KERALA UNIVERSITY OF FISHERIES AND OCEAN STUDIES

Panangad, Kochi- 682506, Kerala

M. Sc. Food Science and Technology

Syllabus 2024

Regulations, Eligibility, Scheme and Syllabus For

M. Sc. Food Science and Technology

(Effective from 2017 Admission onwards)

All the general rules and regulations laid down by the Kerala University of Fisheries and Ocean Studies PG Curriculum shall be applicable.

SCOPE OF THE PRORGAMME

Food safety, security and quality assurance have today become subject of national importance. However, implementation needs skilled man power. There is now an urgent need to accomplish this task. M.Sc. Food Science and Technology offers great scope for employment as managers and quality control personnel needed for the food processing industries as there is ever growing demand for processed foods in coming years.

ELIGIBILITY CRITERIA

Those students who possess Bachelor degree in Food Science and Technology/ Food Technology/ any branch of Life Sciences are eligible for admission to M.Sc. Food Science and Technology Programme. B. Tech Food Science and Technology and B. Voc Food Processing Technology/ Food Technology are also eligible, as per the qualifications mentioned in the prospectus.

PROGRAMME AND SCHEME OF EXAMINATIONS

1. M.Sc. Food Science and Technology Programme shall have four semesters with 5 core courses and 3 core practical course, 5 core courses and 4 core practical courses and 6 core courses and 4 core practical courses each in 1st , 2nd and 3rd semesters, One/ two elective courses and one open elective course each in 2nd and 3rd semesters. 4th Semester is exclusively for dissertation.
2. There shall be external university examination of 3 hour duration for each theory courses at the end of the each semester, to be conducted after the completion of 80 working days.
3. Each practical examination is of 3 hour duration.
4. Project / dissertation evaluation and viva-voce shall be conducted at the end of the programme only.
5. Project / dissertation shall carry 20 credits.

EVALUATION AND GRADING

The evaluation scheme for each course shall contain two parts (a) Internal evaluation and (b) external evaluation. 50% marks shall be given to internal evaluation and the remaining 50% to external evaluation.

Internal evaluation: The internal evaluation shall be based on predetermined transparent system involving periodic written tests, assignments, seminars and attendance. In respect of theory courses and based on written tests, lab skill/records/viva and attendance in respect of practical courses. The weight age assigned to various components for internal evaluation is a follows.

Components of Internal Evaluation

	Component	Weightage
A	Assignment	10
B	Seminar/ Classroom participation	10
C	Attendance	5
D	Test	25

** The MOOC marks may be considered for the Open Elective Courses*

Practical examination (internal evaluation)	100
Practical exam	40
Record	20
Viva-voce	20
Attendance	20

To ensure transparency of the evaluation process, the internal assessment grade awarded to the students in each course in a semester shall be published on the notice board at least one week before the commencement of external examination. There shall not be any chance for improvement for internal grade. A Schedule of the internal examinations shall be prepared by the Dean/ HoD as the case may be, notified to the students at the beginning of each semester. Supplementary examination for mid- term shall be conducted only with the prior approval of the Vice Chancellor on very special cases. It will be sanctioned only in exceptional cases and after very careful scrutiny

The course teacher shall maintain the academic record of each student registered for the course, which shall be forwarded to the University, through the college Principal.

External evaluation: The external Examination in theory courses is to be conducted by the University with question papers set by external experts. The evaluation of the answer scripts shall be done by examiners based on a well-defined scheme of valuation. The external evaluation shall be done immediately after the examination preferably in a Centralized Valuation Camp. If there is a difference of more than 10% between first and second valuations, third evaluation will be conducted by the passing board of examinations and it will be taken as final marks. The passing board will be constituted by the Hon'ble Vice Chancellor from the list of external and internal examiners appointed for the valuation of the answer papers. There will be no provision for revaluation of answer script at any stage. The passing board may decide to give moderation subject to a maximum permission for each paper and in total for a pass to secure certain percentage of pass if necessary. However, the maximum marks awarded to a student should not exceed '5' per semester.

A separate minimum of 50% of marks for internal and external examinations shall be secured by the candidates for a pass.

The evaluation of a course shall be indicated by grade points ranging from 0-10. The total combined marks of a course divided by 10 will give the grade point which has to be rounded to the first two decimal places. Average of the grade point of all the courses in respective semesters shall be the GPA for the semester. A student has to obtain a minimum OGPA of 5/10 in the first two semesters, with a pass in each paper, in order to register for the 4th semester. All practical examinations will be internally evaluated as per the procedures.

Marks %	Classification
<50%	Failed (Grade point <5)
50 to 59%	Second Class (Grade point of 5 and <6)
60 to 74%	First class (Grade point of 6 and <7.5)
>75%	First Class with distinction (Grade point of 7.5 and above)
*Fractions of marks will be rounded to the nearest number	

The first rank will be awarded to the student who secures the highest OGPA, provided that the candidate secures grade point 7.5/10 or more.

Project /Dissertation work

The student will devote the first three semesters for course work and the final semester for dissertation/ project work related to a relevant area of specializations. Any of the faculty from the list of Faculty can be the supervising guide. The student shall prepare and submit the dissertation/project report (three copies) printed (A4 size) and hard bound to Head of the Department.

The plan of the Dissertation/project report shall be as decided by the Board of Studies/Academic Council from time to time. For the evaluation of the Dissertation/Project Report, a Board will be constituted by the Head of the Department. The Board shall consist of the Project Guide, External Examiner(s) and the Head of Department concerned.

The Dissertation/ Project report shall be subject to double valuation: One by internal faculty, that is, the Guide, and the other by an external examiner. The average of these two marks shall be marks of the Dissertation/ Project report to be awarded to the student. Maximum marks are 50:50. The external evaluation shall be done by external member of the Board of Viva-voce after its constitution. In unavoidable circumstance, the student can submit the project report as late submission with a late of fee of Rs.500/- However, the maximum permission time for late submission shall not exceed one month.

Sl. No.	Name	Reg. No.	Internal Evaluation Marks (50)			External Evaluation Marks (50)			Final Marks (100)
			Thesis (30)	Presentation and Viva-voce (20)	Total (50)	Thesis (30)	Presentation and Viva-voce (20)	Total (50)	
1									
2									

Dissertation - Thesis Pattern

1. Title page
2. Declaration by candidate
3. Certificate from Guide
4. Certificate from Head of the Department & Countersigned by Internal & External Examiners
5. Acknowledgement
6. Table of contents
7. List of Tables
8. List of Figures
9. Abbreviations
10. Abstract – 1 page
11. Introduction - (5-10 pages, includes introduction of the topic, scope and objectives of the study)
12. Review of Literature
13. Materials and Methods
14. Results & Discussion
15. Summary
16. References
17. Appendix, if any
18. Publications if any
19. Reference citation pattern- as that of APA format

Maximum number of pages should be between 50-100 pages (from Introduction to References) excluding graphs & Tables.
Font – Times New Roman,
Line space – Double space for text
Font Size – 12 for text 14 for subtitle (Bold) 16 for title (Bold)

1V. Grievance Redress Mechanism for internal evaluation

There is provision for grievance redresses at four levels- first at the level of teacher concerned; second, at the level of Department committee consisting of the Head of the Department, Departmental Coordinator and the teacher concerned; third, at the level of the Dean of the Faculty. HOD and a senior faculty member of the Faculty nominated by the Dean each year, and also a student member of that class nominated by the HOD. And fourth, at University level committee consisting of the Pro-vice chancellor, Dean of the Faculty and a subject expert nominated by the Vice-Chancellor, Controller of the Examination and the Convener of the Examination standing Committee.

Department and School level complaints will be filed within one week of the publication of the results and the decision taken within the next two weeks. Appeals, if any, on such decision shall be filed in the University level committee within a period of one week and decision taken within one month for the date of the submission of complaints. The time schedule in regard to the grievance redresses will be announced by the colleges concerned and the University in advance.

Normalization of continuous internal evaluation may be done by the university when there is inflation of grades in internal evaluation. The grades will be scaled down proportionately if the variation between the internal and external evaluation exceeds 40%.

Repetition of courses: A student who has not secured the minimum of 50% marks in a course may appear for re-examination of that course in a subsequent semester, whenever the course is offered. If a student is absent in internal examinations, on genuine grounds, the supplementary examination may be sanctioned by the Vice – Chancellor as a special case, on the request of student.

Late arrival in examinations: Student will not be allowed to enter the examination hall after 30 minutes of commencement of the examination and to leave the examination hall within one hour after the commencement.

V. Evaluation of Project Report/ Dissertation

Dissertation will be valued by two examiners (one internal and one external, 50% each) who conduct the practical examination (external) at the time of 4th semester. Distribution of marks allotted for dissertation will be as follows

Methodology	20%Marks
Content	40%Marks
Presentation	10%Marks
Answering question	10%Marks
Originality or overall outlook	20%Marks

VI. The Structure of the Programme

Duration of the programme	4 semesters
Accumulated minimum credits required for the successful completion of the programme	90
Minimum attendance required	75%

The Vice-Chancellor shall condone up to 10% of the shortage, if the candidate applied with necessary supporting evidence and remitting a fee of Rs. 1000/- on the recommendation of the Dean/ Head of the Department.
Each semester shall have a maximum of 110 working day, which include actual class days and examination days.

AIMS OF THE POST-GRADUATE PROGRAMME IN FOOD SCIENCE AND TECHNOLOGY

- Provide students with learning experiences that help instill deep interests in learning different areas of food processing technology such as fruits and vegetable processing technology, cereals, oil seeds processing technology, fish processing technology etc.;
- Develop broad and balanced knowledge and understanding of key concepts, principles, and theories related to food science and technology;
- Equip students with appropriate tools of analysis to tackle issues and problems in the field of food science and technology.
- Develop in students the ability to apply the knowledge and skills they have acquired to the solution of specific theoretical and applied problems in the area,
- Provide students with the knowledge and skill base that would enable them to undertake further studies in the subject and related areas or in multidisciplinary areas that involve food science and technology and help develop a range of generic skills that are relevant to wage employment, self-employment and entrepreneurship, research, teaching and so on

The **PROGRAMME SPECIFIC OUTCOMES (PSO)** relating to M.Sc. Food Science and Technology degree programme may include the following:

PSO1 Demonstrate a systematic or coherent understanding of the fundamental concepts, principles and processes underlying the academic field of food science and technology, its different subfields (food chemistry, nutrition, processing, engineering, etc.), and its linkages with related disciplinary areas/subjects

PSO2 Exhibit skills related to specialization areas within food science and technology and other related fields of study, including broader interdisciplinary subfields (nanotechnology, patent filing, etc.).

PSO3 Utilize hands-on-lab work and practical skills which develop problem solving abilities required for a successful career in food industry, teaching, research, food quality monitoring, product quality, consumer goods industry, food products, etc.

PSO4 Apply procedural knowledge that creates different types of professionals in the field of food science and technology and related fields such as food industry, teaching, research, product quality, consumer goods industry, food products, etc.

PSO5 Develop appropriate methodologies in order to conduct analyses or other chemical investigations; and apply relevant knowledge and skills to seek solutions to problems that emerge from the subfields as well as from broader interdisciplinary subfields relating to the subject

TEACHING-LEARNING PROCESSES

As the programme of study in food science and technology is designed to encourage the acquisition of disciplinary/subject knowledge, understanding and acquire academic and professional skills required for food science and technology-based professions and jobs, learning experiences should be designed and implemented to foster active/participative learning. Development of practical skills will constitute an important aspect of the teaching-learning process. A variety of approaches to teaching-learning process, including lectures, seminars, tutorials, workshops, peer teaching and learning, practicum and project-based learning, field-based learning, substantial laboratory-based practical component and experiments, open-ended project work, technology-enabled learning, internship in industry and research establishments etc. will need to be adopted to achieve this. Problem-solving skills and higher-order skills of reasoning and analysis will be encouraged through teaching strategies.

Syllabus of the Master's Programme

M.Sc. Food Science and Technology ***(With effect from academic year 2017) Course Structure, Scheme & Syllabus***

I Semester

Course	Course Code	Course Title	L	P	Exam Duration	Internal (%)	External (%)	Credits
Core	MFT2101	General Biochemistry	3		3 hrs	50	50	**3**
Core	MFT2102	Food Chemistry and Nutrition	3		3 hrs	50	50	**3**
Practical	MFT 2103	Biochemical and Food Analysis		4	3 hrs	50	50	**2**
Core	MFT2104	General Microbiology	3		3 hrs	50	50	**3**
Core	MFT2105	Food Microbiology	3		3 hrs	50	50	**3**
Practical	MFT 2106	Microbiology Practical		4	3 hrs	50	50	**2**
Core	MFT 2107	Biostatistics and Computer Applications in Food Industry	3		3 hrs	50	50	**3**
Practical	MFT 2108	Biostatistics and Computer Applications in Food Industry Practical		2	3 hrs	50	50	**1**
		Total Credits						**20**

II Semester

Course	Course Code	Course Title	L	P	Exam Duration	Internal (%)	External (%)	Credit
Core	MFT 2201	Principles of food Engineering and plant layout	3		3 hrs	50	50	3
Core	MFT 2202	Technology of Cereals, Legumes and Oil seed processing	3		3 hrs	50	50	3
Practical	MFT 2203	Technology of Cereals, Legumes and Oil seed processing practical		2	3 hrs	50	50	1
Core	MFT 2204	Technology of Fruit and vegetable processing	3		3 hrs	50	50	3
Practical	MFT 2205	Technology of Fruit and vegetable processing practical		2	3 hrs	50	50	1
Core	MFT 2206	Technology of Meat, poultry and dairy processing	3		3 hrs	50	50	3
Practical	MFT 2207	Technology of Meat, poultry and dairy processing		2	3 hrs	50	50	1
Core	MFT 2208	Fish processing technology	2		3 hrs	50	50	2
Practical	MFT 2209	Fish processing technology practical		2	3 hrs	50	50	1
Elective	MFT 2210 MFT 2211	Baking and confectionary technology Dietary foods and nutraceuticals	2		3 hrs	50	0	2
Open Elective	OST	Open Elective	3	-	3 hrs	50	50	3
		Total Credits						**23**

III Semester

Course	Course Code	Course Title	L	P	Exam Duration	Internal (%)	Externa (%)	Credits
Core	MFT 2301	Technology of Spice and Plantation Crops Processing	2		3 hrs	50	50	2
Practical	MFT 2302	Technology of Spice and Plantation Crops Processing Practical		2	3 hrs	50	50	1
Core	MFT2303	Food Additives and Flavour Technology	3		3 hrs	50	50	3
Practical	MFT2304	Food Additives and Flavour Technology Practical		4	3 hrs	50	50	2
Core	MFT2305	Food Packaging Technology	2		3 hrs	50	50	2
Practical	MFT2306	Food Packaging Technology Practical		2	3 hrs	50	50	1
Core	MFT2307	Quality Assurance and Food Safety	3		3 hrs	50	50	3
Practical	MFT2308	Quality Assurance and Food Safety Practical		2	3 hrs	50	50	2
Core	MFT2309	Food Laws and Environmental Issues	2		3 hrs	50	50	2
Core	MFT2310	Entrepreneurship and Food Business Management	1		1hr	50	50	2
Elective	MFT2311	Dried, Cured, Smoked, Marinated and Fermented foods	3		3 hrs	50	50	Choose one 3 credits
	MFT 2312	Postharvest Handling, Transportation and Storage						
	MFT 2313	Food Biotechnology						
Open Elective	OST	Open Elective	3		3 hrs	50	50	3
Activity (credit)	MFT 2314	Industrial Training						1
Activity (non-credit)		Earn While You Learn						
Non-credit course		Research Methodology/ Technical Writing						
		Total Credits						**27**

IV Semester

Course	Course Code	Course Title	L	P	Exam Duration	Internal (%)	External (%)	Credits
Core	MFT 2401	Dissertation			3 hrs		100	20
Total Credits								**20**
Total credits for M. Sc. Food Science and Technology								**90**

SYLLABUS
Semester I

MSc Food Science and Technology

I Semester

Course	Course code	Course title	L	P	Credits
Core	MFT2101	General Biochemistry	3		3

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

COMFT2101	Expected Course Outcome	Learning Domains	Mapping to PSO
COMFT2101.1	Understanding the relevance of biomolecules	R/U	1
COMFT2101.2	Relate the properties and functions of biomolecules in living system to health and metabolism	R/U	1
COMFT2101.3	Relate the properties of molecules to food matrix and evaluate it	U/A/E	1,2
COMFT2101.4	Explain basic analysis relevant to macro- and micromolecules	An/E	1,2
COMFT2101.5	Evaluate biochemical pathways significant in metabolism	U/R/A	3
**Remember (R), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

MFT2101 General Biochemistry 3

Module I 12 hours

Carbohydrates- metabolic pathways: Aerobic and Anaerobic degradation. Glycogenesis, glycogenolysis, Emden–Mayerhoff Pathway. Alternate pathways of carbohydrate metabolism. Hexose monophosphate shunt. Hormonal regulation of blood glucose.

