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ST ALOYSIUS

(DEEMED TO BE **UNIVERSITY**)

MANGALURU 575003-INDIA

Course structure and syllabus of

M.Sc.

FOOD SCIENCE & TECHNOLOGY

Semester I, II, III & IV

2024 ONWARDS

ST ALOYSIUS

(DEEMED TO BE UNIVERSITY)

MANGALURU 575003 – INDIA

School of Life Sciences

BOS MEETING

BOS meeting of School of Life Sciences was held on 22th April 2024, at 9.30 am in AppliedBiology Laboratory

LIST OF MEMBERS OF THE BOS IN LIFE SCIENCES

Sl no	Members with Address	Designation
1.	Dr Hemachandra hemachandra_amin@staloysius.edu.in 9035961509	Dean, School of Life Sciences
2.	Dr Renita Maria Dsouza renita@staloysius.edu.in 9945923172	Associate Dean, School of Life Sciences
3.	Dr Lyned Dafny Lasrado lyneddafny@staloysius.edu.in 9686021928	Assistant Dean, School of Life Sciences
4.	Dr Jyothi Miranda Department of Botany jyothi@staloysius.edu.in 7022560938	Professor
5.	Dr Asha Abraham Department of Post Graduate Studies & Research in Biotechnology drashaabraham@staloysius.edu.in 9449555802	Associate Professor
6.	Dr Hariprasad Shetty Department of Zoology shettyhariprasad@staloysius.edu.in 9945886947	Associate Professor
7.	Dr S N Raghavendra Department of Post Graduate Studies & Research in Food Science raghavendra_sn@staloysius.edu.in 9945888845	Assistant Professor

8.	Dr Santhosh Wilson Goveas Department of Post Graduate Studies & Research in Biotechnology santhoshgoveas@staloysius.edu.in 9448724682	Assistant Professor
9.	Dr Chandrashekara G Joshi Chairperson Department of Biochemistry Mangalore University josheejoshee@gmail.com 9448446641	Subject expert in Biochemistry
10.	Dr Shyama Prasad Sajankila Department of Biotechnology NMAMIT, Nitte, Karkala shyama.sajankila@nitte.edu.in 9611202842	Subject expert in Biotechnology & Microbiology
11.	Dr Smitha Hegde Professor & Deputy Director NUCSER, Nitte University Deralakatte smitha.hegde@nitte.edu.in 9886036077	Subject expert in Biotechnology & Zoology
12.	Dr Archana Prabhat Professor & Coordinator Department of PG Studies in Food Science & Nutrition Alva's College (Autonomous), Moodbidri drarchanaprabhat@gmail.com 9986665759	Subject expert in Food Science
13.	Dr Giby Kuriakose Assistant Professor PG Department of Botany, Sacred Heart College Kochi, Kerala-670106 giby.kuriakose@shcollege.ac.in 7012608038	Subject expert in Botany
14.	Dr Shreelalitha Suvarna Assistant Professor shreelalitha_suvarna@staloysius.edu.in 9964215205	HOD UG & PG Biotechnology
15.	Dr Swarnalatha Assistant Professor swarnalatha@staloysius.edu.in 9900284662	HOD UG & PG Biochemistry

16.	Ms Shilpa B Assistant Professor shilpa_botany@staloysius.edu.in 9535887279	HOD Botany
17.	Dr Daniella Ann L Chyne Assistant Professor daniella_chyne@staloysius.edu.in 9676389466	HOD UG & PG Food Science
18.	Dr Vaishali Rai Assistant Professor vaishali_rai@staloysius.edu.in 9980313361	HOD Microbiology

I SEMESTER

Paper	Instructions hours/ week		Duration of exam hours	Marks		Total Marks	Credits
	Theory	Practical		CIA*	Exam		
PH 591.1 **(Theory) Food Chemistry**	4	-	3	30	70	100	4
PH 593.2 **(Theory) Principles of Food Processing and Preservation**	4	-	3	30	70	100	4
PH 593.1 **(Theory) Fruits and Vegetables Processing Technology**	4	-	3	30	70	100	4
PH 596.1 **(Theory) Processing of Milk and Dairy Products**	3	-	3	30	70	100	3
PH 597.1 **(Theory) Waste Management and Environmental Sustainability**	3	-	3	30	70	100	3
PH 594.1P **(Practical) Food chemistry and Preservation**	-	8	4	30	70	100	4
PH 595.1P **(Practical) Processing Technology: Milk, Fruits, Vegetables, and their Products**	-	8	4	30	70	100	4

*Continuous internal assessment

II SEMESTER

Paper	Instructions hours/ week		Duration of exam hours	Marks		Total Marks	Credits
	Theory	Practical		CIA*	Exam		
PH 591.2 **(Theory)** Food Process Engineering and Instrumentation	4	-	3	30	70	100	4
PH 592.2 **(Theory)** Processing Technology of Cereals, Pulses and Oil Seeds	4	-	3	30	70	100	4
PH 595.2 **(Theory)** Spices and Plantation Crops Technology	3	-	3	30	70	100	3
PS 596.2 **(Theory)** Research Methodology and Ethics	3	-	3	30	70	100	3
PO 598.2 **(Open Elective)** Essentials of Food Science	3	-	3	30	70	100	3
PH 593.2P **(Practical)** Food Process Engineering and Instrumentation	-	8	4	30	70	100	4
PH 594.2P **(Practical)** Processing Technology of Cereals and spices	-	8	4	30	70	100	4

*Continuous internal assessment

III SEMESTER

Paper	Instructions hours/ week		Duration of exam hours	Marks		Total Marks	Credits
	Theory	Practical		CIA*	Exam		
PH 591.3 **(Theory)** **Food Microbiology**	4	-	3	40	60	100	4
PH 592.3 **(Theory)** **Nutraceuticals and Functional Foods in Human Health**	4	-	3	40	60	100	4
PO 595.3 **(Theory - CBCS)** **Basics of food safety and labelling**	3	-	3	40	60	100	3
PH 593.3P **(Practical)** **Food microbiology & Functional foods**	-	8	4	40	60	100	4

*Continuous internal assessment

IV SEMESTER

Paper	Instructions hours/ week		Duration of exam hours	Marks		Total Marks	Credits
	Theory	Practical		CIA*	Exam		
PH 593.4 **(Theory)** **Food Biotechnology**	4	-	3	40	60	100	4
PH 592.4 **(Theory)** **Food Packaging**	4	-	3	40	60	100	4
PH 591.4 **(Theory)** **Meat, fish and Poultry processing technology**	4	-	3	40	60	100	4
PH 595.4 **(Theory)** **Food Safety and Quality Control**	3	-	3	40	60	100	3
PH 597.4P (Practical**)** **Food Biotechnology and Food safety**	-	4	3	40	60	100	4
PH 594.4P **(Practical)** **Meat, fish and Poultry processing technology**	-	4	4	40	60	100	3

*Continuous internal assessment

PROGRAMME OUTCOMES (PO)

By the end of this programme, students will be able to

PO1: Demonstrate a comprehensive understanding of the principles, concepts, and theories in food technology, including food processing techniques, food preservation methods, and the physical, chemical, and microbiological properties of food..

PO2: Analyze the composition, structure, and quality of food products, as well as evaluate the efficiency and effectiveness of food processing operations and technologies in terms of food safety, shelf-life extension, and sensory attributes.

PO3: Critically evaluate food regulations, standards, and industry practices, and assess their compliance with food safety regulations, quality assurance protocols, and ethical considerations, as well as evaluate the environmental and socioeconomic impacts of food production and processing.

PO4: Apply their knowledge and skills in food technology to develop and optimize food processing methods, formulate new food products, and implement quality control measures to ensure the safety, nutritional value, and sensory acceptability of food products.

PO5: Demonstrate creativity and innovation in designing novel food products, processes, and technologies that meet consumer demands, market trends, and sustainability goals, while adhering to food safety regulations and industry standards.

PO6: Exhibit leadership qualities, effective communication skills, and the ability to manage and supervise food production facilities, research projects, and teams of food technologists, and contribute to the advancement of the field through research, education, and industry collaboration.

First Semester MSc. Food Science and Technology

Course Core Content

(PH 591.1) **Food Chemistry**

Credits: **4** Total Hours: **56**

Course Outcomes

On Completion of this Course the students will be able to:

CO1: Understand the fundamental principles of food chemistry

CO2: Analyze the physico-chemical properties of carbohydrates, lipids, proteins, and enzymes

CO3: Examine the interactions between food components and processing techniques

CO4: Propose strategies for controlling these reactions to ensure food safety and quality

Interpret the significance of food chemistry in addressing global challenges

Unit I: Water, Vitamins and Minerals **14 Hours**

Food chemistry: Definition, scope and importance. Water and Ice: Physical properties, structure of water and ice, Phase transition of water molecule, water soluble interaction, water activity and relative vapor pressure. Dispersed System: surface chemistry, colloidal interaction, creaming foams and emulsion. Proximate analysis. Vitamins, Minerals and changes during processing. Food Additives: Sweeteners, Flavour enhancers, food colours, antimicrobial agents, emulsifiers.

Unit II: Carbohydrates **14 Hours**

Carbohydrates: Definition and importance, classification, sources, functions, physico-chemical Properties of carbohydrates, Cellulose, Guar and Locust Bean Gum, Xanthan, Carrageenan's, Algins, Pectins, Gum Arabica and Dietary fiber. Starch (functionality of starch – gelatinization and retro gradation), Browning reaction in food: Enzymatic and non-enzymatic browning and applications in food.

Unit III: Fats and Fatty Acids **14 Hours**

Fatty acids: Nomenclature and classification, Physical properties and chemical reactions, Lipids: Chemical Classification; Lipolysis, rancidity (hydrolytic rancidity, oxidative rancidity and microbial rancidity) and flavour reversion, auto-oxidation, modification of fats and oils (hydrogenation and inter esterification, winterization and acetylation); transfats; fat substitutes.

Unit IV: Proteins and Amino acids **14 Hours**

Amino acids: classification, physical properties, chemical reaction. Peptides: Nomenclature, physical and sensorial properties, Proteins: conformation, physical properties, texturized protein, denaturation of protein, gel formation, chemical and enzyme catalyzed reactions in protein processing. Digestibility coefficient, biological value, net protein utilization (NPU), protein efficiency ratio (PER). Enzymes: Nomenclature, specificity, structure, enzyme cofactor, theory of Enzyme catalysis, Enzyme utilization in food industries.

Recommended Books and References:

1. John M. deMan, John W. Finley, W. Jeffrey Hurst & Chang Yong Lee (2018). Principles of Food Chemistry, 4th Edition, Springer Publications.
2. Vickie A. Vaclavik, Elizabeth W. Christian & Tad Campbell (2020). Essentials of Food Science (Food Science Text Series), 5th Edition, Springer Publications.
3. H. D. Belitz & W. Grosch (2013). Food Chemistry, 2nd Edition, Springer Science & Business Media.
4. Srinivasan Damodaran, Kirk L. Parkin & Owen R. Fennema (2008). Fennema's Food Chemistry, 4th Edition, CRC Press/Taylor & Francis, Boca Raton.
5. Steve W. Cui (2012). Food carbohydrates: chemistry, physical properties, and applications, CRC Press Taylor & Francis Group.
6. Akoh, Casimir C., (2017). Food Lipids: chemistry, nutrition, and biotechnology, 4th Edition, Boca Raton: Taylor & Francis.

First Semester MSc. Food Science and Technology

Course Core Content

(PH 592.2) **Principles of Food Processing and Preservation**

Credits: **4** Total Hours: **56**

Course Outcomes

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

CO1: Evaluate the source and variability of raw food material and their impact on food processing operations.

CO2: Analyze the spoilage and deterioration mechanisms in foods and methods to control deterioration and spoilage.

CO3: Develop the unit operations required to produce a given food product.

CO4: Evaluate the principles and current practices of processing techniques and the effects of processing parameters on product quality.

