waste and the recovery of useful material from waste as byproducts

CO3: Interpret data regarding different waste treatment method.

CO4: Apply different methods in industry and domestic purpose.

CO-PO-PSO mapping:

CO(s)	Program Outcomes											Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1	3	2	2	1	-	2	1	-	1	1	3	3	3	1
CO 2	3	3	3	3	3	2	2	2	1	2	3	3	2	1
CO 3	2	2	1	3	3	3	3	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Course Contents:

Module I:

Industries and Environment: 8L

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.

Module II:

Management of Industrial Waste Water and Treatment Plants: 10L

Treatments: Aerobic and anaerobic biological treatment – batch and high rate reactors-Chemical oxidation – Ozonation – Photo catalysis – Wet Air Oxidation – Evaporation – Ion Exchange – Membrane Technologies.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.

Module III:

Solid Waste Sources and Segregation: 10L

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. 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.

Module IV:

Energy Recovery and Waste Disposal: 10L

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. Energy Auditing. 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.

Module V:

Waste Management in different industrial segments: 6L

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.

Revision: **4L**

Text Book/References:

1. Environmental Biotechnology; Bhattacharyya B C & Banerjee R; Oxford University Press.

2. Water & Wastewater Engineering; Fair GM, Geyer JC & Okun DA; 1986, John Wiley & Sons, Inc.

3. Food Industry Wastes: Disposal and Recovery; Herzka A & Booth RG; 1981, Applied Science Pub Ltd.
4. Wastewater Treatment; Bartlett RE; Applied Science Pub Ltd.
5. Symposium: Processing Agricultural & Municipal Wastes; Inglett GE; 1973, AVI.
6. Environmental Biotechnology: Principles and Applications; Rittmann BE & McCarty PL; 2001, Mc-Grow-Hill International editions.

SEMESTER IV

SECOND YEAR SECOND SEMESTER

(4TH SEM)

SEMESTER IV:

SL No.	**Core/Elective**	**Code**	**Subject Name**	**Contact Hours/Week**				
				L	T	P	Total	Credit points
PRACTICAL								
1	Major Project	MFT481	DISSERTATION (COMPLETION)	0	0	24	24	12
Total Credit							**24**	**12**

TOTAL CREDIT: 68