Module II 10 hours

Bioenergetics- principle of bioenergetics. Free energy; endergonic and exergonic processes. Formation and breakdown of ATP. Biological oxidation and reduction. Oxidative phosphorylation. Enzymes involved in electron transport. Chemiosmotic theory. Inhibitors of respiratory chain.

Module III 10 hours

Composition, classification and mode of action of proteins: proteins and amino acids. Structure and classification. Protein degradation and denaturation. Urea cycle. Metabolism of amino acids. Biosynthesis of Proteins. Nucleic acids and nucleotides. Structural changes of proteins during food processing.

Enzymes: Classification, structure, activity and inhibition. Biosynthesis. Role of enzymes in digestion and metabolism. Role of enzymes in industrial food processing.

Protein hormones and their role in human health. Hormone action, regulation and biosynthesis.

Module IV 12 hours

Lipids: Fatty acids: saturated and polyunsaturated fatty acids; omega-3 and omega -6 fatty acids. Biosynthesis of fatty acids. Beta- oxidation. Triglycerides and phospholipids. Structure and composition of fatty acids of common edible oils. Auto-oxidation. Estimation of oxidative rancidity in foods- peroxide value, thiobarbituric acid value, role of antioxidants, Essential fatty acids and their role in human nutrition.

Module V 10 hours

Prostaglandins, thromboxanes and leucotrienes-formation from arachidonic acid and role of cyclo-oxygenases. Their structure and biosynthesis and role in pathology.

Regulatory metabolism: Inter relation of carbohydrates, lipids and proteins. Role of vitamins in human health and their deficiency diseases. Diabetics, types of diabetics.

Reference books

Boyer, R.F. 2002. Concepts in Biochemistry, 2nd edn. Wiley, New York.C Campbell,

M.K. and S.O. Farrell. 2002. Biochemistry, 4th edn. Brooks/ Cole. Metzler, D.E. 2003.

Biochemistry, 2nd edn. Academic Press.

Moran, A. L., Horton, A. R., Scrimgeour, G., & Perry, M. (2011). Leninger Principles of biochemistry.

Nelson, D.L. and M.M. Cox. 2000. *Lehninger's Principles of Biochemistry*, 3rd edn. Macmillan Worth Publishers.

Tumpf, P.K., G.Bruening, and R.H. Doi. MM. 2001. *Outlines of Biochemistry*, 5th edn. H e i n e m a n n Medical Books.

M. Sc. Food Science and Technology

I Semester

Course	Course code	Course Title	L	P	Credits
Core	MFT2102	Food Chemistry and Nutrition	3		3

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

COMFT2102	Expected Course Outcome	Learning Domains	Mapping to PSOs
COMFT2102.1	Demonstrate a sound knowledge of the macro- and micro-components of food	U	1
COMFT2102.2	Relate the properties and structures of the chemical components to the physical, chemical and functional properties of the food	A/E	1
COMFT2102.3	Describe the physical and chemical interactions between food components and their impact on nutrition and quality	An/E	1,2
COMFT2102.4	Explain the basic analyses of major and trace food components	An/E	1,2
COMFT2102.5	Evaluate and interpret food analysis data and communicate in a scientific manner	An/E	2
**Remember (R), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

MFT2102 Food Chemistry and Nutrition 3

Module I **10 hours**

Food Chemistry – definition, scope and importance of water in food, physical properties of water and ice. Water activity and relative vapour pressure. Relative vapour pressure and food stability.

Principles of colorimetry, spectrophotometry, fluorometry, atomic absorption spectroscopy and chromatographic methods- HPLC and GC.

Module II **12 hours**

Carbohydrates- classification, physical and chemical properties of sugars; functional properties and uses of pectic substances; gums and dietary fibre in food; browning reaction in food- enzymatic and non-enzymatic browning, their occurrence and application in food. Starches: functionality of starch in foods, gelatinization and retro gradation of starches, modified starches, resistant starch.

Module III **12 hours**

Chemistry of amino acids and proteins. Classification of proteins, chemical and physical properties of proteins; techniques used in elucidation of protein structure. Protein conformation, functional properties of proteins in foods, hydrolysis of protein, major food proteins and their sources. Changes in proteins during processing, chemical modification of proteins. Enzymes– classification, mechanism of action, purification, commercial applications, food enzymes.

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Module IV **10 hours**

Oils and fats- their chemistry, occurrence, classification and composition. Physical and chemical properties of fats. Rancidity and flavor reversion, oil sources, extraction and refining, hydrogenation and interesterification.

Module V **10 hours**

Vitamins, classification, properties and chemistry; enrichment and fortification; changes during processing. Emulsions, definition, classification and functional properties. Essential oils, chemistry, occurrence and extraction. Terpeneless oils and their uses in food.

Reference books

Belitz, H.D. (2005). *Food Chemistry*. Springer Verlag.

Lee, F. (2012). *Basic food chemistry*. Springer Science & Business Media. Srinivasan,

Damodaran, Kirk, L. Park and Owen R. Fennema. 2008. *FoodChemistry*, CRC Press,

Taylor and Francis Group, New York.

Varelis, P., Melton, L., &Shahidi, F. (2018). *Encyclopedia of Food Chemistry*. Elsevier.

Velisek, J., Koplik, R., &Cejpek, K. (2020). *The chemistry of food*. John Wiley & Sons.

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I Semester

Course	Course code	Course title	L	P	Credits
Practical	MFT2103	Biochemical and Food Analysis Practical		4	2

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

COMFT2103	Expected Course Outcome	Learning Domains	Mapping to PSOs
COMFT2103.1	Demonstrate sampling methods for food analyses	U/A	1,2
COMFT2103.2	Estimation of proximate composition of food	An/E	2
COMFT2103.3	Analyse physico-chemical properties of food	An	2
COMFT2103.4	Apply chemical separation techniques in food analysis	U/A	2,3,4
COMFT2103.5	Analyses of data, interpretation and communication in scientific manner	U/S	2,3,4,5
**Remember (R), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

- Estimation of glucose in food
- Estimation of sodium, potassium, calcium and iron in food
- Purification of proteins
- Separation of proteins by gel electrophoresis
- Chromatography- column, paper, thin layer, GLC
- Sampling techniques and sampling of foods for analyses
- Estimation of moisture, proteins, Nitrogen, fats, minerals, sugar, crude fibre in foodsz
- Estimation of amino acids
- Estimation of vitamins– ascorbic acid, carotene, thiamine
- Analysis of lipids– free fatty acid, acid value, saponification value and iodine value
- Determination of starch and pectin substances using different methods
- Isolation of starch and casein
- Estimation of lactose in milk

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I Semester

Course	Course code	Course title	L	P	Credits
Core	MFT2104	General Microbiology	3	0	3

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

COMFT2104	Expected Course Outcome	Learning Domains	Mapping to PSOs
COMFT2104.1	Explain the morphology and ultrastructure of microbes, microscopic techniques, staining methods, and their application.	U	1
COMFT2104.2	Demonstrate various culture media, culturing techniques, methods of growth and reproduction and preservation methods of bacteria	U	1
COMFT2104.3	Explain phenotypical and genotypical modifications in bacteria, interpret different types of mutations and extend the discussion to bacterial recombination process	R/An	1,2
COMFT2104.4	Explain taxonomy, nomenclature and classification of bacteria based on classical and molecular characteristics.	U	1
COMFT2104.5	Apply various methods of physical and chemical control of microorganisms with special emphasis on the evaluation of disinfectant action.	R/A	1,2
R-Remember, U- Understand, A-Apply, An-Analyse, E-evaluate, C-Create, S-Skill, I-Interest and Ap Appreciate			

MFT2104 General Microbiology 3

Module 10 hours

The scope and evolution of microbiology; the five-kingdom concept; prokaryotes and eukaryotes; types of microorganisms: bacteria, fungi and virus.

Microscopy- general principles, types of microscope- bright field, dark field, UV, fluorescent, phase contrast and electron microscopes. Microscopic examination of bacteria- wet mount, fixed and stained; microbiological stains- simple and differential staining, Gram, acid fast, spore and negative staining.

Characteristics of bacteria- morphology and fine structure- cell wall, flagella, fimbriae, capsules, internal structure- cytoplasmic membrane, cytoplasm, inclusion bodies, nuclear material, spores.

Module II 10 hours

Cultivation of bacteria- nutritional requirements, nutritional types of bacteria, bacteriological media- types of media- general, selective media and differential media. Physical conditions for growth- effect of environment on growth.

Reproduction and growth of bacteria- cell division and new cell formation, growth rate and generation time, growth curve. Batch culture and continuous culture, measurement of growth. Isolation of bacteria, cultural characteristics of bacteria, maintenance and preservation of bacterial culture, type culture collections

Module III 10 hours

Bacterial metabolism- energy production and utilization, fundamental principles of energetics, oxidation-reduction reactions and energy production, respiratory chain. Energy metabolism in heterotrophic and chemoautotrophic bacteria, anaerobic respiration, energy utilization by bacteria.

Bacterial modifications, mutation and genetics- phenotypical modifications- morphological, cultural and biochemical, genotypical modifications- mutation, types of mutations, replica plating, bacterial recombination, conjugation, transformation and transduction.

Bacterial taxonomy- nomenclature and classification, classification schemes, Bergy's and Adansonian Classifications.

Module IV 12 hours

Fungi- moulds and yeasts. Distinguishing characteristics of moulds- morphology and cell structure. Reproduction- sexual and asexual spores. Physiology and nutrition of moulds- cultivation of moulds. Morphological examination- classification of moulds, important groups of moulds. Yeasts- morphology and structure, cultural characteristics, reproduction, physiology of yeasts, classification of yeasts.

Viruses- animal viruses; Virion- structure and composition, replication of viruses, isolation and identification, cultivation of animal viruses. Bacterial viruses- bacteriophages, general characteristics, morphology and structure, isolation and cultivation, reproduction of bacteriophages- lytic and lysogenic cycles; bacteriocins.

Module V 12 hours

Control of microorganisms- fundamentals of control- control by physical agents. Heat sterilization- dry and moist heat, steam under pressure, autoclaves- laboratory and industrial models, pasteurization. Control by low temperature, desiccation, osmotic pressure, radiations- UV, X-ray, electron beam, radurisation and radappertisation. Filtration sterilization- bacterial filters, Seitz filter, Berkfield, Chamberland filters, sintered glass filters, membrane filters, HEPA filters. Chemical control of

microorganisms- disinfectants, germicides, sanitizing agents. Groups of antimicrobial agents- phenols, alcohols, halogens, hypochlorites, chloramines, heavy metals- oligodynamic action. Antimicrobial action of dyes, quaternary ammonium compounds, glutaraldehyde and formaldehyde, ethylene oxide, beta-propionolactone. Evaluation of disinfectant action- the phenol coefficient. Control by antibiotic and therapeutic agents.

Reference books

Ananthanarayanan and JayaramPaniker. *Text Book of Microbiology*. Pelczar ,

Reid and Chan. *Microbiology*. Tata McGraw hill edition.

Salle, mA. J. *Fundamental Principles of Bacteriology*. TMH Edn.

Surendran, P.K., Nirmala Thampuran, V. N. Nambiar and K. V. Lalitha. *Laboratory Manual on Microbiological Examination of Seafood*. CIFT, Cochin.

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I Semester

Course	Course Code	Course Title	L	P	Credits
Core	MFT2105	Food Microbiology	3		3

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

Course Outcome No.	Expected Course Outcome	Learning Domains	Mapping to PSOs
1	Classify and compare the different categories of microorganisms relevant to food system	R	1
2	Explain various factors affecting the microbial growth in food and their nutritional requirements and will be able to identify the sources of microbial contamination and spoilage of food	U/A	1
3	Summarize the different kinds of food spoilage, various principles of food preservation and their suitable applications in food	U/A	1
4	Explain different food borne infections and intoxications and recommend measures for its prevention	U/E	2,3,4
5	Utilization of microorganisms for the production of different food products	U/A/C	2,3,4,5
**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

MFT2105 Food Microbiology 3

Module I 10 hours

Microorganisms of importance in foods- major genera usually found in foods. Morphological, cultural and physiological characters of bacteria, moulds and yeasts important in foods. Industrially important moulds. Intrinsic and extrinsic factors in food affecting growth of microorganisms. Sources of microbial contamination of food- General principles underlying spoilage of food- causes of spoilage, classification of foods based on ease of spoilage.

Module II 12 hours

Principles of food preservation- preservation by use of high temperature- heat resistance of microorganisms and their spores, thermal death time, TDT curve, decimal reduction time, D-value, z-value and F-value. Determination of thermal process,12 D concept. Preservation by retorting and pasteurization.

Low temperature preservation of foods- effect of chilling and freezing on microorganisms. Preservation by curing and drying- effect of water activity; microbiology of dried foods.

Module III 10 hours

Contamination, preservation and spoilage of different food items– cereal and cereal products, sugar and sugar products, vegetables and fruits, meat and meat products, fish and other seafood, eggs, poultry and milk and milk products. Spoilage of canned foods- causes of spoilage, classification of canned foods based on acidity; aerobic and anaerobic spoilage of canned foods. Spoilage of dried and cured products. Spoilage of oils, bottled beverages, spices, etc.

Module IV 10 hours

Food borne infections and intoxications. Bacterial food poisoning- infection types, *Vibrios, Salmonella*, enteropathogenic *E.coli, Clostridium perfringens, Campillobacter, Shigella*. Intoxication type- *Clostridium botulinum* and botulism, *Staphylococcus aureus, Bacillus cerius*. Mycotoxins- aflatoxin, ochratoxin. Food-borne viral infections- Enteroviruses, Hepatitis virus, Polio virus. Algal toxins- paralytic shellfish toxin, ciguatera toxin. Parasites- protozoa.

Module V 12 hours

Fermented food products. Fermentation- definition, types of food fermentations- lactic acid fermentation, bacterial cultures involved, homo fermentation and hetero fermentation. Pathways of fermentation- propionic acid fermentation, cultures involved; alcoholic fermentation, cultures involved, pathways of alcohol production from different substrates. Products of fermentation- dairy products, bread, malt beverages- beer- different types, wines, distilled liquors, vinegar fermentation, fermented vegetables, tea, coffee and cocoa fermentation.

Reference books

Doyle, M. P., Diez-Gonzalez, F., & Hill, C. (Eds.). (2020). *Food microbiology: fundamentals and frontiers*.

John Wiley & Sons.

Jay, James, M. 2000. *Modern Food Microbiology*, 2nd edn. CBS Publisher.

Shen, C., & Zhang, Y. (2017). *Food Microbiology Laboratory for the Food Science Student: A Practical Approach*. Springer.

Surendran, P.K., Nirmala Thampuran, V. N. Nambiar and K. V. Lalitha. *Laboratory Manual on Microbiological Examination of Seafood*. CIFT, Cochin.