Unit I: **Scope and importance of food processing** **16 Hours**

Scope and importance of food processing in the present scenario, Factors affecting various food spoilage: Physical, Chemical, Microbial. Conventional preservation methods: Pickling, Salting, Smoking and Sugar addition. Types of heat treatments and its effects on foods, heat preservation and processing: UHT and HTST. Thermal death time: Determination of process time. Canning: Introduction, principles and processing of foods. Water activity: Role of water activity in food preservation; Intermediate Moisture Foods (IMF): Principles, Characteristics, advantages and problems of IM foods. Food Frying: Principles and process: shallow frying, deep frying and frying oils. Mechanism of Oil uptake during frying: Factors affecting the frying process.Vacuum frying method, advantages, possible applications, economical feasibility.

Unit II: Processing and Preservation by Drying and Dehydration **12 Hours**

Drying process, drying curves. Different drying methods and types of dryers; Dehydration and Concentration: Changes in foods during dehydration and concentration. Rehydration and reconstitution of food. Separation and concentration of food components, their applications in food industries. Different types of evaporators

Unit III: **Processing and Preservation by low temperature** **12 Hours**

Refrigeration: Principles, components, refrigeration load - and its effect on storage, changes in foods during

refrigeration. Freezing: Freezing curves, freezing methods, slow and quick freezing, factors determining freezing rate, frozen storage, changes in food during freezing. Chilling: Equipment, Cold storage, application in fresh and processed foods, Reefer units for frozen food transportation.

Unit IV: **Processing and Preservation by Novel Technologies** **16 Hours**

Green Technologies for Food Processing and the feasibility of their applications in the food industries: Super critical fluid extraction, Ultrasound treatment, High pressure processing (HPP), Pulse electrical field (PEF), Ohmic heating, Microwave processing, Food irradiation (x-rays, gamma rays and electron beam), Interaction of radiation with food components, non-thermal plasma, Ozone treatment, Electrolyzed water, Anti-microbials Principles and applications of Hurdle technology. Life Cycle Assessment (LCA) tool for assessing environmental impact of food products Packaging materials designed for processed foods. Food preservatives: Types, uses and effects of class I and class II preservatives in foods.

Recommended Books and References:

1. Romain Jeantet, Thomas Croguennec (2016). *Handbook of Food Science and Technology 2:* Food Process Engineering and Packaging. Wiley-ISTE.
2. Romeo T. Toledo, Rakesh K singh (2018). *Fundamentals of Food Processing Engineering (*4e). Springer.
3. Peter J Fellows (2016). *Food Processing Technology: Principles and Practice (4e).* Woodhead publishing/Elsevier Science.
4. Berk, Zeki (2018). *Food Process Engineering and Technology (3e).* Academic Press.
5. Tzia, Constantina (2016). *Handbook of Food Processing: food safety, quality, and manufacturing processes*. CRC Press.
6. Sankar Chandra Deka, Dibyakanta Seth (2020). *Technologies For Value Addition In Food Products And Processes*. Apple Academic Press.
7. O.P. Chauhan (2019). *Non-Thermal processing of foods*. CRC Press.
8. Chemat, Farid (2019). *Green Food Processing Techniques: Preservation, Transformation and Extraction*. Academic Press.
9. Smith, J. S., & Hui, Y. H. (Eds.). (2008). *Food processing: principles and applications*. John Wiley & Sons.

First Semester MSc. Food Science and Technology

Course Core Content

(PH 593.1) **Fruits and Vegetables Processing Technology**

Credits: **4** Total Hours: **56**

Course outcome:

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

CO1: Improved learning of the concepts of physiological characteristics of fruits and vegetables.

CO2: To understand in detail about fruit losses during storage and ways to prevent it.

CO3: Thorough Knowledge and understandings of the specific processing technologies used for different foods and the various products derived from these materials.

CO4: The students gain understanding of particular aspects of the product and process involved in processing fruits and vegetables.

Unit I

Indian and global scenario of production and processing of fruits and Vegetable. Classification and composition of fruits and vegetables and their nutritional significance. Climacteric and non-climacteric fruits; Pre-harvest factors influencing post-harvest physiology, post-harvest handling, post-harvest treatments, edible coatings in fruits. Physical and chemical indices of fruit maturity, Biochemical changes during ripening.

Unit II

Pre-processing operations: washing, blanching, peeling, sorting and grading of fruits and vegetables; Pre cooling, Minimal processing of fruits and vegetables; Pre-storage treatments; Preserving the colour, flavour and nutrient content of the products. Storage studies: Controlled Atmosphere (CA) Modified atmospheric storage of fruits and vegetables and hypobaric storage and recent developments. Canning of fruits and vegetables, Dehydration and Freezing of Fruits and Vegetables. Processed Fruit and Vegetable product standards

Unit III

Process technologies for development of jam, jellies and marmalades; Role of pectin and theories of gel formation. Fruit juice production: Juice extraction and clarification, methods of bottling. Fruit

juice concentrates, Intermediate Moisture Foods (IMF), powders-preparation and specifications. Fruit beverages: Squash, Cordial, Crush, Ready to Serve (RTS), Ready to Drink (RTD), Ready to Eat (RTE), nectar and syrups. Fruit and Vegetable Fibres. Processing of Tomato and Tomato products. Natural colors, mushroom and its value-added products. Value added products of Banana and Beans.

Referencess:

1. Fellows, P. J. (2022). Food processing technology: principles and practice. Woodhead publishing.
2. Luh, B. S. (2023). Principles and applications of vegetable processing. In Processing Vegetables (pp. 3-48). Routledge.
3. W.V Cruess (2004): Commerical Fruit and Vegetable Products. Allied Scientific Publishers. Bikaner (India)
4. A.K. Thompson: Fruit and Vegetables – Harvesting, handling and storage. Edition Blackwell Publishing, 3rd Edition (2014)
5. Srivastava and Sanjeev Kumar : Fruit and Vegetable Preservation–Principles and Practices,
6. Revised and Enlarged Third edition (2017), International Book distributing Co. Lucknow (India)
7. Er. B. Pantastico: Post harvest Physiology, handling and utilization of tropical and Subtropical fruits and vegetables. AVI Publishing Company, Inc.R.P.
8. Girdharilal Preservation of Fruits and Vegetables. ICAR, New Delhi Thord Edition (2009)
9. Dauthy, M.E. Fruit and Vegetable Processing. International Book Distributin Co. Lucknow,
10. India. II *Edition*, NIIR Publications, *India*, 2004 Hamson, L.P. Commercial Processing of Vegetables. Noyes Data Corporation, New Jersey.
11. Post-Harvest Management and Processing of Fruits and Vegetables (English, Paperback, G K Mathur, S S Chasta, N S Rathore) Edition 2012
12. Advances in Postharvest Fruit and Vegetable Technology (Contemporary Food Engineering) Ron B.H. Wills, John Golding , 1st Edition (June 2015).
13. Vaclavik, V. A., & Christian, E. W. (2008). Essentials of Food Science (3rd ed. 2008.). New York, NY: Springer New York : Imprint: Springer

First Semester MSc. Food Science and Technology

Course Core Content

(PH 596.1) **Processing of Milk and Dairy Products**

Credits: **3** Total Hours**: 42**

Course Outcomes

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

CO1: Understand the manufacturing processes of various dairy products, while implementing quality control measures throughout the production chain.

CO2: Analyze the historical evolution, strengths, and global positioning of the dairy industry in India to discern operational dynamics effectively and propose strategies for industry advancement.

CO3: Evaluate knowledge of the physico-chemical properties of milk and their applications in dairy product processing to innovate product development and meet market demands effectively.

CO4: Synthesize information on the composition, processing techniques, and defects of different dairy products, to optimize production processes.

Unit I **14 Hours**

Dairy industry in India: scope, strengths and opportunities for dairy industry, operation flood, cooperative dairy organizations, Anand pattern, and perspectives. Milk: definition, biosynthesis of milk, composition and nutritive value, sources and types of milk, factors affecting composition of milk. Physico-chemical properties of milk. Milk fat structure, fat destabilization; Milk proteins and their types; Precipitation (casein micellar structure and its aggregation). Quality control tests.

Unit II **14 Hours**

Steps involved in the production of market milk, Storage and processing of milk: chilling, pasteurization (LTHT & HTST), sterilization (Retort), homogenization, UHT Processing. Clarification and standardization of milk. Membrane processing of milk: Microfiltration, Ultrafiltration and Reverse osmosis in dairy industry. Aseptic packaging.

Condensed and evaporated milk: Composition, process of manufacture, defects. Technology of milk powders – Whole Milk Powder (WMP) and Skimmed Milk Powder (SMP): Composition, process of manufacture, defects. Instantization of milk powder. Introduction of starter cultures & their importance in dairy industry. Technology of Cheese: Classification, Nutritive value,

processing of cheddar, mozzarella cheese, defects. Technology of frozen milk products: Composition, process of manufacture, defects. Technology of milk products: Butter, Yoghurt, Shrikhand, Ghee, Channa and Cream.

Unit III **14 Hours**

Novel concepts in dairy products: Cream powder, sterilized cream, butter spread, butter powder, cheese spread, whey protein concentrates, Lactose powder, infant milk powder. Standards for Milk and its products. Adulterated and Synthetic milk, Bio-preservatives-characteristics and their applications in enhancing the shelf life of dairy. Dairy plant sanitation: Hygiene in dairy Industry, CIP, different types of cleansing, cleansing and sanitizing agents

Recommended Books and References:

1. Jenness, R., Patton, S., 2018. Principles of dairy chemistry. Medtech, a division of Scientific International, New Delhi.
2. Le Floch-Fouéré, C., Schuck, P., Tanguy, G., Lanotte, L., Jeantet, R. (Eds.), 2021. Drying in the dairy industry: from established technologies to advanced innovations, First edition. ed, Advances in drying science & technologies. CRC Press, Boca Raton London New York.
3. Hilton Deeth, Phil Kelly, 2020. Processing And Technology Of Dairy Products. MDPI AG, S.l.
4. Hui, Y.H., 1993. Dairy science and technology handbook. VCH, New York, N.Y.
5. Singh, P.K., 2017. Advances in dairy science technology. Educationist Press, an imprint of Write & Print Publications, New Delhi.
6. Birendra Kumar Mishra, Subrota Hati, 2016. Dairy and food product technology. Biotech Books, New Delhi.
7. Singh, S., 2020. Milk and Milk Processing: Vol.01: Dairy Technology. New India Publishing Agency (NIPA), New Delhi.
8. Truong, T. (Ed.), 2021. Dairy fat products and functionality: fundamental science and technology. Springer, Cham, Switzerland.

First Semester MSc. Food Science and Technology

Course Core Content

(PH 597.1) Waste Management and Environmental Sustainability

Credits: **3** Total Hours: **42**

Course outcomes

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

CO1: Learn physical/chemical/biological characteristics of industrial waste water and to understand the theory, engineering application, and design technique for the industrial wastewater treatment unit processes.

CO2: Design various environmental structures like water treatment plants, waste water treatment systems and air pollution control equipment.

CO3: Better understanding of solid waste remedial measures and their importance and undertake projects related to solid waste management.

CO4: A sound understanding of the principal environmental policy issues

Unit I **14 Hours**

Introduction: Indian and global scenario of waste generated, Classification of waste: solid and liquid waste, Solid waste: storage and disposal methods - land-filling, burial, incineration, recycling. Storage and disposal methods of liquid and gaseous waste. Legal aspects related to storage and disposal. Standards for emission or discharge of environmental pollutants from food processing industries. legislation related to environmental management (NGT, CPCB). Waste regulations-national and international scenario.

Unit II **14 Hours**

Biological treatment of food industry wastes. Recycling of food industry waste. Waste water treatment: Ion exchange treatment of waste water. Physical, chemical and biological characteristics of waste water. Measurement of organic content in waste water. Physical, chemical and biological unit operations in waste water treatment. Effluent treatment plants (ETPs). Zero liquid Discharge: Challenges, Technologies (Solvent extraction, Evaporation technologies, Membrane Bioreactor Technology (MBR).