MSc Food Science and Technology

I Semester

Course	Course code	Course title	L	P	Credits
Practical	MFT2106	Microbiology Practical	0	4	2

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

COMFT2106	Expected Course Outcome	Learning Domains	Mapping to PSOs
COMFT2106.1	Demonstrate good laboratory practice and safety measures in the microbiology laboratory	U	1
COMFT2106.2	Develop practical skills in microscopy and their handling techniques and demonstrate various staining methods of bacteria and fungi from different sources	A	2,3
COMFT2106.3	Prepare various culture media and demonstrate pure culture techniques for the isolation of microorganisms	A	2,3,4
COMFT2106.4	Analyze the total population of bacteria and fungi in food samples	An	3,4,5
COMFT2106.5	Apply various biochemical tests and perform antibiotic sensitivity assay to evaluate the response of bacteria	A/An	3,4,5
R-Remember, U- Understand, A-Apply, An-Analyse, E-evaluate, C-Create, S-Skill, and Ap Appreciate			

MFT2106 Microbiology Practical 2

- Introduction to good laboratory practice and safety in the microbiology laboratory
- Microscopy- lens system, proper use and care
- Sterilization of petri dishes, pipettes, tubes, etc. by dry sterilization; Sterilization of culture media by steam sterilization, preparation of culture media- nutrient agar (in flasks and as slants), nutrient broth, diluents (in flasks and in test tubes)
- Preparation of bacterial stains- Simple (methylene blue), Gram- stains; Culture transfer techniques- use of inoculation loop and needle
- Bacterial motility - plain and cavity slides; Bacterial transfers, isolating single colonies, streak dilution for pure cultures, colony morphology; Staining of bacterial cultures- simple staining (methylene blue), differential staining (Gram staining), spore staining, negative staining, flagella staining
- Determination of total bacterial count of a sample- pour and surface (spread), plating techniques; MPN techniques for indicator bacteria- coliforms, faecal coliforms and *E.coli*; Biochemical reactions of isolated cultures- nitrate reduction, indole production; Starch hydrolysis, sugar fermentation, MR VP tests, catalase and cytochrome oxidase tests; Presumptive identification of bacterial isolate
- Effect of environment on bacterial growth- effect of salt, incubation temperature, pH; Testing of antibiotic sensitivity of bacteria- agar diffusion method.
- Isolation of yeast and mould– plating of a commercial food product on potato dextrose agar/ DRBC agar/ RBC agar; Isolation and staining of mould and yeast; Phenol coefficient method for comparing disinfectant action
- Determination of total bacterial population of a given food (raw) material/ commercial spice sample/ cereal flour sample using nutrient agar/ TG agar
- Determination of lactic acid bacterial (LAB) count of curds/ fermented product using MRS agar with agar overlay
- Estimation of mould and yeast count of wheat flour/ commercial spice powders using PD agar and DRBC/ RBC agar
- Determination of total coliforms and *E. coli* in a commercial fish/ meat sample using VRBGA and T7 agar; *Staphylococus aureus* using BP agar; faecal streptococci in a given sample using KF agar;
Salmonella in raw fish /meat sample by adopting a standard procedure; *V. cholera/ V. parahaemolyticus*
- Estimation of SO^3-reducing clostridia in a given sample; commercial sterility

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I Semester

Course	Course code	Course Title	L	P	Credits
Core	MFT2107	Biostatistics and Computer Applications in Food Industry	3		3

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

COMFT2107	Expected Course Outcome	Learning Domains	Mapping to PSOs
COMFT2107.1	Summarize the basic concepts in statistics and illustrate data graphically and numerically	U/A	1,2
COMFT2107.2	Examine the relationships between data, sampling and distributions	A/E	2,3,4
COMFT2107.3	Demonstrate ability in mathematical and statistical theory including inference and modeling principles	U/A	1,2
COMFT2107.4	Classify the methods, theories and approaches used in sensory evaluation and consumer testing	U/A	1,2
COMFT2107.5	Relate AI frameworks and platforms in the food industry.	U	1
**Remember (R), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

MFT2107 Biostatistics and Computer applications in Food Industry 3

Module I **10 hours**

Elementary concepts in Statistics: Concepts of statistical population and sample from a population; qualitative and quantitative data; nominal, ordinal, ratio, interval data Collection and scrutiny of data, Sampling and nonsampling errors, Sample size determination, Cluster and Multistage Sampling, Examples based on biostatistical experiments, Presentation of data: Diagrammatic and graphical representation of data; histogram. Descriptive statistics: measurement of uncertainty, Concepts of central tendency, Absolute and relative measures of dispersion; Box plot, Lorenz curve.

Module II **14 hours**

Analysis of Bivariate data and Probability: Correlation: Scatter diagram, Principle of least squares, Karl Pearson's correlation coefficient, rank correlation, partial and multiple correlations. Linear regression: Simple linear regression, multiple regression, fit of polynomials and use of orthogonal polynomials. skewness and kurtosis (theory only). Concepts of probability and random variable, Evaluation of probabilities from the binomial and Poisson distributions. Central limit theorem (no derivation) and it'sapplication,Sampling distributions (chi-square,t,F, no derivations), Distribution of sample mean from the population.

Module III **10 hours**

Theory of Estimation and Testing of hypothesis: Point estimation and interval estimation(mean) Basic principles of Experimental Designs, Elements of Quality Control: types, sample procedure, control charts, Testing of hypothesis, Parametric tests, testing of significance based on Z-test, t-test, F- test, Chi-square test, Analysis of Variance,one way and two way classifications

Module IV **10 hours**

Sensory and consumer data: The nature and quality of sensory and consumer data, experimental design issues, survey data, trained panel sensory data, analysis of relationships. Instrumental data: Quality and nature of instrumental data, sampling and replication, experimental design issues, statistical analysis, chemical analysis applications, analysis of relationships. Product formulation: design application in food product development, single ingredient effects, two or more ingredient effects, screening of many ingredients, formulation by constraints. Statistical quality control: types, sample procedure, control charts, acceptance sampling.

Module V **10 hours**

Artificial intelligence, robotics, Simulation and Food process modelling, familiarization of applications of computer and software in food industries. Application of computers in instrumentation and control of food machinery, inventory control, process control. Visit to Industry and case study.

Reference books

Agarwal B.L. Basics Statistics, New Age International (p) Ltd.

Cochran, W.G. (2002). Sampling Techniques. Wiley

Croxton, F.E., Cowden, D.J. Klenis, S. Applied General Statistics, Prentice Hall.

Daniel, W. W. (2007). Biostatistics- A Foundation for Analysis in the Health Sciences,Wiley.Pagano, M.&Gauvreau, K. (2007). Principles of Biostatistics.

Dutta, N. K. (2004). Fundamentals of Biostatistics, Kanishka Publishers.

Gurumani N. (2005). An Introduction to Biostatistics, MJP Publishers.

Nabendu Pal and Sahadeb Sarkar (2013) . Statistics - Concepts and Applications. PHI Learning Private Limited, New Delhi.

Rengasamy R. (2013) AText book of Agricultural New Age International (p) Ltd. Rossi

R.J. (2010). Applied Biostatistics for Health Sciences, Wiley.

Sampath S. (2005). Sampling Theory and Methods.

Wilcox, R. R. (2009). *Basic statistics: understanding conventional methods and modern insights*. Oxford University Press on Demand.

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I Semester

Course	Course code	Course Title	L	P	Credits
Practical	MFT2108	Biostatistics and Computer Applications in Food Industry Practical		2	1

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

COMFT2108	Expected Course Outcome	Learning Domains	Mapping to PSOs
COMFT2108.1	Demonstrate a sound knowledge in using statistical tools	U/R	1
COMFT2108.2	Apply the statistical tools and MS Office tools to portray data visually and diagrammatically	A/E	2,3,4
COMFT2108.3	Apply the sensory evaluation tools in food analyses	An/E	4
COMFT2108.4	Apply the statistical tools in various case-studies	An/E/S	3,4
COMFT2108.5	Evaluate and interpret data and communicate scientifically	S	3,4
**Remember (R), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

- Sample techniques
- Data analysis using Excel/ SPSS/ SAS/ MINITAB
- Graphical representation of data, computation of various measures of central tendency and dispersion.
- Computation of correlation coefficient, fitting of simple linear regression.
- Construction of confidence intervals concerning mean.
- Parametric tests of Hypothesis concerning mean.
- Chi-square tests for goodness of fit and independence.
- ANOVA and ANACOVA
- Student's t-test
- Consumer survey and data analysis
- Quality control data collection and analysis
- Sensory panel data collection and analysis
- Instrumental data analysis

Syllabus
Semester II courses

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II Semester

Course	Course Code	Course Title	L	P	Credits
Core	MFT2201	Principles of Food Engineering and Plant Layout	3		3

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

COMFT2201	Expected Course Outcome	Learning Domains	Mapping of PSOs
COMFT2201.1	Summarize the concept of fluid dynamics and viscosity and its significance in foods.	U/A	1
COMFT2201.2	Explain the fundamental mechanisms of heat transfer and heat exchangers and thermal processing units in food industry	U	1
COMFT2201.3	Outline the principles, instrumentation and phase change in unit operations in food processing	U/A	1
COMFT2201.4	Illustrate the mechanical handling operations and their applications in the food industry	U	1
COMFT2201.5	Summarize the importance of plant designs, process economics and regulatory requirements for food industries	U/A	1
**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

MFT2201 Principles of Food Engineering and Plant Layout 3

Module I **10 hours**

Introduction to food engineering. Mass and energy balance, fluid dynamics, fluid flow applications. Factors influencing heat and mass transfer. Newtonian and non-Newtonian fluids. Viscosity and texture-significance in foods. Viscoelastic behavior of dough/ paste. Instruments for measuring viscosity and texture.

Module II **12 hours**

Mechanisms of heat transfer- conduction, convection, radiation. Thermal properties of foods. Conductive heat transfer in solid foods; convective heat transfer coefficient, forced convection, overall heat transfer coefficient. Heat exchangers, evaporators, condensers, jacketed kettles. Thermal processing principles-evaporation, pasteurization, sterilization, distillation, blanching, HTST, UHT. Batch and continuous operations. Types of retorts and pasteurizers.

Module III **12 hours**

Phase change operations- evaporation, drying, sublimation. Mass and heat transfer, enthalpy. Factors influencing drying rate, water activity, equilibrium relative humidity, vapour pressure, drying curve, sorption isotherms. Types of dryers and evaporators.

Freezing and thawing- ice crystal formation- influence on rate of freezing; freezing and thawing curves. Principle of mechanical refrigeration; properties of refrigerants. Thawing techniques- air, water, dielectric, etc. Types of freezers.

Freeze drying- phase diagram and triple point of water.

Module IV **10 hours**

Mechanical separations- filtration, membrane concentration, sieving, centrifugation, sedimentation. Mechanical handling of foods- conveying, elevation. Size reduction- mixing, kneading, blending. Other process techniques- irradiation, infra-red, pulsed electric, etc.

Module V **10 hours**

Plant designs: process designs development and general design considerations.

Process economics: Economic feasibility of projects using order of magnitude cost estimates

plant and equipment cost estimations, product cost estimations; batch versus continuous operations. Factors to be considered for location and layout of food plants. Regulatory requirements of food industries. Decision processed for raising efficiency, productivity and quality in food plant operation.

Reference books

Berk, Z. (2018). *Food process engineering and technology*. Academic press. Das, H.

2005. *Food Processing Operations Analysis*. Asian Books.

Heldman, D. R. (Ed.). (2012). *Food process engineering*. Springer Science & Business Media

Majumdar, A.S. 2004. *Dehydration of Products of Biological Origin*. Oxford and IBH Publication.Rao, G.C. 2006.*Essentials of Food Process Engineering*.BS Publications.

Rao, M.A, S.S.H. Rizvi and A.K. Datta. 2005. *Engineering Properties of Food*, 3rd edn.Taylor and Francis.

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II Semester

Course	Course code	Course Title	L	P	Credits
Core	MFT2202	Technology of Cereals, Legumes and Oilseed Processing	3		3

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

COMFT2202	Expected Course Outcome	Learning Domains	Mapping to PSOs
COMFT2202.1	Demonstrate a sound understanding of nutrition and structure of grains, legumes and oil seeds	R/U	1
COMFT2202.2	Relate the nutritional and structural characteristics on processing and preservation of grains, legumes and oilseeds	R/U	1
COMFT2202.3	Classify the concept of quality in relation to grains, legumes, oilseeds and by-products or value added products	An/E	1
COMFT2202.4	Recommend the sustainable utilization of underutilized resources for future developments and innovations.	An/E	2,3,4
COMFT2202.5	Evaluate and interpret grain, legume, oilseed quality data and communicate in a scientific manner	E/S	3,4,5
**Remember (R), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

MFT2202 Technology of Cereal, Legume and Oils Seed processing 3

Module I **12 hours**

Current status, growth rate, and economic importance of bakery and confectionary industry in India. Product types, nutritional and safety of products, pertinent standards and regulations.Post harvest management, handling, transportation and storage, infestations and pest control.

Production of cereals, legumes and oil seeds in India, production statistics. Commercially important varieties. Harvest, transport, storage.

Wheat: Types and characteristics. Milling. Wheat based products and by products. Gluten content in wheat. Wheat flour and *atta*- manufacture *atta*, commercial methods.

Module II **8 hours**

Rice: Types of germ plasm. Physical and chemical characteristics and proximate composition of commercially important varieties. Starch content. Processing of rice- milling, par-boiling. Rice bran and rice bran oil. Effect of different types of processing on storage and keeping quality of rice.

Rice based products, Production of rice powder. Rice based commercial products and by-products. *Basmathi* rice and its flavour components.

Module III **10 hours**

Other cereals: Maize, corn, barley, oats, sorghum and millets- varieties, chemical composition; nutritive value. Methods of processing. Products and value added products.

Module IV **10 hours**

Legumes: Commercially important species. General composition, characteristics and processing. Products and value added products.

Module V **8 hours**

Oils seeds: Major commercial species. Methods of production of oil.

Vegetable oils- fatty acid composition, methods of commercial extraction, refining, bleaching and deodorization, coconut processing and coconut oil extraction

Module VI **6 hours**

Bakery Products: Ingredients and processes for breads, biscuits, cookies and crackers, cakes and pastries, doughnuts, rusks, other baked products.

Equipment, product quality characteristics, faults and corrective measures for bakery products. Defining and assessing quality of ingredients and products, breakfast cereals, macaroni products, sprouted grains.

Reference books

Chakraborty, M.M. 2003. *Chemistry and Technology of Oils and Fats*. Prentice Hall.

Delcour, Gunstone, F. (Ed.). (2011). *Vegetable oils in food technology: composition, properties and uses*. John Wiley & Sons.

Dendy, D.A.V. and Dobraszczyk, B.J. 2001. Cereal and Cereal Products. Aspen. Owens, G. (Ed.). (2001). *Cereals processing technology*. CRC Press.

Pyler, E.J. and L.A. Gorton. 2009. *Baking: Science and Technology*, Vol. II: Formulation and Production, 4th edn. Sosland Publishing Co., Kansas City.

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II Semester

Course	Course code	Course title	L	P	Credits
Practical	MFT2203	Technology of cereals, legumes and oilseed processing practical		2	1

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

COMFT2203	Expected Course Outcome	Learning Domains	Mapping to PSOs
COMFT2203.1	Identify the processing technology associated with cereals, pulses & oil seeds	A/An	2
COMFT2203.2	Evaluation of physical, chemical and rheological characteristics of cereals	A/E	3,4
COMFT2203.3	Create and analyze the composition of baked products including bread, biscuit and cake	An/C	3,4
COMFT2203.4	Create and apply the skills of processing and evaluation and development of value added products	A/U/E	4,5
COMFT2203.5	Experiential learning through industrial visits	An/E	4,5
R-Remember, U- Understand, A-Apply, An-Analyse, E-evaluate, C-Create, S-Skill, and Ap Appreciate			

- Estimation of proximate composition of cereals
- Estimation of proximate composition of oil seeds
- Estimation of proximate composition of legumes
- Estimation of rheological properties of rice and wheat
- Determination of gluten content of wheat
- Parboiling of rice and practical training of milling at domestic/ industrial establishments
- Estimation of amylose content of rice
- Malting, puffing and popping of grains
- Extraction of rice bran oil and purification
- Preparation of bread and cakes
- Preparation of buns
- Preparation of cookies and biscuits in the laboratory
- Visit to industrial establishments

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II Semester

Course	Course code	Course Title	L	P	Credits
Core	MFT2204	Technology of Fruit and Vegetable Processing	3		3

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

COMFT2204	Expected Course Outcome	Learning Domains	Mapping to PSOs
COMFT2204.1	Demonstrate a sound understanding of fundamentals of processing and preservation of fruits and vegetables	U	1
COMFT2204.2	Identify the equipments used in fruit and vegetable processing	U/A	2,3,4
COMFT2204.3	Relate the chemical composition, pigments and enzymes to processing and preservation of fruits and vegetables	A/An	1
COMFT2204.4	Summarize the standards and quality parameters for fruits and vegetables	U	1
COMFT2204.5	Explain the sustainable utilization of underutilized native fruit and vegetable resources for future developments and innovations	U/A	2,3,4
**Remember (R), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

MFT2204 Technology of Fruit and Vegetable Products **3**

Module I **12 hours**

Global production trends. Climacteric and non-climacteric fruits. Physiology of maturity, ripening, and senescence in fruits, and vegetables. Maturity indices and harvesting of vegetables. Post-harvest losses, phases of loss and measures to reduce the losses.