Unit III **14 Hours**

Types of waste generated, characterization and utilization of by-products of food industrial wastes from cereals, pulses, oilseeds, fruits, vegetables, beverage, sugar, dairy, eggs, meat, fish and poultry processing industries. Methods of utilizing wastes to make value added products: Pectin, food colourants, antioxidants from fruit peels (citrus, mango, pomegranate), lycopene from tomato peels, biomolecules and enzymes from food processing industries. Detailed understanding of the various type of industrial waste generated and the importance of waste management and byproduct utilization from food industrial wastes.

Recommended Books and References:

1. Robert R. Zall (2004), Managing Food Industry Waste: Common sense methods for Food Processors, Blackwell Publishing.
2. Robertson, M. (2021). *Sustainability principles and practice*. Routledge.
3. Nath, P. C., Ojha, A., Debnath, S., Sharma, M., Nayak, P. K., Sridhar, K., & Inbaraj, B. S. (2023). Valorization of food waste as animal feed: a step towards sustainable food waste management and circular bioeconomy. *Animals*, *13*(8), 1366.
4. Bhatia, L., Jha, H., Sarkar, T., & Sarangi, P. K. (2023). Food waste utilization for reducing carbon footprints towards sustainable and cleaner environment: a review. *International Journal of Environmental Research and Public Health*, *20*(3), 2318.
5. Loannis S. and Arvanito yannis (2008). *Waste Management in Food Industry*, Academic Press.
6. Ioannis S. Arvanitoyannis (2010) Waste Management for the Food Industries, Publisher: Academic Press, London.
7. Charis M. Galanakis (2015) *Food Waste Recovery*: Processing Technologies and Industrial Techniques Academic Press, London.
8. SpringerLink (Online service), Oreopoulou, V., & Russ, W. (2007). Utilization of By-Products and Treatment of Waste in the Food Industry (1st ed. 2007.). New York, NY: Springer US : Imprint: Springer.
9. Maria Kosseva and Colin Webb (2013). *Food Industry Wastes: Assessment and Recuperation of Commodities*. Academic Press, London, UK.
10. Vasso Oreopoulou & Winfried Russ (2006). *Utilization of By-Products and Treatment of Waste in the Food Industry*. Springer Science & Business Media.

11. Elena Cristina Rada (2016) *Waste Management and Valorization: Alternative Technologies*. CRC Press.
12. Garrett Leonard Riley (2016) *Food Waste: Practices, Management and Challenges*. Nova Science Publishers.
13. Metcalf and Eddy Inc. (2003). *"Wastewater Engineering - Treatment and Reuse"*. 4th Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

I Semester M.Sc. Food Science and Technology

Core Lab Course Content

(PH 594.1P) **Food Chemistry & Preservation**

8 Hours/week

Credits:**4** Total hours: **96**

Course Outcomes

On completion of this practical the students will be able to:

CO1: Analyze the chemical composition of different food items and understand how various chemical compounds contribute to their flavor, texture, and nutritional value.

CO2: Analyze the principles of food preservation techniques such as canning, freezing, and drying, and evaluate their effectiveness in preserving food quality and safety.

CO3: Evaluate the impact of different preservation methods on the sensory characteristics, nutritional content, and shelf-life of food products.

CO4: Design and implement experiments to develop innovative food preservation techniques that address specific challenges in food processing and storage.

List of Experiments

1. Determination of moisture content in food sample
2. Determination of crude fat content /oil content by Soxhlet method
3. Estimation of total lipid content in egg yolk
4. Determination of Acid value or Free fatty acids of the oil sample
5. Estimation of crude protein by Kjeldahl method
6. Estimation of protein in food sample by Biuret/Lowry's method
7. Determination of ash content in food
8. Determination of crude fiber content
9. Estimation of Ascorbic acid in food sample
10. Estimation of Calcium in milk sample.
11. Food Preservation by Conventional methods: Pickling, Salting, Vinegar, Smoking and Sugar addition.
12. The effect of dry heat methods (open pan) on the physiological and sensory properties of vegetables.

13. The effect of moist heat (closed pan) on the physiological and sensory properties of vegetables.
14. Measuring of oil uptake of vegetables: Deep fat frying
15. Measuring of oil uptake of vegetables: Shallow fat frying
16. Drying of the vegetables – measuring the moisture loss, water activity calculation.
17. Freeze drying of vegetables – physiological changes and comparison studies with their traditionally dried counterparts.
18. Blanching of vegetables before freezing and sensory evaluation, comparison with controls.
19. Enzymatic browning of fruits and vegetables using different solutions: observing the browning process and evaluating the best method for each fruit and vegetable.
20. Concentration of milk by open pan evaporation method.

Recommended books and References

1. Miller, D. D., & Yeung, C. K. (2022). *Food chemistry: A laboratory manual*. John Wiley & Sons.
2. Horwitz, W., & Latimer, G. W. (2000). Association of official analytical chemists. (2010). *Official methods of analysis of AOAC international*.
3. Wrolstad, R. E., Acree, T. E., Decker, E. A., Penner, M. H., Reid, D. S., Schwartz, S. J., ... & Sporns, P. (Eds.). (2005). *Handbook of food analytical chemistry, volume 1: Water, proteins, enzymes, lipids, and carbohydrates*. John Wiley & Sons.
4. Baur, F. J., & Ensminger, L. G. (1977). The association of official analytical chemists (AOAC). *Journal of the American Oil Chemists' Society*, *54*(4), 171-172.
5. Karel, M., & Lund, D. (2003). *Physical principles of food preservation: revised and expanded*. CRC Press.
6. Prokopov, T., & Tanchev, S. (2007). Methods of food preservation. In *Food safety: A practical and case study approach* (pp. 3-25). Boston, MA: Springer US.

First Semester MSc. Food Science and Technology

Core Lab Course Content

(PH 595.1P) Processing Technology: Milk, Fruits, Vegetables, and their Products

8 Hours/week

Credits:**4** Total hours: **96**

Course Outcomes

On completion of this practical students will be able to:

CO1: To demonstrate proficiency in various methods of processing fruits, vegetables, milk, and dairy products.

CO2: Analyze the factors influencing the quality and shelf life of processed fruits, vegetables, milk, and dairy products.

CO3: In order to critically evaluate the efficiency and effectiveness of different processing methods and technologies in terms of product quality and safety.

CO4: To create new dairy products through the application of advanced processing techniques, considering consumer preferences and market trends.

List of Experiments

1. Sanitary collection of Milk samples.
2. Determination of protein content in milk and milk products.
3. Determination of fat content in milk by Gerber method
4. Determination of total solids in milk
5. Extraction of casein from milk
6. Determination of salt content in butter.
7. Preparation of Paneer/ Cottage cheese.
8. Rapid Platform tests to determine the quality of milk.
9. Determination of the Specific gravity of milk.
10. Processed milk quality assessment
11. Determination of lactose content in milk by the Lane-Eyon method.
12. Preparation of milk powder by Lyophilization.
13. Determination of physical quality parameters in fruits and vegetables
14. Determination of Pectin strength.
15. Estimation of Titrable acidity and TSS in fruit juices
16. Preparation and sensory evaluation of Pickle.

17. Preparation of Jam.
18. Analysis of Tomato Ketchup
19. Tomato Processing (Soup, Chutney, Puree and Paste)
20. Preparation of Jelly.

Recommended Books and References

1. Food Safety & Standard Authority of India (FSSAI) (2012). Manual of methods of analysis of foods (milk & milk products). Ministry of Health & Family Welfare, Government of India New Delhi p1-22
2. Food Safety & Standard Authority of India (FSSAI) (2012). Manual of methods of analysis of foods (fruits and vegetable products). Ministry of Health & Family Welfare, Government of India New Delhi p1-22
3. Dar, A. H., Kumar, N., Shah, S., Shams, R., & Aga, M. B. (2022). Processing of fruits and vegetables. In Agro-Processing and Food Engineering: Operational and Application Aspects (pp. 535-579). Singapore: Springer Singapore.
4. Nielsen, S. S. (Ed.). (2003). Food analysis laboratory manual (p. 557). New York, NY, USA:: Kluwer Academic/Plenum Publishers.
5. Nollet, L. M. (2004). Handbook of Food Analysis-3 Volume Set.
6. Schuck, P., Jeantet, R., & Dolivet, A. (2012). Analytical methods for food and dairy powders. John Wiley & Sons.

Second Semester M.Sc. Food Science and Technology

Core Course Content

(PH 591.2) **Food Process Engineering and Instrumentation**

Credits: **4** Total Hours: **56**

Course Outcomes:

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

CO1: Repeat the basics of units, dimensions and conversions of units

CO2: Understand the nature and properties of various fluids and instruments used in food industries

CO3: Describe the different types of boilers, accessories and its application in food industries

CO4: Analyze the different materials used in plant construction

Unit I: Units and Dimensions **14 Hours**

Introduction, Classification of Unit and Dimensions Systems, Conversion of Units. **Mass:** Conservation of mass, open system, closed system and material balance. Energy: Forms of Energy, Heat Energy and Enthalpy. Steam and Its Properties: Formation of Steam. Humidity and Psychrometric chart.

Unit Operation: Unit operations in Food Processing. Boilers, types of boilers and accessories.

Unit II: **Engineering Properties** **14 Hours**

Mechanical, Thermal and Electrical properties of food. Materials for food plant construction: Mild Steel (MS), Stainless Steel (SS). Corrosion in metals. Laws of Thermodynamics.

Fluid Mechanics: Introduction, Nature of properties of fluids, Viscosity and Consistency. Newtonian and Non-Newtonian Liquids. Rheology: Basic, Equipment's and Simple Rheological Models. Pumps for food plants. Flow measuring devices, viscosity measuring devices.

Unit III: Heat and Mass Transfer **14 Hours**

Theory of Heat Transfer, Classification of Heat Transfer Processes. Mechanisms of Heat Transfer: Conduction, Convection and Radiation. Heat exchanger, Boiling, Condensation and Evaporation. Freezing and Thawing. Thermal Processing of Foods. Fouling of heat transfer surfaces.

Mass Transfer: Classification, Theories and Laws of Mass Transfer. Factors affecting Mass Transfers.

Unit IV: Food samples and sampling techniques **14 Hours**

Food samples and sampling techniques, Sensory analysis of foods, Electronic evaluation of sensory attributes – Electronic nose, Electronic tongue. Colour measurement in foods, Texture analysis in foods, Principles and application of Spectrophotometer, Infrared Moisture analyzer, Gas Chromatography (GC),

High Performance Liquid Chromatography (HPLC), Fourier-transform infrared spectroscopy (FTIR) and Atomic absorption spectrometry (AAS) . Enzyme kinetics and enzyme immobilizatio

Recommended Books and References:

1. Anandha Ramakrishnan, C. & Padma Ishwarya, S. (2019). *Essentials and Applications of Food Engineering*, Publisher: Taylor & Francis Group, CRC Press, International Standard Book Number 13: 978-1-138-36655-8.

2. Paul Singh, R. & Dennis, R. (2020). *Introduction to Food Engineering*, Publisher: Elsevier Science & Technology, 5th Edition, ISBN: 9780123985309, 2013.

3. Romeo T. Toledo. (2000). *Fundamentals of Food Process Engineering* Publisher: CBS, 2nd Edition, ISBN: 0-412-05311-X.

4. Hosahalli S. Ramaswamy & Michele Marcotte. (2005). *Food Processing: Principles and Applications,* Publisher: CRC Press. ISBN-13: 978-1587160080.

5. Zeki Berk. (2009). *Food Process Engineering and Technology*, Publisher: Elsevier Science & Technology. ISBN: 978-0-12-373660-4.

6. Smith, P.G. (2009). *Introduction to Food Process Engineering,* Publisher: Springer Press, 2nd Edition, ISBN 978-1-4419-7661-1.

7. Subbulakshmi G. & Shobha A. Udupi. (2001). *Food Processing and Preservation*, Publisher: New Age International Pvt. Ltd., ISBN: 8122412831.

8. Bird, R. Byron, Stewart & Warren E. Lightfoot. (2009). *Transport Phenomena*, Publisher: Academic Internet Publishers, 2nd Edition.

9. Pomeranz,Y. & Mrloan. (1978). *Food Analysis: Theory and Practice*, Westport, connectiant: AVI.

10. Amerine, M.A. Pangborn, R.M., & Rosseler, E.B. (1965). *Principles of Sensory Evaluation of Food*. Publisher: Academic Press, New York.

Second Semester M.Sc. Food Science and Technology

Core Course Content

(PH 592.2) Processing Technology of Cereals, Pulses and Oilseeds

Credits: **4** Total Hours: **56**

Course Outcomes

On Completion of this Course students will be able to:

CO1: Analyse the processing techniques and physicochemical characteristics of cereals, pulses, and oilseeds

CO2: Design and develop value-added products from grains and legumes

CO3: Examine the utilization of byproducts from processing operations

CO4: Propose sustainable methods for waste reduction and value addition

CO5: Discuss the socio-economic and nutritional implications of cereal, pulse, and oilseed processing technologies

Unit I: Wheat and Wheat Products 14 Hours

Wheat: Types and physicochemical characteristics; wheat milling -products and byproducts; factors affecting quality parameters; physical, chemical and rheological tests on wheat flour. Bread manufacturing, role of ingredients, bread faults, staling. Additives used in bakery products: Flour improvers, leavening, bleaching agents and enzymes. Technology of bakery products: Biscuit, cakes, pasta, macaroni. Production of starch and vital wheat gluten. Corn: Types and nutritive value; dry and wet milling, processing of corn in breakfast cereals, snacks, tortilla etc., production of glucose syrups, dextrose, high fructose corn syrups.

Unit II: Rice and Products 14 Hours

Rice: Classification, physicochemical characteristics; cooking quality; rice milling technology; byproducts of rice milling and their utilization; Rice bran stabilization, oil extraction and refining, parboiling methods of rice criteria of quality of rice: aging of rice – quality changes; Rice products: Flaked rice, parched rice, puffed rice; Fermented products (idli, dosa, miso and sakè). Barley: composition, milling, malting of barley, chemical and enzymatic changes during malting, uses of malt. Oat: composition, processing of oat, byproducts of oatmeal milling. Ragi and Jowar: Structure and composition, processing methods.

Unit III: Pulses and Legumes **14 Hours**

Pulses and Legumes: Status, production and major growing areas of in India and worldwide; Structure and chemical composition of pulses and legumes; Anti nutritional factors; Milling and processing of pulses; Utilization of pulses and legumes for value added products; Extrusion cooking technology; Snack foods; Development of low-cost protein foods; Protein concentrates and isolates.

Unit IV: Oil and Oilseeds **14 Hours**

Oilseeds: Sources and composition; Oil extraction process – mechanism, solvent, SCE, oil refining, utilization of biproducts of oil milling; Factors affecting extraction; Utilization of oil mill by-products; packing and storage of fats and oils, physio-chemical properties of oils, changes during storage; Nutritional food mixes from oilseeds.

Recommended Books and References:

- Neelam, Grewal Raj Bala & Khetarpaul (2019). Bakery Science and Cereal Technology, Daya Publishing House.
- Liangli L. Yu, Rong Tsao, Fereidoon Shahidi (2012). Cereals and Pulses: Nutraceutical Properties and Health Benefits, Wiley and Blackwell publisher.
- Rosentrater K.A & Evers A.D (2018). Kent's Technology of Cereals. 5th Edition. Woodhead publishing, Oxford, UK.
- Brijesh K Tiwari, Aoife Gowen, Brian McKenna (2011). Pulse Foods: Processing, Quality and Nutraceutical Applications, Food Science and Technology, International series, Academic press.
- Chakraverty. A (2019). Post-Harvest Technology of Pulses, Legumes and Oilseeds, Oxford & IBH Publishing Company.
- Nagi H.P.S, Shrama Savita, Sekhon K.S (2012). Handbook of Cereal Technology. Kalyani publisher. New Delhi.

Second Semester M.Sc. Food Science and Technology

Core Course Content

(PH 595.2) Spices and Plantation Crops Technology

Credits: **3** Total Hours: **42**

Course Objectives

On completion of this course the students will be able to**:**

CO1. Understand the technologies of post-harvest processing of spices and plantation crops and their role in providing better quality produce to the consumer.

CO2. Apply knowledge of spice processing techniques to assess and address issues related to adulteration, ensuring compliance with standard specifications and quality control measures.

CO3. Assess the effectiveness of processing methods of horticultural crops processing methods, incorporating sensory evaluation, grading standards, and value addition to ensure consistency and excellence in final products

CO4. Evaluate the impact of spices and plantation crops on national economic development and agricultural sustainability, trade, and export potentials.

Unit I: Processing Technology of Spices 14 Hours

Spices: Classification; Importance of plantation crops grown in India. Role of plantation crops in national economy and export potential. Processing of Indian spices: Pepper, Cardamom, Ginger, Chili, Turmeric, Clove, Garlic, Cinnamon, Mint and Vanilla. Standard specification of spices. Adulteration in spices. Processing of Oleo resins and Essential oils; Culinary herbs: Lavender, Saffron and Parsley. Fumigation and irradiation of spices. Cryogenic processing of spices.

Unit II: Processing Technology Tea and Coffee 14 Hours

Coffee: Production, Composition and Processing of coffee: Wet and Dry methods, Grading of coffee, Defects in coffee beans; Brewing of coffee; Instant Coffee technology; Methods of decaffeinating coffee. Types of coffee. Processing of chicory and its uses in coffee. Tea: Production, Chemistry and Composition; Processing of different types of tea; Technology of CTC tea. Tea products such as soluble tea, instant tea, tea concentrates, decaffeinated tea and flavored tea; Quality evaluation and grading of tea.

Unit III: Processing Technology Cocoa and its Products 14 Hours

Cocoa: Production and market statistics, Composition, Processing: Changes during fermentation; Processing of cocoa products (cocoa powder, cocoa liquor and cocoa butter) Quality control during cocoa processing. Chocolates: Nutritive value and Types; Processing of chocolates. Nuts: Composition; Processing of Coconut, Cashew nut, Arecanut, Sugarcane and Palm and its value added products.

Recommended Books and References:

1. Afoakwa, E.O., 2016. Chocolate science and technology, Second edition. ed. John Wiley & Sons Inc, Chichester, West Sussex, United Kingdom.
2. Afoakwa, E.O., 2014. Cocoa production and processing technology. CRC Press, Taylor & Francis Group, Boca Raton London New York.
3. Galanakis, C.M. (Ed.), 2017. Handbook of coffee processing by-products: sustainable applications. Academic Press, London.
4. Hii, C.L., Borém, F.M. (Eds.), 2020. Drying and roasting of cocoa and coffee. CRC Press, Boca Raton, Florida.
5. Lakshmi, P., Sung, E., 2016. The encyclopedia of spices and herbs: an essential guide to the flavors of the world, First edition. ed. Ecco, an imprint of Harper Collins publishers, New York, NY.
6. Culinary Herbs and Spices: A Global Guide, 2021. . Royal Society of Chemistry, Cambridge. https://doi.org/10.1039/9781839164446
7. McWilliams, M. (Ed.), 2021. Herbs & spices: proceedings of the Oxford Symposium on Food and Cookery 2020. Prospect Books, London.
8. Pereira, L.L., Moreira, T.R., 2021. Quality determinants in coffee production, Food engineering series. Springer, Cham.

Second Semester M.Sc. Food Science and Technology

Core Course Content

(PS 596.2) **Research Methodology and Ethics**

Credits: **3** Total Hours: **42**

Course Objectives

On completion of this course the students will be able to**:**

CO1. Understand the scientific approaches to research and analyze research subject related literature in, critically evaluating research methodologies, experimental designs, and data interpretation techniques used in published studies, and identifying strengths, limitations, and gaps in current research.

CO2. Demonstrate an understanding of the fundamental principles and concepts of research methodology in food science, including study design, data collection methods, statistical analysis, and research ethics.

CO3. Critically evaluate research proposals, experimental protocols, and research findings in food science, assessing the validity, reliability, and significance of research outcomes, and synthesizing evidence to draw informed conclusions.

CO4. Apply research methodologies and experimental techniques to design, conduct, and analyze data from food science research projects, demonstrating proficiency in data collection, statistical analysis, and scientific writing.

Unit I: Research Problem and Design **14 Hours**

Research: Types, objectives, research approaches, research and scientific methods, criterions of good research. **Research Problem:** Definition and techniques involve in defining a problem**. Research Designs**: Meaning, need for research design, features and types. Basic principles of experimental design, selection of experimental material, Essential Constituents of Literature Review.

Unit II: Sampling **14 Hours**

Need for sampling, unit, population and sample, sampling methods, Important Sampling Distributions, Central Limit Theorem and Sampling Theory, Skewness and Kurtosis. Sampling design: Steps in Sampling Design, Criteria of Selecting a Sampling Procedure, Characteristics of a Good Sample Design. Data: Collection of Primary Data and Secondary Data, Frequency distribution. Classification and summarization of data. Presentation of Data - Diagrams and Graphs.

Unit III: Introduction to statistics **14 Hours**

Measures of Central Tendency (Mean, Mode and Median); Measures of Central Dispersion (Range, Standard Deviation, Standard Error, Coefficient of Variation); Elementary Probability Theory – Addition and Multiplication – Bayes Theorem – Random Variables and Probability distribution- Binomial, Poisson, and Normal. Study of relationship between variables. Basic concept of hypothesis testing - Type I and type II errors. Tests based on Means & Proportions on Normal. Two-way analysis of variance (RBD), LSD, - Multiple comparison tests (DMRT, Bonferonni, Dunnett's). t test for independent samples, paired samples, F test two sample variances: One-way ANOVA, two-way ANOVA, Correlation & Regression (three variables). Response Surface Methodology; Theory and application in food product development.

Unit IV: **Scientific/technical writing and research presentation** **14 Hours**

Types, Structure and components of Scientific Reports; Technical Reports and Thesis; Steps in the preparation of reports and thesis layout, structure and language of typical reports, illustrations and tables, bibliography, referencing and foot notes. Citation, Impact factor, h-index and Acknowledgement. **Ethics in research:** Responsible conduct; the regulations and ethics of animal use in research; Research ethics for human subjects; Role of ethics committees in biological research; **Intellectual Property Rights (IPR):** patenting of process and products; reproduction of published material; plagiarism.

Recommended Books and References:

1. Torres, R. A., & Nyaga, D. (2021). Critical research methodologies: ethics and responsibilities (Vol. 181). Brill.
2. Iphofen, R. (Ed.). (2020). *Handbook of research ethics and scientific integrity*. Cham: Springer.
3. Bandarkar, P.L. and Wilkinson T.S. (2000): Methodology and Techniques of Social Research, Himalaya Publishing House, Mumbai.
4. Copper, H.M. (2002). Intergrating research: A guide for literature reviews (2nd Edition). California: Sage Harman, E & Montages, I. (Eds.) (2007). The thesis and the book, New Delhi: Vistar.
5. Mukherjee, R. (1989): The Quality of Life: Valuation in School Research, Sage Publications, New Delhi.
6. Stranss, A and Corbin, J. (1990): Basis of Qualitative Research: Grounded Theory Procedures and Techniques, Sage Publications, California
7. Montgomery, D. C., (2001). Design and Analysis of experiments, Fifth Edition, John Wiley & Sons.
8. Kothari, C.R. (2008). Research Methodology: Methods and Techniques. Second Edition. New Age International Publishers, New Delhi
9. Vining, G. G., Kowalski, S. (2010). Statistical Methods for Engineers.2nd Edn. Cengage Learning (RS), Boston, USA

Second Semester M.Sc. Food Science and Technology

Core Lab Course Content

(PS 593.2P) Food Process Engineering and Instrumentation

4 Hours/week

Credits:**2** Total hours: **48**

Course Outcomes

Upon completion of this course, students will be able to:

CO1: To apply principles of food process engineering to design, operate, and optimize various food processing equipment and unit operations

CO2: Analyze the physical and chemical properties of food materials and their impact on food processing operations.