Preservation, handling, packing and transport of fresh fruits and vegetables; pre-processing, grading, cleaning and storage- chilled storage, modified atmosphere packing.

Scope of fruits/vegetables of commercial importance in Kerala: Mango, Banana, Jackfruit, Pineapple, Papaya, Guava, Passionfruit, Rose Apple, Custard Apple, Breadfruit, Gooseberry, Bimbli, Carambola, Mangosteen, Rambutan,Tapioca and Yams.

Module II **10 hours**

Processing methods by drying and osmotic dehydration using sugar. Flavour, colour and nutritional changes during drying and storage. Production of fruits juice powders by vacuum drying, spray drying and freeze drying. Production of marinades and pickles.

Module III **12 hours**

Production of juices, jams, pastes and marmalades. Pectin content of fruits, role of pectin in products. Pasteurisation, Canning of fruits in sugar syrup; vegetables in brine. Bottling, canning and retort pouch packing of fruit and vegetable products, Retorts. Preservatives and antioxidants used in fruit processing.

Tomato based products like purees and sauces. Fermented fruit juices. Aseptic packing of fruits and vegetables and their extracts.

Module IV **12 hours**

Freezing of fruits and vegetables: methods and equipment. Problems associated with freezing

Fruit and vegetable based value added products. Jellies, soups, sugar preserved candies, fruit bars- methods of production.

Fruit preservatives and flavour enhancers. Extraction of natural colours from fruits and vegetables for use in food industries and their standards and quality parameters.

Module V **8 hours**

Technology of production of wine, beer and alcohol production from sugars, starches and fruits juices. Technology of processing of drinking water. Waste utilization- ensilage using vegetables.

Reference books

Alzamora, S.M., M.S. Tapia and A. Lopez- Malo. 2005. *Minimally Processed Fruits and Vegetables: Fundamental Aspects and Applications.* Springer.

CBS. 2005. *Hand Book of Fruit Science and Technology: Production, Storage and P r o c e s si n g*. Marcel, Dekker.

Salunkhe, D.K.and S.S.Kadam. 2005. *Handbook of Fruit Science and Technology: Production, Composition, Storage and Processing*. Marcel Dekker.

Vaclavik, V.A. and E. W. Christian. 2005. *Essentials of Food Science*. 2nd edn. Springer.

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II Semester

Course	Course code	Course title	L	P	Credits
Practical	MFT2205	Technology of Fruits and vegetable processing practical's		2	1

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

COMFT2205	Expected Course Outcome	Learning Domains	Mapping to PSOs
COMFT2205.1	Evaluation of FSSAI specifications in fruit and vegetable products	R/U/An	1,2
COMFT2205.2	Demonstrate processing of fruit and vegetable and develop value added products	U/A	1,2
COMFT2205.3	Demonstrate various post-harvest operation of fruits and vegetables	U/A	1,2
COMFT2205.4	Apply the processing and preservation skills in fruit and vegetable products	A/An	3,4,5
COMFT2205.5	Demonstration of novel technologies in preservation and packaging of fruits and vegetables	U/A	1,2
R-Remember, U- Understand, A-Apply, An-Analyse, E-evaluate, C-Create, S-Skill, and Ap Appreciate			

MFT2205 **Technology of Fruit and Vegetable Products Practical** **1**

- Quality evaluation of fruits and vegetables by visual and sensory methods
- Extraction of fruit juices and processing drinks using sugar and preservatives
- Pre-processing of vegetables
- Preparation of dried fruits and vegetables
- Preparation of jams
- Preparation of jellies and marmalades
- Freezing preservation of fruit and vegetable products
- Pickling of fruits
- Pickling of vegetables
- Industrial training in commercial establishments/factories.
- Extension of shelf life of various foods/ agricultural produce by irradiation
- Modified atmospheric packaging to extend shelf life of vegetables and fruits
- Determination of water activity and drying curve of foods

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II Semester

Course	Course Code	Course Title	L	P	Credits
Core	MFT2206	Technology of Meat, Poultry and Dairy Processing	3		3

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

COMFT2206	Expected Course Outcome	Learning Domains	Mapping to PSOs
COMFT2206.1	Define the basic principles and terminology related to the processing, production, and storage of meat, poultry, and dairy products..	R	1
COMFT2206.2	Compare the different types of meat and their physical and chemical characteristics; the fundamental processes involved in the production of meat, poultry, and dairy products	U	1,2
COMFT2206.3	Apply knowledge to solve practical problems in meat, poultry, and dairy processing.	U/A	1,2,3
COMFT2206.4	Evaluate the importance of utilizing by-products of meat industry	U/A	2,3
COMFT2206.5	Apply knowledge for value addition to meat, poultry and milk	A	2,3,4,5
**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

MFT2206 Technology of Meat, Poultry and Dairy Products 3

Module I **12 hours**

Meat: Different types of meat- beef, mutton, pork, rabbit meat, etc.- their physical and chemical characteristics, and proximate composition.

Structure of muscle and its properties as meat: the muscle cell and different classes of proteins in meat. Muscle contraction- rigor mortis. Cold shortening, muscle aging. Muscle structure and meat toughening.

Collagen: Role of collagen in meat texture and quality. Drip loss. Effect of cooking- loss of water. Recent advances in the chemistry of rancidity of fat in meat. Autoxidation and free radical mechanism. Estimation of rancidity in meat. Chemistry of meat flavor. Chemistry of meat binding.Meat microbiology and safety; microbial spoilage of meat.

Module II **10 hours**

Abattoirs- layout and requirements. Stunning methods, methods of slaughtering and dressing, hoisting facilities, tenderization. Fresh meat inspection.

Processing of meat and preservation- drying, smoking, pickling, canning and freezing methods; vacuum and gas packing of meat. Meat based products like salami, kebabs, sausages, minces and intermediate moisture foods.

Module III **10 hours**

Poultry industry. Production of broiler chicken and meat quality. Poultry processing plant, processing operations- bleeding, scalding, de-feathering.

Microbiology of poultry meat. Preservation by chilling and freezing. Poultry meat products- dressed chicken, sausage, cutlets, etc. Packing of products.

Eggs: Chicken and duck eggs and their basic differences; composition, vitamin and cholesterol contents; nutritive value.Products- whole egg, egg powder, egg yolk products. Production, packing, transport and storage techniques.

Module IV **10 hours**

By products of meat industry: Gelatin, albumins and important biochemical- insulin, bile salts, haemoglobin, etc. and their production methods and applications in industry/ medicine. Extraction of wool and wool processing.

By-products of poultry industry: Gelatin from egg and its commercial uses. Use of poultry waste.

Mould V **12 hours**

Dairy products: Composition of milk of different animals. Testing of milk. Preservation- pasteurization and bottling of milk. Operations in a dairy plant. High temperature processing (UHT) of milk and packing. Production of whole/ skim milk powder, condensed milk, and milk based products like cream, butter, cheese, yogurt, *ghee*, *khoa*, *burfi*, *paneer*, other milk sweets. Freezing preservation of milk and milk products, Microbial changes in freeze preservation. Technological aspects of freezing (freezing methods). Phase diagrams and freezing curves for pure water and water in foods. Freezing point depression, nature of freezing process, crystallization. Frozen storage, thawing.

Ice cream- various types, characteristics; additives- their roles; and preservatives used in manufacture. Standards for ice creams as per Bureau of Indian Standards and other international agencies like USFDA and *Codex Alimentarius.*

Reference books

Aneja, R.P., Mathur, B.N., R.C. Chandan and A.K. Banerjee. 2002. *Technology of Indian M i l k Products*. Dairy India Publ.

Gopakumar, K. 1997. *Tropical Fishery Products*. Oxford and IBH.

Hui, Y.H. 2001. *Meat Science and Applications*. Marcel and Dekker. Kerry *et al*. 2002. *Meat Processing*. Woodhead Publ. CRC Press.

Mead, M. 2004. *Poultry Meat Processing and Quality*. Woodhead Publ. Stadelman, W.J. and O.J. Cotterill. *Egg Science and Technology*, 4th edn. CBS. Walstra, P. (Ed.). 2006. *Dairy Science and Technology*, 2nd edn. Taylor and Francis.

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II Semester

Course	Course code	Course title	L	P	Credits
Practical	MFT2207	Technology of Meat, Poultry and Dairy Processing Practical		2	1

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

COMFT2207	Expected Course Outcome	Learning Domains	Mapping to PSOs
COMFT2207.1	Summarize processing technologies of meat, poultry and dairy products	U	1
COMFT2207.2	Evaluate the quality parameters of meat, poultry and dairy products	U/An	2,3,4
COMFT2207.3	Remember and understand the FSSAI standards for meat, poultry and dairy products	R/U	1
COMFT2207.4	Apply the processing skills and knowledge in various value added products	A/C/S	2,3,4,5
COMFT2207.5	Experiential learning in meat, poultry and dairy industry	C/S	4,5
R-Remember, U- Understand, A-Apply, An-Analyse, E-evaluate, C-Create, S-Skill, and Ap Appreciate			

- Meat preservation by drying, curing, smoking, salting and pickling
- Estimation of shelf life of meat subjected to different types of processing
- Estimation of proximate composition of meat and egg
- Preparation of meat and egg based products
- Training of meat production in slaughter houses, evaluation of meat bone yield ratio under commercial conditions at slaughter homes and industrial establishments
- Production and processing of milk; application of HTST process.
- Testing of milk for quality
- Preparation of cheese, yogurt and butter, milk powder, khoa, paneer, etc. and their evaluation
- In- house factory trainingat meat, milk and ice creams industrial establishments
- Preservation by different freezing techniques
- Study on the effect of rate of freezing on foods and ice crystal formation; Study on freezing preservation of various foods; Operation of freezers and cold stores; Construction of freezing curve of foods
- Familiarization with canning equipment and instruments; Canning of various foods- meat, fish, other products; Construction of survivor curve, TDT curve and determining F-value and cook value
- Drying and salting of meat, fish, vegetables, etc.

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II Semester

Course	Course code	Course title	L	P	Credits
Core	MFT2208	Fish Processing Technology	2		2

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

COMFT2208	Expected Course Outcome	Learning Domains	Mapping to PSOs
COMFT2208.1	Explain the importance of fish processing and preservation	U/A	1
COMFT2208.2	Summarize the criteria for quality maintenance in seafood industry	U/A	1
COMFT2208.3	Illustrate different fish byproducts and its utilization	U/C	1,2,3
COMFT2208.4	Evaluate the physical and chemical properties of fishery products	An/E	2,3,4
COMFT2208.5	Utilize fish by-products for novel value-added products	U/C	2,3,4,5
R-Remember, U- Understand, A-Apply, An-Analyse, E-evaluate, C-Create, S-Skill, and Ap Appreciate			

Module I **6 hours**

Chilled preservation and products: sashimi grade fish, steaks, loins and minced meat. Frozen products: types of frozen fish, shellfish, crabs, lobsters, squid and cuttlefish. Accelerated freeze dried products.

Module II **6 hours**

Salt cured and dried products: sun dried, mechanically dried and salt dried products; Colombo cured and other cured products. Water activity, water activity and microbial spoilage, water sorption, chemical changes during drying. Drying methods, psychrometrics, drying calculation, cured products, microbial spoilage in cured and dried products.

Smoke cured products: chemistry of wood smoke, smoking methods- cold and hot methods, smoke generation, carcinogens in smoke, smoke kilns; use of smoke liquid. safety and nutritive value.

Marinades: Processing of marinades; fish pickle; shelf life and spoilage.

Fermented products: methods, indigenous products, principles of preservation.

Module III **6 hours**

Thermally processed products- canned products, retort pouch products. Thermal process calculation, D-value, F-value; storage changes and spoilage. High temperature short time (HTST) processed products. Canning- containers for canned food, thermal destruction of bacteria, Heat transfer in canned food, process lethality, predicting the process. Effect of heat processing on food, process calculations, cook values, aseptic canning, storage of canned food, canning operations, problems in canned products and solution. Retorts.

Module IV **6 hours**

Food Irradiation: History and mechanism, electro-magnetic spectrum, forms of radiant energy, Principles of using electromagnetic radiation and non-ionising radiation, advantages and disadvantages, effect of radiation on food components, control of considerable changes in food during irradiation. High pressure in food preservation, industrial high pressure system, commercial application, high pressure food processing conditions, pressure inactivation of vegetative cells and micro-organisms, high pressure freezing, Membrane filtration techniques in food preservation, high intensity light, ultra sound as preservation technologies. MAP, pulsed electric fields, hurdle technology and minimal technology.

Module V **6 hours**

Battered and breaded products: different types- coated prawn, fish fillet, patties, burger, roll, etc.; and their preparation, nutritional and economic significance of products.

Technology of processing and preservation of gel forming fish flour; its property and utilization. Surimi and fish paste products- fish sausage, fish cake, etc. Unit operations in analogue product preparation- crab sticks, moulded lobsters.

Module VI **6 hours**

Fish protein concentrate: Methods of production, functional properties, types of FPC, texturized products/ marine beef. Fish protein powder- production and properties.

Fish hydrolysates: Production and utilisation, biochemical composition and importance in food and nutrition. Incorporation of FPC/ hydrolysates into various food products.

Miscellaneous products: Protein extract from shrimp and crab shell and squilla; shark fin/ fin rays; fish liver/ body oil; processing of snail meat and jelly fish. Production, product characteristics and composition.

Other products: beche-de-mer, processing of snail meat and jelly fish, shark fin/ fin rays, seaweed products- agar, algin, carrageenan- use in foods.

By-products from underutilized fish or fish processing waste: fish meal, fish silage, chitin, chitosan, fish maws, fish oil, squalene, etc.- product characteristics, methods, uses.

Reference books

Balachandran, K.K. 2001. *Post-harvest Technology of Fish and Fish Products.* Daya Publishing House, Delhi.

Borda, D., Nicolau, A. I., &Raspor, P. (Eds.). (2017). *Trends in fish processing technologies*. CRC Press

Gopakumar, K. 1997.*Tropical Fishery Products*. Oxford and IBH.

Gopakumar,K. (Tech. Ed.). 2002. *Textbook of Fish Processing Technology*. ICAR, New Delhi.

Ninawe, A.S. and K. Rathnakumar. 2008. *Fish Processing Technology and Product Development*, Narendra Publishing House, Delhi.

Sen, D.P.2005. *Advances in Fish Processing Technology*. Allied Publishers.

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II Semester

Course	Course code	Course title	L	P	Credits
Practical	MFT2209	Fish Processing Technology Practical		2	1

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

COMFT2209	Expected Course Outcome	Learning Domains	Mapping to PSOs
COMFT2209.1	Experiment with the quantification and estimation of physical and chemical properties of fish and fishery products	U/A	1,2,3
COMFT2209.2	Demonstrate the processing and preservation technology in fish and fishery products	U/A	1,3,4
COMFT2209.3	Recall the FSSAI standards of fish and fishery products	R/U	1
COMFT2209.4	Quality evaluation of fish and fish products	A/E	2,3,4
COMFT2209.5	Apply the skills and knowhow to create novel value added fish products	A/C	2,3,4,5
R-Remember, U- Understand, A-Apply, An-Analyze, E-evaluate, C-Create, S-Skill, and Ap Appreciate			

MFT2209	**Fish Processing Technology Practical**	**1**

- Dressing styles of fish and shellfish
- Smoke curing of foods
- Preparation of pickles/ marinated products
- Chilled products- dressed fish, prawn
- Frozen products- fish, prawn, crab, cuttlefish, squid- in various forms
- Preparation of dried, salted, smoked and pickled fish products
- Thermally processed products in can and retort pouch- fish, prawn, etc. in brine, s a u c e , curry; cut out test of canned products
- Preparation of battered and breaded fish products- breaded prawn, breaded fish fillet, fish patties, fish burger
- Quality evaluation of coated products
- Production of surimi, fish sausage; quality evaluation
- Preparation of FPC, fish hydrolysates, fish wafers
- Extraction of fish oil; study of its characteristics
- Familiarization with fish meal, fish silage, beche-de-mer, shark fin rays, agar, algin, carrageenan, fish maws, chitin and chitosan

Elective I (MFT 2210, 3 Credits

Open Elective I 3 Credits

Syllabus
Semester III courses

M. Sc. Food Science and Technology

III Semester

Course	Course code	Course Title	L	P	Credits
Core	MFT2301	Spices and Plantation Products Technology	2		2

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

COMFT2301	Expected Course Outcome	Learning Domains	Mapping to PSOs
COMFT2301.1	Summarize the spice and plantation crop processing, quality control, and their value addition	R/U	1
COMFT2301.2	Demonstrate the latest technological advancements and their applications in improving quality, and marketability of plantation crops.	R/U/A	1,2
COMFT2301.3	Explain advancements in post-harvest technology, and product development of spices and plantation crops	U/A	1,4,5
COMFT2301.4	Interpret international/ national standards and its significance in quality assurance practices	U/A	1,4
COMFT2301.5	Evaluate and elucidate market trends, trade policies, and economic factors affecting the spice and plantation product industries	A/An	1,2,4
**Remember (R), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

MFT2301 Technology of Spice and Plantation Crops processing **2**

Module I **8 hours**

Spices, condiments, seasonings and culinary herbs- classification. Major Indian spices- pepper, cardamom, chilli, turmeric, ginger, garlic, clove, cumin, coriander, cinnamon, fenugreek, mace, mint, vanilla, nuts (cashewnut)- chemical composition, processing, packaging, fumigation, irradiation. Effects on food- flavour, antimicrobial effects.