CO3: Critically evaluate the use of instrumentation and control systems in food processing, and recommend improvements for enhanced process control and automation.

CO4: Design and develop new food processing techniques and strategies to improve the efficiency and sustainability of food production processes

List of Experiments

1. Psychrometric chart
2. Determination of density, specific gravity and viscosity
3. Determination of percentage loss and milling rate by Hammer mill
4. Determination of settling velocity
5. Difference test (sensitivity and threshold test)
6. Determination of bulk and tap density
7. Drying kinetics
8. Spray drying
9. Colour measurements
10. Texture analysis
11. Determination of material thickness by Screw Gauge
12. Determination of material thickness by Vernier Caliper

Recommended Book and References

1. Valentas, K. J., Rotstein, E., & Singh, R. P. (1997). Handbook of food engineering practice. CRC press.
2. Sun, D. W. (Ed.). (2011). Handbook of food safety engineering. John Wiley & Sons.
3. Barbosa-Cánovas, G. V., Ma, L., & Barletta, B. J. (2017). Food engineering laboratory manual. CRC Press.
4. Saravacos, G. D., & Kostaropoulos, A. E. (2002). Handbook of food processing equipment (Vol. 2012, pp. 331-381). Kluwer Academic/Plenum.
5. Toledo, R. T., Singh, R. K., & Kong, F. (2007). Fundamentals of food process engineering (Vol. 297, p. 211). New York: Springer.
6. Loncin, M. (2012). Food engineering: principals and selected applications. Elsevier.

Second Semester M.Sc. Food Science, Nutrition & Dietetics

Core Lab Course Content

(PH 594.2P) **Processing of Cereals & Spices**

8 Hours/week

Credits:**4** Total hours: **96**

Course Outcomes

Upon completion of this course, students will be able to:

CO1: Demonstrate various processing techniques for cereals, pulses, oilseeds, spices, and plantation crops to preserve quality and enhance shelf life.

CO2: Analyze the physical and biochemical properties of cereals, pulses, oilseeds, spices, and plantation crops and their impact on processing technologies.

CO3: Critically evaluate the use of processing technologies and equipment, identifying opportunities for improvement and optimization in the processing of cereals, pulses, oilseeds, spices, and plantation crops

CO4: Create new value-added products from cereals, pulses, oilseeds, spices, and plantation crops by integrating advanced processing technologies and techniques.

List of Experiments

1. Physical test for cereal grains
2. Cooking of Pulses
3. Fermentation power of yeast
4. Determination of gelatinization temperature
5. Determination of functional properties of cereal grains
6. Determination of cooking quality of rice
7. Preparation of cake
8. Preparation of peanut butter
9. Preparation of cookies
10. Preparation of pasta
11. Extraction of caffeine from tea/coffee.
12. Detection of adulterants in coffee/tea.
13. Detection of adulterants in spices
14. Extraction of essential oils from spices
15. Detection of theobromine content in chocolates.
16. Determination of scavenging activity of spices by DPPH method

17. Extraction of volatile oils from spices
18. Determination of specific gravity/density of oils.
19. Method of measuring colour value in capsicum
20. Preparation of different types of coffee.

Recommended Book and References

1. Panda, H. (2010). Handbook on spices and condiments (cultivation, processing and extraction). ASIA PACIFIC BUSINESS PRESS Inc..
2. Brennan, J. G., & Grandison, A. S. (Eds.). (2012). Food processing handbook. Weinheim, Germany:: Wiley-Vch.
3. Food Safety & Standard Authority of India (FSSAI) (2012). Revised Manual on Spices, Herbs and Condiments. Ministry of Health & Family Welfare, Government of India New Delhi
4. Ruiz-de-Cenzano, M., Rochina-Marco, A., Cervera, M. L., & de la Guardia, M. (2015). Cereals and pulses. Handbook of Mineral Elements in Food, 521-557.
5. Raghavan, A. S. M. G. V., & Ramaswamy, H. S. (2003). Handbook of Postharvest Technology Cereals, Fruits, Vegetables, Tea, and Spices.

Second Semester M.Sc. Food Science & Technology

Open Elective Course Content

(PO 598.2) **Essentials of Food Science**

Credits: **3** Total hours: **42**

Course Outcomes:

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

CO1: Investigate the history and evolution of food processing

CO2: Establish the knowledge of the structure, composition, nutritional quality and post-harvest changes in various plant foods.

CO3: Evaluate the structure and composition of various animal foods.

CO4: Analyze the processing methods of dairy products.

Unit-I : Cereals **14 Hours**

Rice, wheat and Millets - Structure Composition and Nutritive Value. Milling of wheat and rice. Starch: Sources, Principles of Starch cookery. Types of Batter and Dough, Dough rheology. Leavening agents, Cake manufacturing and role of ingredients. Pulses: Sources, Structure and Composition; Milling and processing,

Unit-II : Fruits and Vegetables **14 Hours**

Composition, Classification, Nutritive value, role of Pectin; Postharvest handling, Pre-processing operations. Canning of fruits and vegetables. Spices and Condiments: Pepper, Clove, Cinnamon, Ginger and Cardamom; Adulteration in Spices.

Unit-III: Dairy Science **14 Hours**

Definition, composition and nutritive values, Sources and types of milk. Milk fat structure, Milk protein types. Processing of milk: Pasteurization (LTHT & HTST). Cheese: Classification, types, processing of cheddar cheese. Egg: Structure, Composition, Nutritive value, Quality evaluation of egg, Grading, egg storage and preservation methods, egg products. Meat: Structure, Composition, Nutritive value, Methods of stunning and slaughtering, Aging and meat tenderization, Storage and preservation of meat. Fish: Composition, Nutritive value, classification, post-harvest changes in fish, factors affecting quality of fish, preservation methods.

Recommended Books and References:

1. Rupesh S. Chavan, Megh R. Goyal (2018). *Technological Interventions in Dairy Science*. CRC Press.
2. Ashok Kumar Agrawal, Megh R. Goyal (2017). *Processing Technologies for Milk and Milk Products*. Apple Academic Press Inc.
3. Kurt A. Rosentrater, A. D. Evers (2018). *Kent's Technology of Cereals (5e)*. Woodhead Publishing.
4. Sneh Punia, Anil Kumar Siroha, Manoj Kumar (2022). *Handbook of Cereals, Pulses, Roots and Tubers – Functionality, health benefits and applications*. CRC Press.
5. Elhadi M. Yahia (2019). *Postharvest Physiology and Biochemistry of Fruits and Vegetables*. Woodhead Publishing.
6. Derrick B. McCarthy (2017). *Meat and Meat Processing*. Nova Science Publishers.
7. Daneysa Lahis Kalscchne, et. al. (2020). *Advances in Meat Processing Technologies: Modern Approaches to Meet Consumer Demand*. Bentham Science Publishers.
8. Rabinarayana Mishra (2022). *Handbook on Fish Processing and Preservation*. CRC Press.

Third Semester MSc. Food Science & Technology

Course Core Content

(PH 591.3) **Food Microbiology**

Credits: **4** Total Hours: **56**

Course Outcomes:

On Completion of this Course the students will be able to:

CO1: Understand the fundamentals of food microbiology.

CO2: Learn the novel methods for detection of immunological components.

CO3: Study the criteria for microbiological assessments in various food products.

CO4: understand the food borne pathogens and toxins produced by them and its health effect.

Unit I **12 Hours**

Introduction, Scope, Historical developments of General and Food Microbiology; Classifications of microorganisms; Bacterial group based on morphology - gram positive, gram negative, motile, non-motile, sporulating and non-sporulating. Different sources of microorganisms in foods; Microbial growth curve, factors (intrinsic and extrinsic) affecting growth of microorganisms.

Unit II **16 Hours**

Natural micro flora of various foods**:** Food spoilage and microbes of Milk, Fish, Meat, Poultry and other products. Contamination, Preservation and Spoilage of Cereals, Sugars, Fruits and Vegetable products. Measures to prevent microbial food poisoning, Microorganisms important in Foods. Isolation and Detection of Microorganisms: Conventional methods, Rapid methods, Immunological methods, Fluorescent anti body, Radioimmunoassay, ELISA and PCR.

Unit III **14 Hours**

Food microbiology and Public health: Food - borne Illness; Food - borne Poisoning, Infections and Intoxications: Bacterial agents of food poisoning by *Salmonella, Bacillus cereus, Listeria, Clostridium, Staphylococcus*. Non-bacterial agents of food poisoning: Poisonous algae and protozoa. Food poisoning by Fungus: Mycotoxins. Food -borne illness by Viruses.

Unit IV **14 Hours**

Food Sanitation and Control: Indicator microorganisms for monitoring the quality of foods Ex. *E coli*. Emerging food borne pathogens, recent examples of food borne disease outbreaks. Microbiological criteria for foods such as Milk, fish and meat products. HACCP. Enforcement and Control agencies (Codex, FDA and FSSAI).

Recommended Books and References:

7. John M. deMan, John W. Finley, W. Jeffrey Hurst & Chang Yong Lee (2018). Principles of Food Chemistry, 4th Edition, Springer Publications.
8. Yousef, A. E., Waite-Cusic, J. G., & Perry, J. J. (2022). *Analytical food microbiology: A laboratory manual*. John Wiley & Sons.
9. Dubey, R. C., & Maheshwari, D. K. (2023). *A textbook of microbiology*. S. Chand Publishing.
10. Vickie A. Vaclavik, Elizabeth W. Christian & Tad Campbell (2020). Essentials of Food Science (Food Science Text Series), 5th Edition, Springer Publications.
11. H. D. Belitz & W. Grosch (2013). Food Chemistry, 2nd Edition, Springer Science & Business Media.
12. Srinivasan Damodaran, Kirk L. Parkin & Owen R. Fennema (2008). Fennema's Food Chemistry, 4th Edition, CRC Press/Taylor & Francis, Boca Raton.
13. Steve W. Cui (2012). Food carbohydrates: chemistry, physical properties, and applications, CRC Press Taylor & Francis Group.
14. Akoh, Casimir C., (2017). Food Lipids: chemistry, nutrition, and biotechnology, 4th Edition, Boca Raton: Taylor & Francis.

Third Semester MSc. Food Science & Technology

Core Course Content

(PH 592.3) Nutraceuticals and Functional Foods in Human Health Total Hours: 56

Credits: 4

Course outcome:

On Completion of this Course the students will be able to:

CO1: Understand the fundamental concepts of nutraceuticals and functional foods.

CO2: Apply knowledge of functional food development

CO3: Evaluate the role of nutraceuticals and functional foods in disease management

CO4: Understand the mechanisms of action and health benefits of probiotics, prebiotics, and synbiotics

Unit I **12 hours**

Nutraceuticals: Introduction, classifications and its concepts; Nutraceuticals as a new dietary ingredient; Biological significance. Nutraceuticals and dietary supplements. Novel sources of (Marine-derived and insects) Nutraceuticals. Functional foods: Introduction and classification; World market for nutraceuticals and functional foods; Regulatory issues. Relevance of nutraceuticals and functional foods in the management of diseases and disorders.

Unit II **15 hours**

Sources and Health Benefits: Natural pigments like chlorophyll, carotenoids, lycopene and anthocyanins; Glucosinolates; Isoflavonoids; Phytosterols; Phytoestrogens; Omega-3 and omega-6 fattyacids; Conjugated Linoleic Acid, Dietary fiber; Antioxidants. Development of functional foods, isolation, storage, processing and stability of phytochemicals/bioactive compounds. Encapsulation Technologies; Recent developments in the isolation, purification and delivery of phytochemicals. Nutrigenomics: nutrigenomics an introduction and its relation to nutraceuticals

Unit III **14 hours**

The role of Nutraceuticals and functional foods in disease prevention: Angiogenesis, Cardiovascular diseases, Cancer, Diabetes, Cholesterol management and Obesity. Relation between nutraceuticals and Parkinsons, Alzheimer's diseases. Toxicity potential of nutraceuticals. Immunomodulation and nutraceuticals. Dosage for effective control of diseases and health benefits with adequate safety.

Unit IV **15 hours**

Prebiotics, Probiotics and Synbiotics: Introduction, criteria for selection, Role of gastro intestinal microbiota in health and disease; health effects of prebiotics and probiotics. Mechanism of action; Different types of prebiotics and their effects on gut microbes: Resistant starch, Fructo-oligosaccharides; Recent advances in probiotics; Challenges and regulatory issues related to probiotic products. Emerging strains and their specific health benefits. FOSHU Foods

Recommended Books & References:

1. Handbook of Nutraceuticals and Functional Foods Edited by Robert E.C.
2. Wildman ,Robert Wildman. Taylor C. Wallace , Routledge Publishers, Second Edition, April 26, 2007, ISBN-13: 978-0849364099 ISBN-10: 0849364094
3. Nutraceuticals by L. Rapport and B. Lockwood, Pharmaceutical Press, ISBN-13: 978-0853696599 ISBN-10: 0853696594 Edition: 2nd , April 26, 2007
4. Nutrition for the Older Adult by Melissa Bernstein, and Ann Schmidt Luggen (Author), ISBN-13: 978-0763736248 ISBN-10: 0763736244 Edition: 1st , August , 2009
5. Brigelius-Flohé, J & Joos HG. (2006). Nutritional Genomics: Impact on Health and Disease. Wiley VCH.
6. Losso JN. (2007). Angi-angiogenic Functional and Medicinal Foods. CRC Press
7. Robert EC. (2006). Handbook of Nutraceuticals and Functional Foods. 2 nd Ed. Wildman.
8. Shi J. (2006). Functional Food Ingredients and Nutraceuticals: Processing Technologies. CRC Press.
9. Webb GP. (2006). Dietary Supplements and Functional Foods. Blackwell Pub.
10. Kesharwani, R. K., Keservani, R. K., & Sharma, A. K. (Eds.). (2021). Nutraceuticals and 12. Functional Foods in Immunomodulators. Springer. https://doi.org/10.1007/978-981-16-0143-3
11. Egbuna, C., Dable-Tupas, G., et al. (Eds.). (2020). Functional Foods and Nutraceuticals: Bioactive Components, Formulations, and Innovations. Springer. https://doi.org/10.1007/978-3-030-54859
12. Wildman, R. E. C., & Wallace, T. C. (Eds.). (2023). Handbook of Nutraceuticals and Functional Foods (3rd ed.). CRC Press. https://doi.org/10.1201/9781003208355
13. Bashir, K., Jan, K., & Ahmad, F. J. (Eds.). (2024). Functional Foods and Nutraceuticals: Chemistry, Health Benefits and the Way Forward. Springer. https://doi.org/10.1007/978-3-031-59365-9

Third Semester MSc. Food Science & Technology

Course Core Content

(PO 595.3) **Basics of Food Safety and Labelling**

Credits: 3 **Total Hours: 48**

Course Outcomes:

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

CO1- Describe key concepts and principles of food safety and hygiene.

CO2- Identify microbiological, chemical, and physical hazards in food production and processing.

CO3- Analyse and interpret food labelling laws and nutritional information.

CO4- Apply food safety standards and regulations to real-world scenarios.

Unit I **14 Hours**

Introduction to Food Safety: Importance of food safety in the food processing industry. Overview of international food safety organizations (e.g., WHO, FAO). Food hazards, Food quality assurance: Objectives, Importance, Functions and Principles. Food quality control: Objectives, Importance, Functions and Principles. Pest prevention and control, Current Scenario: Challenges to food safety. Food Adulteration: Nature of adulterants, methods of evaluation.

Unit II **18 Hours**

Food Safety & Quality Systems: Total Quality Management (TQM); Good Agricultural Practices (GAP), Good Manufacturing Practices (GMP), Good Hygienic Practices (GHP), Good Lab Practices (GLP), Standard Operating Procedures (SOP). Hazard Analysis Critical Control Point (HACCP) system, ISO standards. Evaluation of severity of a hazard controlling food hazards. Traceability: Tracking and Recalling Program. Food Hygiene Program: Training programs. Personal habits, Hygiene verification. Food quality Standards: FSSAI and BIS. International Food Safety Standards: Global Food Safety Initiatives, Overview of international standards and agreements (e.g., Codex Alimentarius, GFSI).

Unit III **16 Hours**

Introduction to Food labeling, Regulations and Guidelines; Declaration of ingredients and additives; Allergens Labeling. Energy and References for intake. Nutritional labeling regulations: Mandatory and optional nutrients; Nutritional descriptors and approved health claims. Front of Pack (FOP) Nutrition Labeling; Date Labels, Storage instructions and Shelf life indications Digital and Smart Labeling: Use of QR codes and RFID tags for enhanced consumer information. Eco-

labels and Sustainability Claims: Understanding eco-friendly labeling and sustainability certifications. Role of food labelling in food traceability.

Recommended Books & References:

1. Early, R. (2005): Guide to Quality Management Systems for the Food Industry, Blackie, Academic and professional, London.

2. Gould, W.A and Gould, R.W. (2006). Total Quality Assurance for the Food Industries, CTI Publications Inc. Baltimore.

3. Bryan, F.L. (2000): Hazard Analysis Critical Control Point Evaluations a Guide to Identifying Hazards and Assessing Risks Associated with Food Preparation and Storage. World Health Organization, Geneva.

4. Jerry D'Souza, Jatin Pradhan. , (2010) Handbook of Food Processing, Packaging & Labeling 5. James L. Summers, Elizabeth J. (Betty) Campbell (2008) Food Labeling Compliance Review, 3rd Edition ISBN: 978-0-470-75250-0

6. Pomeraz, Y. and MeLoari, C.E. (2006): Food Analysis: Theory and Practice, CBS publishers and Distributor, New Delhi.

7. FSSAI, FSIS, EU and FAO website for updates

8. Ronald H. Schmidt, Gary E. Rodrick (2005) Food Safety Handbook, John Wiley & Sons Publisher (ISBN 047143227X, 9780471432272)

9. Rajesh, M., and George, J. (2005) “Food Safety Regulations, Concerns and Trade: The Developing Country Perspective”, Macmillan.

10. Naomi, R., and Watson, D. (2007) “International Standards for Food Safety”, Aspen Publication.

11. Forsythe, S.J. (2020). The Microbiology of Safe Food (3rd ed.). Wiley-Blackwell.

12. DeWaal, C.S., & Plunkett, D. (2011). Food Safety: A Guide to What You Really Need to Know. Praeger.

11. De Vries, J. (Ed.). (2021). *Food safety and toxicity*. CRC press.

Third Semester MSc. Food Science & Technology

Core Lab Course Content

(PH 593.3P) Food Microbiology and Functional Foods

8 Hours/week

Credits:**4** Total hours: **96**

Course Outcomes

On completion of this practical the students will be able to:

CO1: Identify basic microbiological laboratory practice, culturing, isolating and handling of microbes.

CO2: Evaluate the intricacies of various microbiological staining techniques and estimate total count in food samples.

CO3: Understand and perform analytical techniques to quantify bioactive compounds and phytochemicals in food and plant samples.

CO4: Apply scientific knowledge and practical skills in developing innovative food products with enhanced health benefits.

List of Experiments

1. Sterilization and introduction to microbiological laboratory instruments.
2. Microbiological Culture Media Preparation.
3. Inoculation techniques (Pour plate)
4. Inoculation techniques (Spread plate)
5. Inoculation techniques (Streaking methods)
6. Isolation and Maintenance of Pure Cultures.
7. Enumeration of Soil Microorganism (Serial Dilution).
8. Staining Techniques (Simple, negative, differential staining and capsule staining).
9. Study of the microbiological quality of milk by MBR test.
10. Determination of a Bacterial Growth Curve: Classical and Two-Hour Methods.
11. Estimation of total microbial bacterial plate count of spoiled food sample.
12. Enumeration of Coliforms and indicator organisms (Most Probable Number).
13. Estimation of Oryzanol in given oil sample
14. Qualitative Analysis of Phytochemicals

15. Estimation of carotenoids
16. Estimation of Chlorophylls
17. Estimation of Capsaicin
18. Estimation of Phenolic Compounds in Given Sample
19. Estimation of total anthocyanins
20. Estimation of lycopene
21. Determination of total antioxidant activity by Phosphomolybdenum method
22. Development of functional food recipe

Recommended books and References

1. Harborne, J. B. (1998). *Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis* (3rd ed.). Springer.
2. Nielsen, S. S. (2024). Introduction to food analysis. In *Nielsen's Food Analysis* (pp. 3-14). Cham: Springer International Publishing.
3. Jayan, H., Pu, H., & Sun, D. W. (2020). Recent development in rapid detection techniques for microorganism activities in food matrices using bio-recognition: A review. *Trends in Food Science & Technology*, *95*, 233-246.
4. Rodriguez-Amaya, D. B. (2001). *A Guide to Carotenoid Analysis in Foods*. ILSI Press.
5. Prieto, P., Pineda, M., & Aguilar, M. (1999). Spectrophotometric quantitation of antioxidant capacity through the formation of a phosphomolybdenum complex: Specific application to the determination of vitamin E. *Analytical Biochemistry*, *269*(2), 337-341.
6. Pattabiraman, T. N. (1993). *Laboratory Manual and Practical Biochemistry*. All India Publishers & Distributors.
7. Prescott L M, Harley J P, Klein D A., (2008). Microbiology 6th Ed., WMC Brown Publishers.
8. Frazier, W.C. (2014) Food Microbiology, McGraw Hill Inc. 5th Edition.
9. García-Lomillo, J., & González-SanJosé, M. L. (2023). Phytochemicals in food and health: extraction, analysis, and bioavailability. Food Chemistry, 377, 131982. https://doi.org/10.1016/j.foodchem.2022.131982
10. Li, J., Huang, W., Zhang, Y., & Cheng, Y. (2022). Phytochemicals and biological activities of Solanaceae plants: Tomato, pepper, and eggplant. Food Chemistry, 373, 131430. https://doi.org/10.1016/j.foodchem.2021.131430

11. Melini, V., & Melini, F. (2022). Functional foods and nutraceuticals: Bioactive compounds, formulation, and health benefits. Foods, 11(3), 375. https://doi.org/10.3390/foods11030375

Third Semester MSc. Food Science & Technology

Core Lab Course Content

(PH 594.3P) **Project / Dissertation**

8 Hours/week

Credits:**4** Total hours: 96

Fourth Semester MSc. Food Science & Technology

Core Course Content

(PH 593.4) **Food Biotechnology** **Total Hours:** 56

Credits : **4**

Course learning outcome:

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

CO1: Impact knowledge about biological and biochemical technology, with a focus on fermented products, the design and operation of industrial practices.

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

CO3: Understand the working principle of equipment during downstream processing

CO4: Evaluate and analyze membrane systems for product recovery at industrial level.

Unit 1 **14 Hours**

Fermentation: Introduction, Types of fermentations; Submerged fermentation and Solid-state fermentation, fermentation kinetics, fermenter design, Types of fermenters; Stirred tank bioreactor, Airlift bioreactor, Fluidized bed bioreactor, Membrane bioreactor, Photo bioreactor, Innovative and special bioreactor. Fermentation systems: batch, continuous and fed batch culture systems, instrumentation and control.

Unit II **14 Hours**

Fermented Food Products: Media ingredients and formulation; Inoculum development for fermenters; Aseptic method of inoculation. Microbial based products; Production of organic acids (Vinegar), enzymes and microbial biomass protein (MBP). Traditional Indian fermented products like idli and shrikhand, Advantages of fermented foods. Fermented products: Process description; malting, mashing, hops, primary and secondary fermentation: Classification (distilled and non-distilled) wines, whisky, beer and vodka, rum; fermentation in tea, coffee, Cheese and cocoa processing, fermented soy-based products (soy sauce).