Module II **7 hours**

Oleoresins and essential oils- chemistry of volatiles, methods of manufacturing- steam distillation and solvent extraction methods; super critical fluid extraction using liquid carbon dioxide. By-products of oleo resin industry.

Enzymatic synthesis of flavour identical. Adulteration problems in spices, storage changes, quality control.

Module III **7 hours**

Tea: Harvesting of tea leaves, chemical composition. Types of tea- CTC, green, oolong- manufacturing processes. Tea products- tea concentrate, instant tea, decaffeinated tea, flavoured tea, etc. Grading of tea- tea tasting. Preparation of tea- black, with milk, etc. Packing and storage of tea- storage changes.

Module IV **7 hours**

Coffee: Ripening of coffee beans, drying, pulping. Production of coffee- fermentation, roasting, brewing, etc. Types of coffee- coffee powder, decaffeinated coffee, instant coffee- blending with chicory, other coffee products. Preparation of coffee for drinking, quality evaluation of coffee. Packing and storage of coffee- storage changes.

Module V **7 hours**

Cocoa: Chemical composition of cocoa beans, fermentation of beans. Products- cocoa powder, cocoa liquor, cocoa butter, chocolates; technology of manufacturing products. Factors influencing quality, quality evaluation. Confectionary products: Hard-boiled candies, toffees, fruit drops, chocolates and other confections, chewing and bubble gums - ingredients, equipment, processes, product quality parameters, faults and corrective measures.

Reference books

Banerji, B. 2002.*Tea Production and Processing*.Oxford Univ. Press.

Baser, Husnu; Can, K.; and Buchbauer, Gerhard. 2010. Handbook of Essential Oils, Science, Technology and Application . Boca Raton, FL : CRC Press, Taylor and Francis Group

Mathew Attokaran 2011 Natural Food Flavors and Colorants © Blackwell Publishing Ltd. and Institute of Food Technologists. ISBN: 978-0-813-82110-8

NIIR. 2004. *Handbook of Spices*. National Institute of Industrial Research Board, Asia Pacific Business Press Inc.

M. Sc. Food Science and Technology

III Semester

Course	Course code	Course Title	L	P	Credits
Practical	MFT2302	Spices and Plantation Products Technology		2	1

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

COMFT2302	Expected Course Outcome	Learning Domains	Mapping to PSOs
COMFT2302.1	Demonstrate the processing and preservation of spices and plantation products.	U/A	1,2
COMFT2302.2	Evaluate the flavor constituents in spices	A/An	2,3,4
COMFT2302.3	Illustrate processing of value added products from spices and plantation crops	A/An	1,2,3,
COMFT2302.4	Assess the physical, chemical and microbial parameters of the spices and plantation products	An	2,3,4
COMFT2302.5	Review the data and express scientifically	An/S	3,4,5
**Remember (R), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

- Estimation of moisture in spices
- Estimation of volatile oil contents of spices
- Determination of aromatic compounds in spices
- Estimation of capsaicin content, Scoville Heat Unit of chillies
- Estimation of curcumin content of turmeric
- Studies on packaging and storage of spices
- Determination of microbial quality of spices
- Determination of adulteration of spices
- Estimation of caffeine in tea and coffee
- Determination of aflavin and thearubigens in tea
- Sensory evaluation of tea, coffee and chocolate
- Determination of components of chocolates
- Extraction of organic natural colours from aromatic plants and vegetables

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III Semester

Course	Course code	Course Title	L	P	Credits
Core	MFT2303	Food Additives and Flavor Technology	3		3

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

COMFT2303	Expected Course Outcome	Learning Domains	Mapping to PSOs
COMFT2303.1	Demonstrate a sound acquaintance of fundamentals of food additives used for shelf life extension, processing support and sensory appeal	R/U	1
COMFT2303.2	Implement the regulations and laws related to the intake of the food additives	U	1
COMFT2303.3	Summarizing the significance, toxicology and regulations related to flavors and flavor enhancers used in food industry	R/U	1,2
COMFT2303.4	Implement the different food additive standards set by the organizations	A	2,4
COMFT2303.5	Apply the knowledge of food additives in different food products as per regulations	A	1,4
**Remember (R), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

MFT2303 Food Additives and Flavour Technology **3**

Module I **10 hours**

Introduction: Types of additives, benefits of additives, risk of additives, regulations. Estimation of food additive intake- NOEL, ADI, toxicological classification of food additives

Nutritional additives: Vitamins- chemistry, units and requirements, properties, commercial forms, amino acids, fatty acids, minerals and trace minerals, regulations and nutritional additives. FSSAI permitted food additives and their limits

Module II **10 hours**

Preservatives (antimicrobials): Chemical and biological preservatives. Mechanisms of action. Antioxidants: phenolic antioxidants- applications, natural antioxidants; oxidation and use of antioxidants. Oxidation measurement, oxidative stability and antioxidant effectiveness, analysis of antioxidants, regulation of phenolic antioxidants.

Module III **12 hours**

Sweeteners: theory of sweetening, non-nutritive sweeteners, nutritive sweeteners, choice of sweeteners.

Food colours: History of the use of colours, role and use of colorants, types of colorants, toxicological considerations.

Emulsifiers: Emulsifier chemistry, emulsifier function and mechanism of action, emulsifier selection. Application in foods: Cereal-based products, dairy products, candy products and miscellaneous applications.

Polysaccharides in foods: Starch, chemically modified starches, glycogen, cellulose and hemicelluloses, pectic substances, plant gums.

Module IV **10 hours**

Enzymes: Functional aspects, mechanism of enzyme action, application of enzymes in the food industry, regulations on the use of enzymes, toxicology. Acid, bases and buffers (pH control agents)

Miscellaneous food additives: Firming agents, formulation aids, processing aids, propellants, solvents, chelating agents, synergists.

Methods used in safety evaluation. Hypersensitivity to food additives. Risks and benefits of food additives.

Module V **12 hours**

Flavour technology: Flavouring agents- flavours – their nature, creation and production.

Function of flavours and their utilization, flavour regulations, flavour safety.

Flavour enhancers: Chemical properties, function in food, use of glutamate in food and regulations, toxicology, applications. Synthetic ingredients of food flavourings.

Quality control of flavourings and their raw materials, beverage flavourings and their applications. Fruit juices, flavouring of confectionery and bakery products, flavours of snack and crisps. Thermal process of flavourings. Dairy flavourings.

Reference books

Attokaran Mathew 2011 Natural Food Flavors and Colorants © Blackwell Publishing Ltd. and Institute of Food Technologists. ISBN: 978-0-813-82110-8

Mahindru, S.N. 2008. *Food Analysis: Characteristics, Detection and Estimation*. APH Publishing

Corporation.
Msagati, T. A. (2012). *The chemistry of food additives and preservatives*. John Wiley & Sons.
Rahman, M.S. 2007. Handbook of Food Preservation, 2nd edn. CRC Press.
Wood, R., Foster, L., Damant, A., & Key, P. (2004). *Analytical methods for food additives*. Elsevier.

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III Semester

Course	Course code	Course title	L	P	Credits
Practical	MFT2304	Food Additives and Flavour Technology Practical		2	1

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

COMFT2304	Expected Course Outcome	Learning Domains	Mapping to PSOs
COMFT2304.1	Recall the importance and standards for food additives by various national and international organizations	R/U/A	1,4
COMFT2304.2	Apply the knowhow on food additives while designing food products	U/A	1,2,4
COMFT2304.3	Analyze and evaluate qualitatively and quantitatively the various food additives	A/An	2,3,4
COMFT2304.4	Evaluate the sensory aspects of food based on additives	An/E	2,3,4
COMFT2304.5	Apply testing methods to differentiate between additives and adulterants.	An	2,3,5
R-Remember, U- Understand, A-Apply, An-Analyse, E-evaluate, C-Create, S-Skill, and Ap Appreciate			

MFT2304 Food Additives and Flavour Technology Practical **1**

- Estimation of vitamins in foods
- Determination of minerals and sodium chloride in foods
- Determination of preservative content- benzoate, sulphite, metabisulphite, sorbate propionate
- Study of antioxidant activity; determination of peroxide value and content of BHA/ BHT, propyl gallate
- Effect of sweeteners; determination of taste threshold value
- Study of food coloring agents- effect on food
- Starch- study of properties of starch in relation to food
- Determination of starch content
- Study of properties of gums- gel formation, stabilization, thickening effect, etc.
- Determination of chelating agents, acidulants and phosphates in food products
- Detection of certain intentional and unintentional food additives in foods
- Organoleptic evaluation of flavours and pigments
- Extraction of flavours and pigments and evaluation

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III Semester

Course	Course Code	Course Title	L	P	Credits
Core	MFT2305	Food Packaging Technology	3		3

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

COMFT2305	Expected Course Outcome	Learning Domains	Mapping to PSOs
COMFT2305.1	Recall the basic concept, principles and terminologies of packaging system	R/U	1
COMFT2305.2	Demonstrate different types of packaging materials, their properties and sustainability aspects.	R/U/A	1,4
COMFT2305.3	Explain the different methods of manufacturing packaging materials and machinery involved.	U	1
COMFT2305.4	Elucidate the different methods to test packaging materials	U/A	1,2,3,4
COMFT2305.5	Application of advanced packaging technologies ensuring compliance with standards.	U/A	1,2,4
**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

Module I **8 hours**

Basic concept of packaging, definition, importance and scope of packaging foods, criteria for packing foods. Functions and design of food package, package development, current status and trends in food packaging.

Packaging materials and containers: Origin of packaging materials; different types; properties, advantages and disadvantages of each material- glass containers, metal cans- tinplate, aluminium, TFS; aluminium foil. Protective lacquers and coatings for metal containers.

Cellulose based materials- paper, paperboard, corrugated fibreboard pouches- bags and boxes.

Module II **6 hours**

Plastic films- polyethylene, polypropylene, polyamides, polyester, PVC, PVDC, PVA, EVOH, polycarbonates, cellophane, inomers, copolymers, phenoxy, acrylic and polyurethanes.

Laminates- objectives, types, methods of lamination. Containers- bags, pouches, retort pouch. Properties of packaging films- mechanical, sealing and barrier. Advantages and disadvantages of each packaging material.

Module III **6 hours**

Manufacture of flexible films: Blown film extrusion, cast film extrusion, film orientation process, co-extrusion process, conversion process. Container manufacture- sheet thermoforming, injection moulding.

Packaging machinery: Bottling, can former, form fill and seal machines, bags- their manufacturing and closing, vacuum packs unit, shrink pack unit, 'tetra pak' unit

Module IV **10 hours**

Packaging requirements and their selection for raw and processed foods for meat, fish, poultry, eggs, milk and dairy products, fruits and vegetables, cereal grains and baked food products, beverages, snacks, etc.

Packaging material testing: Global and specific migration, WVTR, GTR, bursting strength, Cobbs value, tensile strength, tearing strength, impact strength, bond strength, puncture resistance, heat seal strength, transport worthiness tests (drop test, vibration test, compression strength, rolling test), identification of plastics. Safety of packaging materials.

Module V **6 hours**

Recent trends in food packaging: vacuum packaging, modified atmospheric packaging, shrink packaging, retort pouch packaging, aseptic packing, active packaging, intelligent packaging, smart packaging. Advanced packaging technologies, alternative packaging systems to plastic material, nanotechnology. Packaging laws and regulations.

Reference books

Ahvenainen, R. (Ed.) 2003. *Novel Food Packaging Techniques*. CRC Press.

Coles, R., D. McDowell and M.J. Kirwan (Eds). 2003. *Food Packaging Technology*. CRCPress.

Gopakumar, K. 1993. *Fish Packaging Technology: Materials and* Methods. Concept Publishing Company, New Delhi.

Han, J.H. (Ed.) 2005. *Innovations in Food Packaging*, Elsevier Academic Press.

Raija, A. (Ed.)2003. *Novel Food Packaging Techniques*. In: Food Science and Technology S e r i e s ,Woodhead Publishing.

Robertson, G.L. 2006. *Food Packaging: Principles and Practice*, 2nd edn. Taylor & Francis. Srinivasa Gopal, T.K. 2007. *Seafood Packaging*. CIFT Golden Jubilee Series, CIFT, Cochin.

M. Sc. Food Science and Technology

III Semester

Course	Course Code	Course Title	L	P	Credits
Core	MFT2306	Food Packaging Technology Practical		2	1

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

COMFT2306	Expected Course Outcome	Learning Domains	Mapping to PSOs
COMFT2306.1	Demonstrate different types of packaging materials	U/A	1,2
COMFT2306.2	Analyze different thermal and mechanical properties of packaging materials.	U/An	1,2
COMFT2306.3	Demonstrate different equipment used in the evaluation of packaging material characteristics.	U/A	2,3
COMFT2306.4	Select and design appropriate packaging material for specific food products	A	2,3,4
COMFT2306.5	Evaluate the migration and shelf-life stability of packaging material	A/An	2,3,4
**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

MFT2306 Food Packaging Technology Practical 1

- Identification of different types of packaging materials; Measurement of thickness of packaging materials
- Determination of global migration
- Determination of tensile strength and elongation at break of plastic films
- Determination of tearing strength of paper
- Determination of bursting strength, puncture resistance, Cobbs value of CFB
- Determination of heat seal and bond strength of laminates
- Determination of gas (oxygen, carbon dioxide) transmission rate
- Determination of water-vapour transmission rate
- Determination of transport worthiness of containers
- Determination of grease resistance of different packaging materials
- Demonstration of vacuum packaging, modified atmosphere packaging, shrink wrapping, active packaging, retort pouch processing, etc.
- Visit to manufacturing units of packaging materials (flexible films, metal cans, duplex cartons and corrugated fibre board boxes)
- Visit to food processing establishments – milk products, fruit and vegetable products, fishery, meat and poultry products, confectionary, beverages, etc.

M. Sc. Food Science and Technology

III Semester

Course	Course code	Course title	L	P	credits
Core	MFT 2307	Quality Assurance and Food safety	3		3

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

COMFT2307	Expected course out come	Learning domain	Mapping to PSOs
COMFT2306.1	Comprehend the basic concepts of Food Laws and regulations in India and world	R/U	1
COMFT2306.2	Define and apply the concepts of food safety and hygiene	U/A	1,4
COMFT2306.3	Outline the laws and act related to food hazards and toxins	U/A	1,3
COMFT2306.4	Summarize various national and international organization of food standards and quality evaluation	R/U	1,3
COMFT2306.5	Apply quality standards for food manufacturing processes	U/A	1,3,4
**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

MFT2307 Quality Assurance and Food Safety 3

Module I **10 hours**

Sanitation and hygiene: Definition and application to food industry and food service. Microorganisms-normal flora and pathogenic microorganisms; sources of food contamination, origin and contamination along food chain. Foodborne illness.

Sanitizers- chemical and physical properties, mechanisms of action of most common sanitizers used in food industry; cleaning compounds, classification of cleaning compounds. Sequestrants, detergents-chemical and physical characteristics of detergents. Sanitizing methods, precautions to food industry, food safety issues in different foods, prevention and control of contamination of food.

Module II **10 hours**

Food handling and personal hygiene. Food service control points; regulatory requirements. Food contact surfaces; biofilms. Environmental sanitation- premises, equipment, furniture and fixtures. Food safety-definition and controlling hazards in food safety systems. Pest control- insect, rodents, other pests.