Unit III **14 Hours**

Downstream processing: Objectives and problems with downstream processing; Extraction; Liquid-Liquid extraction, Solid phase separations and Supercritical fluid extraction and its application in the food industry. Concentration, purification and polishing; filtration; Membrane systems (MF, UF, NF and RO). Centrifugation, Precipitation, Fractionation and Formulation.

Unit IV **14 Hours**

Basics of genetic engineering; Application of genetic engineering in food science and technology. Genetically modified and biofortified foods, Ethical issues concerning GM foods; Current guidelines for the production, labeling and traceability of GM foods. Bio-safety, Risk assessment, Risk management. IPR; GMO Act 2004. Case study: Golden rice, Bt-Brinjal and Public perception of GM foods.

Recommended Books & References:

1. Joshi, V.K. and Ashok Pandey, edition (2009), Biotechnology: Food Fermentation, Microbiology, Biochemistry and Technology, Vol. I & vol. II Educational Publisher.
2. Khan, F. A. (2020). *Biotechnology Fundamentals Third Edition*. CRC Press.
3. Renneberg, R. (2023). *Biotechnology for beginners*. Academic Press.
4. Bioprocess Engineering, Basic Concepts, II Ed. Michael L Shuler, Fikret Kargi, Prentice Hall of India pvt. Ltd. 2nd edition (2015).
5. Manual of Industrial Microbiology & biotechnology, Arnold Demain & Julian E. Davis, II Ed, ASM Press. Washington DC, 3rd edition (2010).
6. Industrial Biotechnology by Rita Singh, S. Ghosh, Global Vision Publishing Ho, 2nd edition (2018)
7. Industrial Biotechnology: Sustainable Growth and Economic success by Wim Soetaert, Erick J. Vandamme, (21st April 2010)
8. Vogel, H.C. and Todaro, C.L. (2005). Fermentation and Biochemical Engineering Handbook:
9. Stanbury, P.F., A. Whitaker and S.J. Hall, (2016), Principles of Fermentation Technology, 3rd Edition
   Aditya Books (P) Ltd.
10. Peppler, H.J. and D. Perlman, (2004), Microbial Technology: Fermentation Technology, 2nd Edition, Vol. II Academic Press / Elsevier.

Fourth Semester MSc. Food Science & Technology

Core Course Content

(PH 592.4) Food Packaging

Credits: 4 **Total Hours: 56**

Course Outcomes

On Completion of this Course the students will be able to:

CO1: To provide insight into the scope of packaging technology in food industries.

CO2: To learn about different packaging materials and systems used in food industries.

CO3: To provide greater understanding for various food products w.r.t. different packaging requirements.

CO4: To have an understanding about the safety aspects of different packaging materials

Unit I: Introduction to Food Packaging **16 hours**

Definition, functions of food packaging (containment, protection, convenience and communication), Primary, secondary and tertiary packaging, Paper packaging: types of paper, Properties of paper; Testing of paper packaging materials. Glass packaging materials: Composition and manufacture of glass containers; Properties of glass containers: Mechanical, thermal and optical; testing of glass containers.

Unit II: Plastic packaging materials **12 Hours**

Classification of polymers, Properties of thermoplastic polymers; Processing and converting of thermo plastic polymers (extrusion, blow molding, injection molding, compression molding, lamination and heat sealing); Testing of plastic packaging materials. Safety aspects of packaging materials: Sources of toxic materials and migration of toxins into food materials.

Unit III: Metal packaging materials **12 Hours**

Introduction to Metal Packaging, Types of metals used, Container making processes (Two piece, three-piece and end can manufacturing and protective); Tinning process, Types of cans (Aluminum containers, Tinplate containers). Corrosion of metal packaging.

Unit IV: Packaging Systems **16 hours**

Vacuum and Modified Atmosphere Packaging Systems; Aseptic packaging: Sterilization of packaging material food contact surfaces and packaging systems: Retort pouch packaging; Active and Intelligent food packaging; Edible films and coatings. Nanotechnology in food packaging. Economic and Environmental issues (Recycling); Packaging requirements of selected foods: Cereals and snack food; Milk and dairy products; Spices, horticultural products and microwavable foods.

Recommended Books & References

1. Robertson, G.L. (2016). Food Packaging: Principles and Practice (3rd Edition), Taylor & Francis
2. Ahvenainen, R. (Ed.). (2023). Novel Food Packaging Techniques. Woodhead Publishing.
3. Coles, R., Kirwan, M. J., & Rotabakk, B. T. (Eds.). (2021). Food and Beverage Packaging Technology (2nd ed.). Wiley-Blackwell.
4. Han, J. H. (Ed.). (2022). Food Packaging: Principles and Practice (4th ed.). CRC Press.
5. Kerry, J. P. (Ed.). (2020). Multilayer Flexible Packaging (2nd ed.). Woodhead Publishing.
6. Raheem, D. (2021). Emerging Food Packaging Technologies: Principles and Practice (2nd ed.). Springer.
7. Yam, K. L., & Lee, D. S. (Eds.). (2022). Emerging Food Packaging Technologies: Principles and Practice (2nd ed.). Woodhead Publishing.
8. Jamshidian, M., & Davidson, P. (2021). Bio-based Plastics for Food Packaging Applications. Springer.
9. Rastogi, V. K. (Ed.). (2022). Sustainable Food Packaging Technology. Academic Press.
10. Silvestre, C., & Cimmino, S. (Eds.). (2023). Eco-friendly Food Packaging: Trends and Advances. CRC Press.

Fourth Semester MSc. Food Science and Technology

Course Core Content

(PH 591.4) Meat, Fish, and Poultry Processing Technology

Credits: **4** Total Hours: **56**

Course Outcomes

On Completion of this Course the students will be able to:

CO1: Demonstrate a comprehensive understanding of the physico-chemical properties and nutritional composition of meat, poultry, egg and fish, and evaluate factors affecting their quality.

CO2: Describe the steps involved in the slaughtering and dressing of poultry, pigs, cattle and the process of conversion of muscle to meat

CO3: Apply the knowledge of various cooking and preservation methods to enhance the safety and quality of meat and fish products

CO4: Understand the utilization of by-products from meat and fish processing and their applications

Unit I: 16 Hours

Status and scope of meat, poultry and fish industries, Structure and physico-chemical properties of muscle meat: composition and nutritive value, conversion of muscle into meat (postmortem changes in meat, rigor mortis, cold shortening), Factors influencing the quality of meat (Intrinsic and extrinsic factors), Pre-rigor processing; Stunning types, Slaughtering - Steps in slaughtering and dressing (Poultry, Pig, Cattle); Modern abattoirs-layout and operations, Aging of meat, meat tenderization-natural and artificial methods, By-product utilization.

Unit II: 12 Hours

Cooking methods for meat: Roasting, frying and braising; changes during cooking of meat; Microbiological spoilage of meat and safety concerns, Preservation of meat: chilling, freezing, curing, smoking, dehydration, irradiation, canning and packaging of meat, novel methods of meat processing, Restructured and reformed meat products (sausages), meat analogs, intermediate moisture meat products.

Unit III: **12 Hours**

Egg: Structure, composition and nutritive value; Quality deterioration of egg (Alkaline hydrolysis) Quality evaluation of eggs: Internal and external quality evaluation like, candling, albumen index, Haugh unit, yolk index. Grading of eggs, Egg storage and preservation: Whole egg preservation, pasteurization, dehydration, freezing and spray drying. Egg products and Poultry products

Unit IV: **16 Hours**

Fish: Composition and Nutritive value, Post harvest changes in fish, factors affecting quality of fresh fish, Handling, Preservation (chilling, freezing, glazing, salting and canning of fish) and transportation of fish. Processing of fish by products and their utilization (fish meal, fish oil, fish silage, chitin), surimi, Fish protein concentrates and fish protein hydrolysates.

Recommended Books and References:

1. John M. deMan, John W. Finley, W. Jeffrey Hurst & Chang Yong Lee (2018). Principles of Food Chemistry, 4th Edition, Springer Publications.
2. Vickie A. Vaclavik, Elizabeth W. Christian & Tad Campbell (2020). Essentials of Food Science (Food Science Text Series), 5th Edition, Springer Publication
3. A R Sen, M Muthukumar, B M Naveena. (2013) *Meat Science: A Student Guide.* Satish Serial Publishing House
4. Balachandra K.K. (2013) Post harvest Technology of Fish & Fish Products. Daya Publishing House
5. Mead, G. (2004). Poultry Meat Processing and Quality. Wood head Publishers.
6. Warris, P. D. (2000). Meat science. An Introductory text book. CABI Publishing, UK
7. Kulkarni, V. V., Girish, P. S., Barbuddhe, S. B., Naveena, B. M., & Muthukumar, M. (2021). *Analytical Techniques in Meat Science.* CRC Press.
8. Potter, N. N., & Hotchkiss, J. H. (2012). *Food science.* Springer Science & Business Media.
9. Lawrie, R. A., & Ledward, D. (2014). Lawrie's meat science. Woodhead Publishing.
10. Scanes, C. G., & Christensen, K. D. (2019). *Poultry science*. Waveland Press.
11. Jay, J. M., Loessner, M. J., & Golden, D. A. (2008). *Modern food microbiology*. Springer Science & Business Media.

12. Chauhan, O. P. (Ed.). (2019). *Non-thermal processing of foods*. CRC press.
13. Toldrá, F. (Ed.). (2010). *Handbook of meat processing*. John Wiley & Sons.

Fourth Semester M.Sc. Food Science & Technology

Core Course Content

(PS 595.4) Food Safety and Quality Control 42 Hours

Credits :3

Course learning outcome:

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

CO1: Define key concepts and principles of food safety and quality control.

CO2: Identify microbiological, chemical, and physical hazards in food production and processing.

CO3: Analyze and interpret hygiene, food safety regulations, and quality standards.

CO4: Apply quality control techniques to ensure food safety and quality.

Unit I 13 Hours

Concepts of Food safety and labelling - Definition, Food Hazards: Physical, Chemical and Microbial hazards . Importance of food safety in the food processing industry Current challenges in food safety. Nutritional and Ingredient labeling: Mandatory and optional nutrients; Nutritional descriptors and approved health claims; Product Identification: Traceability Systems. Food adulteration: nature of adulterants, methods of evaluation.

Unit II 13 Hours

Hygiene and Sanitation: Definition of Hygiene, Sanitation and their Importance in food industries. Food Hygiene Program: Training programs, hygiene verification. Water Quality in the Food Industry; Cleaning and Sanitation, CIP (Clean in Place) and COP (Clean out of Place): Cleaning Agents, Sanitizing Agents, and Evaluation of Sanitation Efficacy. Sanitation Program: Sanitation Standard Operating Procedures (SSOPs). Pest Classification: Insects, Rodents, and Birds; Integrated Pest Management (IPM) and Control Measures. Organic Farming.

Unit III 16 Hours

Food Safety regulations and Quality management systems: National and International food quality regulations: BIS, FSSAI, ISO (9000; 14,000; 15,161, and 22,000) and EU. Codex Alimentarius Commission; Introduction to the legal system, WTO agreements: SPS and TBT

agreements.

Quality Control and Assurance: Objectives, Principles, Importance, and Functions. Statistical quality control in the food industry. HACCP, Total Quality Management (TQM); Good Agricultural Practices (GAP), Good Manufacturing Practices (GMP), Good Hygienic Practices (GHP), and Good Laboratory Practices (GLP). Standard Operating Procedures (SOP), PFA laws related to food adulteration.