Introduction to concepts of food quality, food quality assurance and food quality management;objectives, principles of food quality assurance, good manufacturing/ management practices (GMP), good hygienic practices (GHP), good laboratory practices (GLP), food safety and HACCP principles.

Module III **10 hours**

Biological, chemical and physical quality in food processing. Ingredient specifications; product formulation, product attractability, in-process monitoring and records. SOP and SSOP. Introduction to sensory evaluation - types of sensory tests- detection, threshold and dilution tests, different tests for sensory evaluation discrimination, descriptive, affective; flavor profile and tests, ranking tests, methods of sensory evaluation of different food products. Sanitation programme and quality assurance. Chemical hazards- contaminants, additives. Food allergens, natural toxins, etc.

Module IV **12 hours**

Quality standards: Methods of determining quality- objective and subjective methods. Definition and organization of the quality control function in the food industry. Preparation of specifications. In-plant quality control and end product inspection. Instrumental and sensory methods of evaluation. Statistical process control (SPC). Quality evaluation and testing laboratories.

Factory layout and design, regulations for processing units,flow sheet of operations, drainage and sweet water connections. Ware housing of products and raw materials. Utilities for manufacturing units. Water treatment, boilers, types of boilers, quality of steam.

Module V **12hours**

Food laws and standards: FDA regulations, USDA regulations, EPA, EFSH regulations, *Codex Alimentarius* Commission, Food Safety and Standards Regulations for different products, the Prevention of Food Adulteration Act,1954, Export and Import Laws and Regulations, Export (Quality Control and Inspection) Act, 1963., etc. Packaging and labelling laws, regulations.

Concept of food traceability for food safety, traceability, Food safety and Standards Act 2006: Role of national and international regulatory agencies- Bureau of Indian Standards (BIS), AGMARK, Food Safety and Standards Authority of India (FSSAI). Introduction to WTO agreements- SPS and TBT agreements, *Codex Alimentarius* Commission, USFDA, International Organization for Standards (ISO) and its standards for food quality and safety- ISO 9000 series, ISO 22000, ISO 15161, ISO 14000.

Reference

Bremner, H.A. *Safety and Quality Issues in Fish Processing*. CRC Press, New York.

de Vries, J. *Food Safety and Toxicity*. Library of Congress Cataloging – in - Publication data.

Farber, J.M., Evan C.D. Todd (Eds). *Safe Handling of Foods.* Marcel Dec Inc. New York.

Heredia, N., J. Westley and S. Garcia (Eds). *Microbiologically Safe Foods*. John Wiley & Sons Inc., New Jersey.

Hubbard, M. R. 2003.*Statistical Quality Control for the Food Industry*, 3rd edn. Springer. Longree,

K. amdArmbruster, G. *Quantity Food Sanitation*. John Wiley & Sons, New York.

Mehta, Rajesh and J. George. 2005. *Food Safety Regulations, Concerns and Trade: The Developing Country Perspective*, Macmillan.

Newslow, D.L. 2001. *The ISO 9000 Quality System:Applicationsin Food and Technology*, JohnWiley& Sons.

Rees, M. and D. Watson. 2000. *International Standards for Food Safety*. Aspen Publishers, Inc., Maryland.

Rees, N. and D. Watson. 2000. *International Standards for Food Safety*. Aspen Publication.

The Prevention of Food Adulteration Act, 1954, Commercial Law Publishers (India) Pvt. Ltd.

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III Semester

Course	Course code	Course title	L	P	Credit
Practical	MFT2308	Quality Assurance and Food Safety Practical		2	2

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

COMFT2308	Expected Course Outcome	Learning Domains	Mapping to PSOs
COMFT2306.1	Recall the significance of quality assurance and quality control in food safety	R/U	1
COMFT2306.2	Apply the laws and regulations in food safety and quality assurance	U/A	1,3,4
COMFT2306.3	Analyze food safety parameters as per the standards	A/An	2,3,4
COMFT2306.4	Apply sensory evaluation methods to test food products	U/An	1,,3
COMFT2306.5	Skill enhancement through practice and implementation	A/S	2,3,4
R-Remember, U- Understand, A-Apply, An-Analyse, E-evaluate, C-Create, S-Skill, Interest (I) and Ap Appreciate			

MFT2308 Quality Assurance and Food Safety Practical 1

- Determination of sanitary quality of plant and personnel- TPC, pathogenic count of utensils, processing table tops, hands of personnel
- Estimation of coliforms/ *E.coli*in water and ice- by MPN technique
- Analysis of microflora up to generic level- using microscopic observations and chemical tests
- Determination of MIC and MCC of disinfectants
- Sensory evaluation methods: taste threshold test, hedonic scaling, three-sample tests, rank order test, etc.; designing score sheet
- Measurement of viscosity by viscometer
- Measurement of texture and colour using texture analyzer and colour comparator, respectively
- Determination food components- moisture, protein, carbohydrate, fat, minerals, fibre
- Estimation of chemical parameters of food quality
- Detection of toxins in food
- Determination of pesticides in food
- Detection of adulterants in food
- Examination of market samples of foods for quality evaluation

M. Sc. Food Science and Technology

III Semester

Course	Course code	Course title	L	P	Credits
Core	MFT2309	Food Laws and Environmental Issues	2		2

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

COMFT2309	Expected course out come	Learning domain	Mapping to PSOs
COMFT2306.1	Comprehend the basic concept of Food Laws, Environmental Laws and Regulations in India and abroad	R/U	1
COMFT2306.2	Summarize the importance of international regulation of food standards	R/U	1
COMFT2306.3	Explain environmental pollution, its effect on health; identify remedial measures.	U/A	1
COMFT2306.4	Illustrate waste treatment process and its utilization in the development of products	U/A	1,2
COMFT2306.5	Outline Intellectual property rights, patents and its importance	U/A	1,4
R-Remember, U- Understand, A-Apply, An-Analyse, E-evaluate, C-Create, S-Skill, Interest (I) and Ap Appreciate			

MFT2309 Food Laws and Environmental Issues 2

Module I **6 hours**

Historical perspectives including necessity of food laws. Necessity of ensuring quality of food to prevent adulteration.

Food quality, safety and testing: Quality of foods and quality standards like BIS, Agmark and other optional standards; mandatory standards. Food safety systems: quality systems standards including ISO; auditing; Good Manufacturing Practice and HACCP, TACCP, VACCP.

Detection of harmful chemicals and microbes in foods; testing of ingredients and additives; using animals for evaluating safety; clinical studies. Responsibility of agriculture, food industry and food supply sector. Standards of weights and measures, British Regulatory Consortium (BRC), American Institute of Bakers (AIB). Important issues of GM foods. Fortification, nutrition information on label. Organic foods. Safety of additives, processes, etc., affecting consumers and industry.

Module II **6 hours**

Food Safety and Standards Act 2006 and the provisions therein; Integrated Food Law- multi departmental - multilevel to single window control system; Consumer Protection Act. Functioning of Food Safety Commissioner. Patents-IPR, National Accreditation Board for Testing and Calibration Laboratory (NABL), ISO 17025, ISO 17034

Module III **6 hours**

International scenario in food regulation: USFDA, EFSA, UK, Canada, A & N Z, Japan, Malaysia, Singapore. Consumer movements; Intellectual Property Rights and trademarks. Protection of investment and efforts in research and development by patenting, criteria of patentability, national and international patent, terms of patents, copyright. International agencies in food regulation: Food *Codex Alimentarius*; necessity of harmonised food standards for international trade; various aspects and relation with domestic laws; Codex Nodal Agency, FAO, WHO, WTO, TUV, consumer protection forums.

Module IV **8 hours**

Environment and pollution: components of environment; pollution measurements and management; xenobiotic compounds; pesticides and pest management. Microorganisms as components of the environment; microorganisms as indicators of environmental pollution; inorganic pollution; microbial toxicants and pollutants, and their bio-degradation; biodegradation of plastics, biofouling and biofilms; bioremediation.

Control of air quality: Air duct design and room air distribution; air conditioning systems; clean-room air conditioning; important pollutants of air; properties of particulate matter and air pollution control methods; air quality in the processing plants, legal requirements.

Module V **10 hours**

Waste Water Treatment: waste water sources characteristics- standards for disposal of water, physical, chemical and biological characteristics of waste water; measurement of organic content in waste water; physical unit operations in waste water treatment.

Storage and disposal of waste: types of waste generated; non-degradable and biodegradable wastes, waste disposal methods- land-filling, burial, incineration, recycling. Biological treatment of food industry wastes; legal aspects related to storage and disposal; environmental laws; pests and their control.

Utilization of waste: Methods of utilizing wastes to make value added products. Case studies: pectin, food colourants, antioxidants from fruit peels, lycopene from tomato peel, vegetable seed oils, biomolecules and enzymes from meat processing. Generation of biogas, SCP, microalgae, animal feeds, zero emission

plants; recovery and recycling of materials.

Reference books

Hubbard, M.R. 2003. *Statistical Quality Control for the Food Industry*, 3rd edn. Springer.
Mehta, R. and J. George. 2005. *Food Safety Regulations, Concerns and Trade: The D e v e l o p i n g Country Perspective*. Macmillan.
Moorthy, C.K. 2003. *Principles and Practices of Contamination Control and Clean Rooms*. Pharma Book Syndicate.
Newslow, D.L. 2001. *The ISO 9000 Quality System: Applications in Food and Technology*. J o h n Wiley & Sons.
Rees, N. and D. Watson. 2000. *International Standards for Food Safety*. Aspen Publication.
The Prevention of Food Adulteration Act, 1954. Commercial Law Publishers (India) Pvt. Ltd.
Wilson, C.L. 2008. *Microbial Food Contamination*. CRC.

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III Semester

Course	Course code	Course title	L	P	Credits
Core	MFT2310	Entrepreneurship and Food Business Management	2		2

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

COMFT2310	Expected course out come	Learning domain	Mapping to PSOs
COMFT2310.1	Comprehend the basic concepts of entrepreneurship and food business management	R/U	1
COMFT2310.2	Recognize the importance of demand and costing in food business management	R/U	1
COMFT2310.3	Summarize and apply the theories of SWOT analysis	U/A	1,4
COMFT2310.4	Illustrate various government policies and regulations in food sector	R/U	1
COMFT2310.5	Apply the role of stakeholders in the success of food business.	U/A	1,3,4
R-Remember, U- Understand, A-Apply, An-Analyse, E-evaluate, C-Create, S-Skill, Interest (I) and Ap Appreciate			

MFT2310 Entrepreneurship and Food Business Management 2

Module I 10 hours

Entrepreneurship: Importance and growth, characteristics and qualities of entrepreneur, role of entrepreneurship, ethics and social responsibilities; Entrepreneurship development: Assessing overall business environment in the Indian economy; Overview of Indian social, political and economic systems and their implications for decision making by individual entrepreneurs; Globalization and the emerging business/entrepreneurial environment

Module II 10 hours

Concept of entrepreneurship, entrepreneurial and managerial characteristics, managing an enterprise, importance of planning, monitoring, evaluation and follow-up, managing competition, decision making, costing, pricing, demand analysis, SWOT analysis, generation, incubation and commercialization of ideas and innovations; Women entrepreneurship: Role and importance, problems; Corporate entrepreneurship: Role, mobility of entrepreneur; Entrepreneurial motivation; Planning and evaluation of projects: Growth of firm, project identification and selection, factors inducing growth.

Module III 8 hours

Government schemes and incentives for promotion of entrepreneurship; Government policy on small and medium enterprises (SMEs/SSIs); Export and import policies relevant to food processing sector, Venture capital; Characteristics of Indian food processing industries and export; Social responsibilities of business.

Module IV 8 hours

IT for managers, enterprise support applications, systems acquisition and implementation practices, facilitating end-user support, and telework and e-business opportunities, Business plan preparation.

Reference books

L.M. Prasad. 2001. Principles and practices of management, 9th Ed. S. Chand & Sons, New Delhi Koontz Harold. Principles of Management. Tata McGraw-Hill Education Private Limited, New Delhi. PC Thomas. Managerial Economics, 9th Ed. Kalyani Publishers

KK Dewett and MH Navalur Modern Economics theory. S. Chand & Sons, New Delhi

Zimmerer, T. W., &Scarboroug, N. M. (2005). Essentials of entrepreneurship and small business management. Prentice-Hall.

Drucker, P. (2014). Innovation and entrepreneurship. Routledge.

Katz, J. A., & Green, R. P. (2009). Entrepreneurial small business (Vol. 200). New York, NY: McGraw-Hill/Irwin.

MFT 2311, 2312, 2313	**Elective- II**	(as per list given under Elective Course)
OST	**Open Elective- II**	---- do ----

M.Sc. Food Science and Technology

III Semester

Activity	Activity Code	Activity Title	L	P	Credits
Activity	MFT2314	Industrial visit	1		1

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

AOMFT2314	Expected Course Outcome	Learning Domains	Mapping to PSOs
AOMFT2314.1	Identify and describe various processes and technologies used in food production and processing, demonstrating an understanding of industry standards and practices	A/An	2
AOMFT2314.2	Analyze the role of quality control and safety measures in food production, recognizing their importance in ensuring product safety and compliance with regulations.	A/E	2,3
AOMFT2314.3	Evaluate the impact of sustainability practices within the food industry, discussing methods for waste reduction and resource conservation.	C/S	2,3,4
AOMFT2314.4	Engage in discussions with industry professionals to gain insights into career paths and the skills required for success in the food sector.	E/C	4
AOMFT2314.5	Reflect on the experience by comparing theoretical knowledge with real-world applications, articulating lessons learned and their implications for future studies or careers in the food industry	S	4
**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

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III Semester

Activity	Activity	L	P	Credits
Activity	Earn While You Learn			0

On successful completion of the activity, students will be able to:

AO	Expected Activity Outcome	Learning Domains	Mapping to PSOs
AO1	Apply theoretical knowledge in real-world settings by engaging in hands-on food production or processing tasks, enhancing practical skills in the food industry.	A/An	2
AO2	Demonstrate proficiency in laboratory techniques and quality control methods, ensuring food safety and compliance with industry standards.	C/S	2,3
AO3	Collaborate with industry professionals on projects, developing teamwork and communication skills while gaining insights into industry practices.	S	2,3,4
AO4	Analyze the economic aspects of food production, including cost management and pricing strategies, to understand the financial implications of food technology.	S	4
AO5	Reflect on work experiences to evaluate personal growth and skill development, articulating how these experiences inform career aspirations in food science and technology.	S	4
**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

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III Semester

Course code	Course title	L	P	Credits
	Research methodology/ technical writing			0

On successful completion of the activity, students will be able to:

CO	Expected Activity Outcome	Learning Domains	Mapping to PSOs
CO1	Demonstrate an understanding of research principles, including the formulation of research questions and ethical considerations in conducting research.	A/An	2
CO2	Conduct thorough literature reviews and develop well-structured research proposals that clearly outline objectives, methodology, and expected outcomes.	C/S	2,3
CO3	Apply appropriate qualitative and quantitative data analysis techniques to interpret research findings effectively.	S	2,3,4
CO4	Demonstrate the ability to produce clear, concise, and well-organized technical documents, including research reports and journal articles, adhering to academic standards.	S	4
CO5	Communicate research findings effectively through presentations, utilizing appropriate visual aids and strategies for diverse audiences.	S	4
**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

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IV Semester

Course	Course Code	Course Title	L	P	Credits
Core	MFT2401	Dissertation	20		20

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

COMFT2401	Expected Course Outcome	Learning Domains	Mapping to PSOs
COMFT2401.1	Formulate and analyze research questions that demonstrate critical thinking and depth of inquiry in the chosen field.	A/An	2
COMFT2401.2	Apply appropriate research methodologies and techniques to gather and interpret data effectively.	A/E	2,3
COMFT2401.3	Produce a well-structured dissertation that communicates research findings clearly and effectively to a scholarly audience.	C/S	2,3,4
COMFT2401.4	Evaluate and synthesize existing literature to position the research within the broader academic context.	E/C	4
COMFT2401.5	Demonstrate the ability to present and defend research findings confidently in both written and oral formats.	S	4
**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

Syllabus
Elective courses

MSc Food Science and Technology

II Semester

Course	Course code	Course Title	L	P	Credits
Elective	MFT 2210	Baking and Confectionery Technology	2		2

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

COMFT2210	Expected Course Outcome	Learning Domains	Mapping to PSOs
COMFT2210.1	Summarize the concept of baking and confectionery processing and preservation	R/U	1
COMFT2210.2	Relate the baking and confectionery machinery, equipment, and automation in enhancing production efficiency and product quality	U/A	1
COMFT2210.3	Develop new and innovative bakery and confectionery products	U/C	1,2,3,4,5
COMFT2210.4	Define and assess quality of ingredients and products	U/A	1,3
COMFT2210.5	Evaluate and develop ability to scientifically solve practical problems in baking and confectionery.	U/A	1,3,4
**Remember (R), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

MFT 2212 Baking and confectionary technology 2

Module I **5 hours**

Current status, growth rate, and economic importance of bakery and confectionary industry in India. Product types, nutritional and safety of products, pertinent standards and regulations.

Module II **5 hours**

Milling technology- cereals used for milling in India, changes occurring, quality aspects. Equipment used.

Module III **10 hours**

Theory of bakery and bakery fundamentals, Bakery Products: Ingredients and processes for breads, biscuits, cookies and crackers, cakes and pastries (short crust, choux, flaky, pies, tarts, eclairs, puff), gateaux, croissant, donuts, rusks, other baked products.

Equipment, product quality characteristics, faults and corrective measures for bakery products. Defining and assessing quality of ingredients and products. Different types of icing and design- Butter, Royal, Fresh Cream, basic cake decoration

Basic knowledge of baking/ heating, refrigeration, freezing, chilling, interaction of element

Module IV **10 hours**

Confectionary products: Hard-boiled candies, toffees, fruit drops, chocolates and other confections- ingredients, equipment, processes, product quality parameters, faults and corrective measures. Basic chocolate making

Module V **6 hours**

Production and quality of chewing and bubble gums, cocoa products, breakfast cereals, macaroni products, sprouted grains. Basic sugar craft, exotic desserts,

Reference books

Beckette. *Industrial Chocolate Manufacture*.
Edwards, W.P. 2007. *The Science of Bakery Products*. Royal Society of Chemistry.
Faubion, Faridi. *Dough Rheology and Baked Product Texture*. CBS Publications. Matz,
Samuel A. *Bakery Technology and Engineering*. CBS Public6ations.
Matz, Samuel A. *Cookies and Cracker Technology*.
NIIR Board. 2009. *The Complete Technology Book on Bakery Products*, 2nd edn. National Institute of Industrial Research.
Pyler, E.J. and L.A. Gorton. 2009. *Baking: Science and Technology*, Vol. II: Formulation and Production, 4th edn. Sosland Publishing Co., Kansas City.
Turret, R.A.I. 2003. *Grain and Feed Milling Technology*.

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II Semester

Course	Course code	Course Title	L	P	Credits
Core	MFT2211	Dietary Foods and Nutraceuticals	3		3

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

COMFT2211	Expected Course Outcome	Learning Domains	Mapping to PSOs
COMFT2211.1	Demonstrate a sound understanding of fundamentals of dietary foods, functional foods and nutraceuticals	U	1
COMFT2211.2	Summarize role of nutraceuticals to prevent and manage non-communicable diseases	U	1
COMFT2211.3	Relate dietary sources and chemistry of functional phytochemicals to disease prevention	U	1
COMFT2211.4	Explain the role and benefits of prebiotics and probiotics in human health	U	1
COMFT2211.5	Describe the concept of nutrigenomics in relation to nutraceuticals and functional foods	U	1
**Remember (R), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

MFT 2213 Dietary Foods and Nutraceuticals 2

Module I **8 hours**

Concept on nutraceutials: nutraceutical and functional foods, nutraceuticals as new dietary ingredients, biological significance of nutraceuticals, nutraceuticals and dietary supplement,

world market for nutraceuticals, regulatory issues.

The role of nutraceuticals/ functional foods in disease prevention: angiogenesis and cardiovascular diseases, cancer, diabetes, cholesterol management, obesity and inflammation dosage levels.

Module II **8 hours**

Health benefits of nutraceuticals, natural pigments (chlorophyll, chlorophyllin, carotenoids). Anthocyanin, proanthocynadins, glucosinolates, isoflavonoids, phytoestrogens, omega-3 and omega-6 fatty acids, chitin and chitosan.

Module III **6 hours**

Antioxidants, phytosterols; dosage for effective control of disease or health benefit with adequate safety. Generalised protective mechanisms of phytochemicals. Bioavailability of bioactive compounds.

Module IV **6 hours**

Prebiotics and probiotics: usefulness of probiotics and prebiotics in gastro intestinal health and other benefits, beneficial microbes; prebiotic ingredients in foods; types of prebiotics and their effects on gut microbes, resistant starch, fructo-oligosaccharides as probiotic food components.

Module V **8 hours**

Definition, development of functional foods, isolation, storage, processing and stability of phyochemicals/ bioactive compounds.

Nutrigenomics: an introduction and its relation to nutraceuticals. Effects of processing conditions and storage. Effect of environmental conditions in food matrix. Development of biomarkers to indicate efficacy of functional ingredients.

Reference books

Brigelius-Flohé, J. and Joost, H.G. 2006. *Nutritional Genomics: Impact on Health and Disease*. Wiley VCH.

Cupp J. and Tracy T.S. 2003. *Dietary Supplements: Toxicology and Clinical Pharmacology*. Humana Press.

Gibson, G.R. and William, C.M. 2000. *Functional Foods- Concept to Products.*

Owen Fennama. *Food Chemistry*, 4th CRC Press, Taylor and Francis Group. Boca Raton edn.

Losso J.N. 2007. *Angi-angiogenic Functional and Medicinal Foods*. CRC Press.
Neeser, J.R. and German, B.J. 2004. *Bioprocesses and Biotechnology for Nutraceuticals*. Chapman & Hall.
Robert E.C. 2006. *Handbook of Nutraceuticals and Functional Foods*, 2nd edn. Wildman.
Shi, J. 2006. *Functional Food Ingredients and Nutraceuticals: Processing Technologies*. CRC Press. Webb, G.P. 2006. *Dietary Supplements and Functional Foods*. Blackwell Publ.

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III Semester

Course	Course code	Course title	L	P	Credits
Elective	MFT2311	Dried, Cured, Smoked, Marinated and Fermented foods	3		3

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

COMFT2311	Expected course outcome	Learning domain	Mapping to PSOs
COMFT2311.1	Outline the principles and technologies of conventional methods of food preservation	R/U	1
COMFT2311.2	Demonstrate various value added products developed using conventional preservation methods	R/U	1,2,3,4
COMFT2311.3	Identify the problems associated with the conventional methods and products and apply remedial measures	U/A	1,3,4
COMFT2311.4	Illustrate different fermented products and its benefits	U/A	1,3,4
COMFT2311.5	Apply the skills to develop value added products	A/C	3,4,5
**Remember (R), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

MFT 2310 Dried, Cured, Smoked, Marinated and Fermented Foods 3

Module I **10 hours**

Fundamentals of drying- drying curve and sorption isotherms. Factors influencing drying process. Methods and equipment-sun drying, mechanical dryers, solar dryers. Changes in products, spoilage.

Freeze-drying- principle, phase diagram of water, equipment; accelerated freeze-drying.

Module II **10 hours**

Salt curing- principle of preservation; methods of salting various food products; factors influencing salt uptake by foods; quality of salt and products.

Module III **12 hours**

Smoke curing- chemistry of wood smoke; methods of smoking- cold smoking and hot smoking. Smoke kilns, use of liquid smoke and smoke powder. Problems associated with smoking- carcinogens, purification of smoke. Measurement of extent of smoking, various smoked products.

Module IV **10 hours**

Marinated products. Basic principles of marinating. Pickle making- use of vinegar and other ingredients- role of each. Packing of pickles.

Module V **12 hours**

Fermented Products: use of lactic acid bacteria, yeasts, etc. Optimum conditions required for fermentation. Various fermented products of India- methods of preparation. Control of fermentation process, spoilage problems.

Reference books

Eastman Wilbur, F. Jr. 2002. *A Guide to Freezing, Canning and Smoking Meat, Fish and Game.* Storey Publishing.

Kuila, A., & Sharma, V. (Eds.). (2018). *Principles and Applications of Fermentation Technology*. John Wiley & Sons.

NIIR Board. 2009. *The Complete Technology Book on Processing, Dehydration, Canning and Preservation of Fruits and Vegetables*. National Institute of Industrial Research.

Zeuthen, P. and Leif Bogh-Sorensen. 2003. *Food Preservation Techniques*. Woodhead Publishing Ltd.

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III Semester

Course	Course code	Course title	L	P	Credits
Elective	MFT2312	Postharvest Handling, Transportation and Storage	3		3

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

COMFT2312	Expected course outcome	Learning domain	Mapping to PSOs
COMFT2312.1	Summarize the principles and technologies of postharvest handling, processing, preservation and storage	R/U	1
COMFT2312.2	Understand the guidelines and standards for the handling and processing of various food classes	R/U	1,2
COMFT2312.3	Identify the problems associate with postharvest handling and preservation of different food products	U/A	1,3,4
COMFT2312.4	Apply and evaluate the quality factors influencing the shelf-life of the products	A	2,3,4
COMFT2312.5	Apply remedial measures to prevent postharvest losses	U/A	1,2,3,4
**Remember (R), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

MFT 2311 Postharvest Handling, Transportation and Storage **3**

Module I **10 hours**

Maturity indices, methods of maturity determination. Harvesting and handling of important fruits and vegetables. Harvesting tools, primary processing factors affecting postharvest losses. Processing of fruits/ vegetables, wax coating, pre-packing, irradiation, physiological postharvest disorders, chilling injury and disease, prevention of postharvest diseases and infestations, handling and packaging of fruits and vegetables – citrus, mango, banana, tomato, papaya and carrot. Principles of transport and commercial transport operations. Measures to prevent harvesting losses, biotic and abiotic factors affecting the crops during storage, safe storage guidelines, various types of storage structures (traditional and modern)

Module II **10 hours**

Effect of feed, breed and management on meat quality Measures to prevent losses, biotic and abiotic factors affecting the raw and processed products during storage, safe storage guidelines for various meat-based products, various types of storage structures (traditional and modern)

Module III **12 hours**

Handling of fish onboard and landing centres. Chill storage-CSW/ RSW, icing ice production, packaging and storage, transportation of fresh fish/ products, microbiology of fresh fish. Chilled/ refrigerated vehicles for transport. Measures to prevent losses during harvest from wild and culture farms, biotic and abiotic factors affecting raw and processed products during storage, safe storage guidelines for various fishery products, various types of storage structures (traditional and modern)

Module IV **10 hours**

Raw milk quality testing, processing, transportation of fresh milk to dairy plant. Measures to prevent losses during collection, processing, storage and transportation, biotic and abiotic factors affecting the storage, safe storage guidelines for various dairy products, various types of storage structures (traditional and modern)

Module V **12 hours**

Storage and transportation of cereals, pulses and oil seeds; care after harvesting- prevention of germination, pests. Initial drying and storage in silo. Cold storage, recent developments in transportation and storage.Measures to prevent harvesting losses, biotic and abiotic factors affecting the crops during storage, safe storage guidelines for various commodities, various types of storage structures (traditional and modern), infestation and pest control, impact of modernization of technology

Reference books

Brennan, James, G. (Ed.). 2012. *Food Processing Handbook*. Wiley-VCH Verlag GmbH Co. FAO.

2004. *Post-harvest Manual*. FAO Corporate Document Repository.

Fellows, P. J. (2009). *Food processing technology: principles and practice*. Elsevier.

Varzakas, T., &Tzia, C. (Eds.). (2015). *Handbook of food processing: food safety, quality, and manufacturing processes* (Vol. 35). CRC Press.

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III Semester

Course	Course code	Course title	L	P	Credits
Elective	MFT2313	Food Biotechnology	3		3

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

COMFT2313	Expected course outcome	Learning domain	Mapping to PSOs
COMFT2313.1	Summarize the principles and basics of food biotechnology	R/U	1
COMFT2313.2	Explain the role of natural antimicrobials for food preservation	R/U	1
COMFT2313.3	Outline the application of protein engineering to produce enzymes	U/A	1,3,4
COMFT2313.4	Elucidate the application of biotechnology in GM foods	U/A	1,3,4
COMFT2313.5	Identify trade related aspects of biotech foods: IPR and bio-piracy	U	1,2
**Remember (R), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

MFT 2312 Food Biotechnology 3

Module I 12 hours

Introduction to biotechnology- DNA and RNA, structure of DNA, Watson and Crick model, DNA replication, gene, nature of gene, genetic code, gene expression, protein synthesis.

Genetic engineering: Restriction enzymes, PCR, cloning, DNA sequencing, genetic engineering and improvement of food crops, genetically modified plants and animals for enhanced food production; safety of GM food.

Module II 10 hours

Natural antimicrobials for food preservation: Phytoalexins, essential oils and their components; bacteriocins: nisin, pediocins, etc.; use of bacteriocins in food systems as bio-preservatives.

Module III 12 hours

Protein engineering in food technology: methods, applications of protein engineering to produce enzymes-glucose isomerase, Lactobacillus beta-galactosidase and peptide antibiotic- nisin. Biotechnological routes to food flavour production- microbial, enzymatic, etc.

Module IV 10 hours

Biotechnology and food ingredients: biogums, fat substitutes, bio-colours, organic acids and sweeteners. Transgenic plant foods: Golden rice, Bt-brinjal, maize, tomato, potato, soybean, etc.

Module V 10 hours

Biotechnology for food security: prospects and problems, ethical issues concerning GM foods; trade related aspects of biotech foods; intellectual property rights (IPR) and bio-piracy problems; effect of biotech foods on the food business of developing and developed countries.

Reference books

Alexandru Mihai Grumezescu, Alina Maria Holban (2018). Advances in the biotechnology of food industry

Byong H Lee (2015). Fundamentals of Food Biotechnology. Wiley-Blackwell

Debasis Bagchi, Francis C. Lau, Dilip K. Ghosh (2010). Biotechnology in Functional Foods and Nutraceuticals. CRC Press

Kuddus, M. (Ed.). (2018). *Enzymes in food biotechnology: production, applications, and future prospects*. Academic Press.

Rai, Ravishankar. (2016). Advances in food biotechnology. Wiley- Blackwell

Syllabus

Open Elective Courses

(*Offered by the Department*)

M. Sc. Food Science and Technology

II Semester

Course	Course code	Course title	L	P	Credits
Open Elective	OST2206	Food and Nutrition	3		3

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

COOST2206	Expected course outcome	Learning domain	Mapping to PSOs
COOST2206.1	Define the terms and concepts in food science and nutrition	R/U	1
COOST2206.2	Summarize the composition and nutritional significance of different food groups	R/U	1
COOST2206.3	Elaborate the importance and physico-chemical properties of water	U	1
COOST2206.4	Recall the source, function and classification of carbohydrates, proteins and fats	U/A	1,3,4
COOST2206.5	Outline deficiency diseases related to carbohydrate, proteins and fats	U/A	1,3,4
**Remember (R), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

OST2206 Food and Nutrition 3

Module 1 8 hours

Introduction to food science and nutrition, Functions of food, Classification of foods, food groups by ICMR. Role of nutrition in maintaining health. Classification of nutrients. Composition and nutritional significance of cereals, pulses, milk, meat, fish, egg, fruits and vegetables, nuts, oils, and sugar.

Module 2 7 hours

Food Composition, Energy- SI Unit, RDA, Food sources of energy. Carbohydrates-Sources, classification, functions, deficiency diseases. Role of dietary fibre in human nutrition. RDA. Function of sugars in foods, browning reactions.

Module 3 7 hours

Proteins-Sources,Types of Proteins. Classification, Nutritional classification of amino acids, functions. Deficiency diseases. RDA. Protein denaturation.

Module 4 7 hours

Fat and lipids-Sources, Classification, functions. PUFA/Omega 3, n-6 fatty acids. Role of Essential Fatty Acids in health. Deficiency diseases. RDA. Rancidity.

Module 5 6 hours

Water in foods-Molecular structure of water. Physico-chemical properties of water, types of water in foods, water activity of food.