Recommended Books & References:

1. Early, R. (2005): Guide to Quality Management Systems for the Food Industry, Blackie, Academic and professional, London.
2. De Vries, J. (Ed.). (2021). *Food safety and toxicity*. CRC press.
3. Gould, W.A and Gould, R.W. (2006). Total Quality Assurance for the Food Industries, CTI Publications Inc. Baltimore.
4. Miller, D. D., & Yeung, C. K. (2022). *Food chemistry: A laboratory manual*. John Wiley & Sons.
5. Pomeraz, Y. and MeLoari, C.E. (2006): Food Analysis: Theory and Practice, CBS publishers and Distributor, New Delhi.
6. Bryan, F.L. (2000): Hazard Analysis Critical Control Point Evaluations a Guide to Identifying Hazards and Assessing Risks Associated with Food Preparation and Storage. World Health Organization, Geneva.
7. FSSAI, FSIS, EU and FAO website for updates
8. Ronald H. Schmidt, Gary E. Rodrick (2005) Food Safety Handbook, John Wiley & Sons Publisher (ISBN 047143227X, 9780471432272)
9. Rajesh, M., and George, J. (2005) "Food Safety Regulations, Concerns and Trade: The Developing Country Perspective", Macmillan.
10. Naomi, R., and Watson, D. (2007) "International Standards for Food Safety", Aspen Publication.
11. Newslow, D.L. (2007) "The ISO 9000 Quality System: Applications in Food and Technology", John Wiley & Sons.
12. Hubbard, Merton R. (2003) "Statistical Quality Control for the Food Industry", 3rd Edition, Springer,
13. Mortimore, S., & Wallace, C. (2013). HACCP: A Practical Approach (3rd ed.). Springer.
14. Lawley, R., Curtis, L., & Davis, J. (2012). The Food Safety Hazard Guidebook (2nd ed.). Royal Society of Chemistry.

Fourth Semester M.Sc. Food Science & Technology

Core Lab Course Content

(PH 597.4P) Food Biotechnology and Food Safety

8 Hours/week

Credits:4 **Total hours: 96**

Course Outcomes

On completion of this practical the students will be able to:

CO1: Recall and identify the basic methods of fermentation and apply the same in the preparation of fermented foods

CO2: Analyze fermentation techniques use for the extraction of various enzymes and evaluate microbial growth cycles of various microorganism

CO3: Gain proficiency in the application of advanced techniques and the analysis of results to detect food adulteration and assess the quality of various food products

CO4: Critically evaluate existing food safety standards and labeling practices through comprehensive market surveys, assessing their effectiveness in informing consumers and ensuring compliance.

List of Experiments

1. Food biotechnology techniques (Basic lab procedures, equipment's, safety and food sampling and storage)
2. Preparation of yoghurt
3. Preparation of sauerkraut
4. Preparation of Wine
5. Determination of Acidity in vinegar
6. Estimation of Minimum Inhibitory Concentration of Salt and Sugar
7. Extraction of fruit juice using enzymes
8. Quantitative determination of Total proteins by Bradford method
9. Industrial media preparation
10. Identification of genetically modified plants by the chain reaction of the polymerase (PCR)
11. Plant Tissue culture
12. Determination of Microbial Growth Curve
13. Common food adulteration detection tests
14. Qualitative tests for adulteration of milk

15. Quantitative analysis of honey
16. Qualitative analysis of coffee powder
17. Qualitative tests to determine the quality of meat
18. Determination of peroxide value of oils
19. Determination of carotenoid values of palm oil
20. Determination of synthetic food colors
21. Market survey on food labeling of different food products
22. Case study Implementation of HACCP

Recommended Books & References

1. El-Mansi, E.M.T. (2007). Fermentation Microbiology and Biotechnology, CRC/Taylor & Francis.
2. Bioprocess Engineering, Basic Concepts, II Ed. Michael L Shuler, Fikret Kargi, Prentice Hall of India pvt. Ltd. 2nd edition (2015).
3. Manual of Industrial Microbiology & biotechnology, Arnold Demain & Julian E. Davis, II Ed, ASM Press. Washington DC, 3rd edition (2010).
4. Seidman, L. A., Moore, C. J., & Mowery, J. (2021). *Basic laboratory methods for biotechnology: Textbook and laboratory reference*. CRC Press.
5. Gupta, V. K., Tuohy, M. G., Ayyachamy, M., Turner, K. M., & O'donovan, A. (2022). *Laboratory protocols in fungal biology*. Springer International Publishing.
6. Pomeranz, Y., & Meloan, C. E. (2014). Food Analysis: Theory and Practice.
7. Singhal, R. S., Kulkarni, P. R., & Rege, D. V. (2016). Handbook of Indices of Food Quality and Authenticity. Woodhead Publishing.
8. Bogdanov, S. (2017). Honey Composition. International Honey Commission
9. Nielsen, S. S. (2017). Food Analysis Laboratory Manual. Springer.
10. Fletcher, D. L. (2013). Poultry meat quality. Poultry Science.
11. Shahidi, F., & Zhong, Y. (2015). Lipid Oxidation and Improving the Oxidative Stability. CRC Press.
12. Rossell, J. B. (2016). Measurement of carotenoids in palm oil. In Edible Oil Processing
13. (pp. 217-240).
14. Downham, A., & Collins, P. (2015). Colouring our foods in the last and next millennium.
15. International Journal of Food Science & Technology.

16. Grunert, K. G., Wills, J. M., & Fernández-Celemín, L. (2016). Nutrition knowledge, and use and understanding of nutrition information on food labels among consumers in the UK. Appetite.
17. Mortimore, S., & Wallace, C. (2013). HACCP: A Practical Approach. Springer.
18. Philip,A.C. Reconceptualizing quality. New Age International Publishers,Banglore. 2001.
19. Bhatia,R. and Ichhpujan,R.L. Quality assurance in Microbiology. CBS Publishers and Distributors, New Delhi. 2004.
20. Kher, C.P. Quality control for the food industry. ITC Publishers, Geneva. 2000.
21. FSSAI manual of simple methods for testing of common adulterants in food. Food Safety and Standards Authority of India, Ministry of Health and Family Welfare Government of India New Delhi

Fourth Semester M.Sc. Food Science and Technology

Core Lab Course Content

(PH 594.4P) **Meat, Fish, and Poultry Processing Technology**

4 Hours/week

Credits:**4** Total hours: **48**

Course Outcomes

On completion of this practical the students will be able to:

CO1: Develop the ability to assess various quality parameters of meat

CO2: Acquire hands-on experience in using different analytical techniques for meat, fish and poultry products

CO3: Apply various meat processing methods to develop meat products with improved quality

CO4: Demonstrate the ability to apply food science principles in practical settings for meat, poultry and fish products

List of Experiments

21. Effect of cooking time on the organoleptic quality of meat
22. Tenderization of meat using different agents
23. Estimation of fat content
24. Detection of glycogen in meat
25. Determination of extract release volume of meat
26. Determination of water holding capacity of meat
27. Estimation of metmyoglobin content in meat
28. Acceptability of texturized vegetable protein as meat analogue
29. Preparation of restructured meat
30. Quality evaluation of egg
31. Effect of ingredients on the stability of egg white foam
32. Determination of sodium chloride content in dried fish

Recommended books and References

7. Kulkarni, V. V., Girish, P. S., Barbuddhe, S. B., Naveena, B. M., & Muthukumar, M. (2021). *Analytical Techniques in Meat Science.* CRC Press.

8. Miller, D. D., & Yeung, C. K. (2022). *Food chemistry: A laboratory manual*. John Wiley & Sons.
9. Horwitz, W., & Latimer, G. W. (2000). Association of official analytical chemists. (2010). *Official methods of analysis of AOAC international*.
10. Karel, M., & Lund, D. (2003). *Physical principles of food preservation: revised and expanded*. CRC Press.
11. Prokopov, T., & Tanchev, S. (2007). Methods of food preservation. In *Food safety: A practical and case study approach* (pp. 3-25). Boston, MA: Springer US.
12. Jay, J. M., Loessner, M. J., & Golden, D. A. (2008). *Modern food microbiology*. Springer Science & Business Media.
13. Toldrá, F. (Ed.). (2010). *Handbook of meat processing.* John Wiley & Sons.

EVALUATION – POSTGRADUATE PROGRAMMES

CREDITS	FORMATIVE ASSESSMENT 40					SUMMATIVE ASSESSMENT 60
	Internals (2 Internals)	Assignment	Seminar	Quiz	Class Participation	End Semester Exam
5 Credits/ 4 Credits/ 3 Credits (Theory)	50 + 50 =100	5	5	5	5	60
Assigned	20	20				
Apportioned to	40					

CREDITS	Internal Assessment	External Assessment	
		Viva voce – External	Evaluation Test
Field work (5 Credits)	40	30	30
Assigned	40	60	

CREDITS	FORMATIVE ASSESSMENT				SUMMATIVE ASSESSMENT
	Internal (I & II)	Record Keeping	Continuous Assessment	Attendance	Practicals
2 Credits (Practical)	25	10	12	3	30
Assigned	25	25			
Apportioned to	20				30
3 Credits/ 4 Credits (Practical)	Lab Test (I & II)	Internals (I & II)	Attendance	Assignment/Class test	Practicals
Assigned	10	20	5	5	60
Apportioned to	40				

ASSESSMENT CRITERIA

Theory: 60:40; Practicum: 50:50

1. **Ratio of weightage (marks) between Internal & End Semester Examinations for**

   THEORY: 60:40

   THEORY INTERNAL COMPONENT: 30

   - Two internal tests: **50×2=100 converted to 20**
   - Assignment: **05**
   - Quiz/ surprise test / MCQs: **05**
   - Seminar: **05**
   - Class participation: 05
   - Total = **40**

2. Practicum component marks: 40

The internal component of practicum:50

Internal:

- Continuous Assessment of all practical experiments: **20**
- Model practical Test: **40 converted to 20**
- Maintenance of Records: **05**
- Viva: 05

End semester Practicum: 60

Theory End Semester Examination Question Paper Pattern. Time 3 hours

End Semester Theory Examinations will be common for all science departments.

The duration of the examination is **3** hours carrying **60 marks.**

The question paper is divided into **Part–A, Part – B, and Part C.**

Part –A -Objective type carrying from each unit - **15** marks.

Part-B -Analytical questions carrying from each unit - **25**marks

Part –C- Descriptive answer for **20** marks.

Question Paper Pattern Sample

I. Section-A –Any 5 out of 8 3 x 5=15 marks.

Q. 1, 2, 3, 4, 5, 6, 7, 8,

II. Section-B -Answer any 5 out of 8 5 x 5=25 marks

Q. 1, 2, 3, 4, 5, 6, 7, 8

III. Section-C -Answer any 2 out of 4 10 X 2 =20 marks

Q. 1, 2, 3, 4

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Paper Code	Reg. No.:							

St Aloysius (Deemed to be University)

Mangaluru 575003-India

End Semester Exam – Month Year

M.Sc. - Semester – III

Paper – I

Paper Title

Time: 3 hrs.	**Max Marks: 60**

Instructions: Draw Diagrams wherever necessary.

Answer all three sections- A, B, and C.

SECTION–A

I	**Define/Answer any TEN of the following:**	**(3x5=15)**
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
II	**Answer <u>any FIVE</u> of the following**	**(5x5=25)**
9.		
10.		
11.		

12.		
13.		
14.		
15.		
16.		
	SECTION – C	
III	**Answer <u>any TWO</u> of the following**	**(10x2=20)**
17.		
18.		
19.		
20.		
	**********	

Paper Code	Reg. No.:							

St Aloysius (Deemed to be University)

Mangaluru 575003-India

Internal Exam – Month Year

M.Sc. - Semester – III

Paper – I

Paper Title

Time: 3 hrs.	**Max Marks: 60**

Instructions: Draw Diagrams wherever necessary.

Answer all three sections- A, B, and C.

SECTION–A

I	**Define/Answer any FIVE of the following:**	**(3x5=15)**
1.		
2.		
3.		
4.		
5.		
6.		
7.		
II	**Answer <u>any FOUR</u> of the following**	**(5x4=20)**
9.		
10.		
11.		
12.		
13.		

14.		
	SECTION – C	
III	**Answer <u>any ONE</u> of the following**	**(15x1=15)**
17.		
18.		
19.		
	**********	