Reference books

Fennema, Owen R. 1997. *Food Chemistry, Food Science and Technologies*. Marcel Dekker, INC. New York
Gopakumar,K. (Tech. Ed.). 2002. *Textbook of Fish Processing Technology*. ICAR, New Delhi.
Brady, John W. 2013. *Introductory Food Chemistry*.Comstock Publishing Associates
Srilakshmi B. (2018) *Nutrition Science*, New Delhi; New Age International
ShakuntalaManay N, (2017) *Food facts and Principles*, New Delhi, New Age International

M. Sc. Food Science and Technology

III Semester

Course	Course code	Course title	L	P	Credits
Open Elective	OSTT2306	Food Safety and Quality Control	3		3

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

COOST2306	Expected course outcome	Learning domain	Mapping to PSOs
COOST2306.1	Outline concepts and definition in food safety and quality	R/U	1
COOST2306.2	Recall various hazards, toxins and adulterants in food	R/U	1
COOST2306.3	Comprehend the basic concept of Food Laws and Regulations in India and abroad	U	1
COOST2306.4	Summarize the importance of sanitation and hygiene in food industry	U/A	1,3,4
COOST2306.5	Explain Food safety management tools as GMP, GHP, HACCP, PMS	U/A	1,3,4
**Remember (R), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

OST 2306 Food Safety and Quality Control **3**

Module I **8 hours**

Introduction to food safety, Food safety- definition, factors affecting food safety and importance of safe foods. Difference between quality control and quality assurance. Foodborne diseases and infections and microorganisms causing them.

Module II **7 hours**

Food hazards and contaminants, Physical, biological and chemical hazards, food additives, food allergens, food toxins. Food adulteration.

Module III **7 hours**

Sanitation and hygiene, Sanitation programme- SOP and SSOP. Sequestrants, detergents, and sanitizers- chemical and physical properties, mechanism of action of most common sanitizers and detergents used in food industry.

Module IV **7 hours**

Introduction to food quality control, Methods to determine food quality- objective and subjective methods. Food safety management tools- good manufacturing/ management practices (GMP), good hygienic practices (GHP), HACCP principles. Pest control (PMS)- insect, rodents, other pests.

Module V **6 hours**

Food laws and regulations, Role of national and international regulatory agencies- Food Safety and Standards Authority of India (FSSAI), Bureau of Indian Standards (BIS), AGMARK, Codex Alimentarius Commission, USFDA, International Organization for Standardization (ISO) certification for food safety.

Reference books

Gopalakrishna I.T.S., Kandoran M.K., and Mathew P.T., (Eds) 2005. Quality Assurance in Seafood Processing, Central Institute of Fisheries Technology, Cochin.

Mehta, Rajesh and J. George. 2005. Food Safety Regulations, Concerns and Trade: The Developing Country Perspective, Macmillan.

Newslow, D.L. 2001. The ISO 9000 Quality System: Applications in Food and Technology, John Wiley & Sons.

Rees, M. and D. Watson. 2000. International Standards for Food Safety. Aspen Publishers, Inc., Maryland.

Lyon, D.H., M.A. Francombe, T.A. Hasdell, K. Lawson (Eds) 1992. Guidelines for sensory Analysis in Food Products Development and Quality Control. Chepman and Hall, London.

Farber, J.M., Evan C.D. Todd (Eds). Safe Handling of Foods. Marcel Dec Inc. New York.

PulkitMathur. 2018, Food Safety and Quality Control, Orient Blackswan Private Limited, Telengana.

Syllabus
Open Elective Courses
(*Offered by the Other Department*)

Open Elective Courses for II Semester

1.	**OST 2204**	**Diagnostic Microbiology**	**3 credits**
2.	**OST 2201**	**General Oceanography**	**3 Credits**
3.	**OST 2207**	**Analytical Methods in Marine Environment**	**3 credits**
4.	**OST 2202**	**Environment & Biodiversity**	**3 credits**
5.	**ESC 2207**	**Climate Change and Polar Sciences**	**3 credits**
6.	**OST 2203**	**Marine Biotechnology**	**3 credits**

OST2204 Diagnostic Microbiology 3

Module I

Laboratory safety-Good lab hygiene. Microbiological hazards-Biological Safety cabinet: Class I, II & III, Biosafety levels, Universal precautions, Decontamination, Hazardous waste-Infectious waste, Sharp waste and waste disposal.

Module II

Microbiological methods- Morphology, Cultural characteristics, Biochemical characteristic-Indole, Methyl red, VogesPrauskauer, Citrate, Sugar fermentation, Oxidase, Catalase, Antibiotic susceptibility assay- Kirby –Bauer method of Disk Diffusion, Tube dilution technique

Module III

Immunological/ Serological diagnosis- Definition of antigen, antibody, Ag-Ab reaction-precipitation and agglutination. Immunological detection methods- Immunodiffusion- Ouchterlony technique, Immunoelectrophoresis- CouterImmuno Electrophoresis (CIA), RadioImmuno Assay, ELISA, WIDAL, VDRL, ASO Mantoux test

Module IV

Automated Methods for Diagnostic microbiology:, Colorimetric and pattern recognition methods for microbial identification – Vitek bacterial identification system, Flurophore- labelled/ oxidation-reduction substrate metabolism as indicator of growth & substrate utilization-Biolog identification, API 20 E strips, measurement of CO2 as product of metabolic activity- BACTEC system

Module V

Molecular techniques: DNA probes, Blotting techniques-Western blotting, PCR, Emerging techniques in microbiology laboratory- MALDI-TOF Mass Spectrometry –description of this technique in brief.

OST 2201 General Oceanography **3**

Unit 1

Multidisciplinary nature of Oceanography- Ocean and Sea- Major Oceans, Seas and their dimensions- Shoreline, Continental Shelf and Slope- Mid-Oceanic Ridges, Sea mounts and Trenches- Sea bottom materials- Major Oceanographic Expeditions (both international and national).

Unit 2

Physical properties and Chemical composition of sea water- Temperature, Salinity, Pressure and its units- Density and Specific volume anomaly- Effects of temperature, salinity and pressure on density- Light in the sea- Colour of the sea- Sound in the sea.

Unit 3

Horizontal and Vertical distribution of temperature, salinity and density in oceans- T-S diagram- Water masses in World Oceans and in the Indian Ocean- Ocean Mixed Layer, Thermocline, Halocline and Pycnocline- Distributions of dissolved oxygen and nutrients.

Unit 4

Spatial and Temporal scales of variability in ocean- Currents and Circulation- Major circulation gyres and currents of World Oceans- Monsoonal circulation of the Indian Ocean- Upwelling and Sinking- Coastal Upwelling regions and its significance for Fisheries- Waves, Tides, Long-shore Currents and Coastal processes.

Unit 5

Oceanographic Instruments and Data Collection at sea- Methods of Data Processing, Analysis and Ocean Modelling- Remote Sensing of Oceanographic parameters- Oceanographic Satellites and their Sensors - Climate Change and Oceanic Perspectives.

Reference books

Pickard G.L. and W.J. Emery- Descriptive Physical Oceanography- Pergamon press, (1995or latest edition).
Lynne D. Talley, G.L. Pickard, W.J. Emery and James Swift- Descriptive Physical Oceanography: An Introduction- Elsevier (6th edition, 2011).
Robert H. Stewart- Introduction to Physical Oceanography- online edition (public domain), Aug 2003.
Open University Course team and Butterworth-Heinemann: Sea water, its composition, properties and behavior; Open University team, 2nd Edition, 1997, jointly published by Oxford, UK, ISBN 0-7506-3715-3

OST 2207 Analytical Methods in Marine Environment 3

Module I 9 hours

Classical Methods of Analysis, Gravimetric Methods, Titrations in Analytical Chemistry- Neutralization Titrations, Complex Acid/Base Systems, Complexation and Precipitation Titrations, Applications of Classical Methods.

Module II 9 hours

Electro analytical Techniques, Voltametry; Coulometry; Amperometry; Potentiometry; Polarography; Electrolytic conductivity.

Module III 8 hours

Spectrophotometry, Fundamental laws of photometry, interference and photometric error, Basic instrumentation for UV-Vis, IR and Fluorescence spectrophotometers. Flame Spectrophotometry – Flame emission spectrometry, Atomic absorption Spectro photometry – general principles and instrumentation, interferences, Cold vapour techniques for estimation of Mercury, metal hydride generation techniques, Electro thermal atomisation. Atomic fluorescence spectrometry, Inductively coupled Plasma analysis.

Module IV 9 hours

Chromatographic Techniques, Classification of chromatographic techniques. Experimental techniques and applications of Ion exchange, Column, Thin Layer and Paper chromatography. HPLC and Gas Chromatography – Principle, Instrumentation and Detectors. Methods and applications.

Module V 9 hours

NMR and Mass Spectrometry, NMR – Basic Principles and Instrumentation of Continuous Wave and Pulsed Fourier Transform NMR Spectrophotometers, Mass Spectrometry – Basic Principles, Instrumentation – Sample flow, Ionisation methods, mass analysers, Ion collecting systems, Analysis of data.

Reference books

J.M. Mermet, M.Otto, R.Kellner , Analytical Chemistry, Wiley –VCH, 2004.
D.A. Skoog, D.M. West, F.J.Holler, S.R. Crouch, Fundamentals of Analytical Chemistry, 8thEdn, Saunders College Pub, 2007.
G.D. Christian, J.E. O'Reilly, Instrumental Analysis, Allyn and Bacon, 1986.
J.H. Kennedy, Analytical Chemistry: Principles, Saunders College Pub 1990.
J.G. Dick, Analytical Chemistry, R.E. Krieger Pub., 1978.

OST 2202 Environment & Biodiversity **3**

Unit I

Environment: Definition, Structure and composition of atmosphere, hydrosphere, lithosphere and biosphere. Major environmental factors - biotic and abiotic. Natural resources – conservation and management.

Unit II

Fundamentals of Ecology and Ecosystem, Components and function of an ecosystem - Producers – consumers – decomposers. Food chain, Food web, Trophic level, Energy flow, ecological pyramids. Ecological succession. Concept of limiting factors, laws of limiting factors – laws of minimum and tolerance, Earth's carrying capacity. Ecosystem services.

Unit III

Biomes and Habitats - aquatic habitats – fresh water: ponds, rivers, lakes, wetlands – their characteristics, flora and fauna; marine habitats – pelagic, benthic, intertidal, estuarine, Mangroves – their characteristics, flora and fauna.

Unit IV

Definition and types of biodiversity, Ecological, Genetic and organismal diversity; importance of biodiversity. Values of biodiversity, Mega biodiversity countries, biodiversity hotspots – global and Indian. Marine biodiversity. Present status of marine biodiversity in India. Island biodiversity. Causes of biodiversity loss. Threats to biodiversity. Assessment of Biodiversity. Red Data Books. Biodiversity conservation - Strategies for biodiversity conservation, principles of biodiversity conservation - in-situ and ex- situ conservation strategies.

Unit V

Convention on Biological Diversity (CBD). Organizations involved in protection and conservation – CITES, IUCN, WWF for Nature, UNEP. Ramsar Convention 1971, Biodiversity legislation in India - Indian Biodiversity Act 2002, National Biodiversity Authority of India. State Biodiversity Boards and Biodiversity management committees, National bureaus dealing with genetic resources – NBPGR, NBAGR, NBAIM, NBAII and NBFGR. Environmental Impact Assessment (EIA), general guidelines and procedures for the preparation of environmental impact assessment. Public awareness.

Reference books

Guido di Prisco, Peter Convey (auth.), Guido di Prisco, Cinzia Verde (eds.).2012. Adaptation and Evolution in Marine Environments, Volume 1: The Impacts of Global Change on Biodiversity. Springer-Verlag Berlin Heidelberg 236 pp.

Michael Jeffries. 2006. Biodiversity and Conservation (Routledge Introductions to Environment). Routledge 257 pp.

Philippe Goulletquer, Philippe Gros, Gilles Boeuf, Jacques Weber (auth.). 2014. Biodiversity in the Marine Environment. Springer Netherlands 214 pp.

ESC2207 Climate change and polar sciences **3**

Unit 1

Introduction to Climate: The Earth's Climate Machine Definitions, Climate and Weather, Clouds, Storms and Climate-Cloud Formation,, Tropical Cyclones Anticyclones- Global Warming Climate in the Spotlight; the Spectra of Scientific Opinion. The Earth's Natural Greenhouse Effect-General Overview, the radiative balance, greenhouse gases - An Overview, The role of carbon dioxide, methane, nitrous oxide, and water vapour on climate change, Major Uncertainties.

Unit 2

Polar regions as an indicator of climate change, CO^2 Emissions, Human Emissions of CO^2. Carbon Cycling: Some Examples, the Physical Carbon Pump, the Biological Carbon Pump, the Marine Carbon Cycle, and the Terrestrial Carbon CycleGlobal Ocean Circulation: Introduction and Overview; El Niño and the Southern Oscillation; El Niño and its Effects; Indian Ocean Dipole; Upwelling and Climate. Outlook for the Future: IPCC projections; Computer Modeling.

Unit 3

Description of the climate system Ggreenhouse effect and the effect of trace gases and aerosols, Ffeedbacks in the climate system, climate change in the past, ice ages, proxy records, abrupt climate change, Instrumental record of climate, Climate variability on various time-scales, simple models of climate, General Circulation Models, natural and anthropogenic climate change: detection and attribution, impacts and mitigation

Unit 4

Overview of Polar Geology & Geography and Climate;; Physical characteristics; weather and climate, ice coring in Antarctica for paleo-environment studies, logistics operational aspects of Antarctic Science, opportunities, Governance and protection of Antarctic environment, International linkages. Ice characteristics and physical oceanography of polar seas; Sea ice: types, physical and mechanical properties, heat flux, temporal and spatial distribution, melting and freezing processes, forecasting models, and remote sensing of ice/snow covered surfaces. Microbial geochemistry of ice. Currents and water masses, deep and bottom water formation, fronts and eddies, polynya processes, and underwater acoustics.

Unit 5

Arctic; Operational aspects of Arctic meteorology, including polar lows, boundary layer and marginal ice zone influences. Polar oceanography: Sea ice amount, seasonal distribution, melting and freezing processes, physical and mechanical properties, drift and predictions. Currents and water masses, deep and bottom water formation, fronts and eddies. Indian Polar programme: History and status.

OST 2203 Marine Biotechnology **3**

Unit 1
Fundamentals of Marine Biology: physical and chemical parameters of ocean; organisms inhabiting marine environment. Introduction to Marine Microbes and marine bioactive compounds

Unit 2
Bioactive compounds derived from Marine organisms: aminoacids, macrolides, alkaloids, steroids; introduction to Marine Toxins- paral structure and biological functions and applications of marine bioactive compounds.

Unit 3
Common extraction methods for isolation of bioactive compounds from marine sources: Chromatographic separation of compounds- HPLC, TLC, FPLC; Microplate readers and fluorescence spectroscopy.

Unit 4
Enzyme activity: Common screening methods for isolated enzymes and bioactive molecules- enzyme assays: Caspase assay and LDH assay; Bioassays – General benchtop and primary bioassays; comet assay; MTT assay

Unit 5
Marine derived drug discovery and development: Drug toxicity assays – High-throughput screening assays and types- In vitro and In vivo assays; animal and cell based assays; basic clinical evaluation protocols for marine drugs: source and mode of action; Immunodiagnostics of fish diseases.

Reference books
D.S. Bhakuni and D.S. Rawat (2005). Bioactive Marine Natural Products
Abba Kastin (2013). Handbook of Biologically active peptides 2n edition. Acadmic press.
Hermann Ehrlich (2010). Biological Materials of Marine origin. Invertebrates. Springer Press.
Atta Ur- Rahman, M. Iqbal Choudhary, William J Thomsen (2001). Bioassay techniques for drug development.

Open Elective Courses for III Semester

OST 2301	**Coastal Oceanography**	**3 Credits**
OST 2302	**Ornamental Fishes and Aquarium Maintenance**	**3 Credits**
OST 2303	**Fundamentals of Molecular Biology**	**3 Credits**
OST 2304	**Marine Microbes and Diseases**	**3 Credits**
OST 2305	**Marine Geology**	**3 Credits**
OST 2307	**Marine Chemistry**	**3 Credits**

OST 2301Coastal Oceanography **3**

Unit 1

Coastal Geomorphology: sea coasts and shorelines, shoreline features, beaches, behavior of beach, wave action on beach sediments, movement of beach material, beach stability, effect of man on the beach, Long shore currents - rip currents, types of sediment transport, equation governing sediment transport, long-shore sediment transport, cross-shore sediment transport, sediment transport calculations, sediment budgeting, Mud banks.

Unit 2

Introduction to Tides- Lunar and Solar components- Semi-diurnal and Diurnal tides- Spring and Neap tides - range differences- Tide generating forces- tidal currents and tide measurements.

Unit 3

Ocean waves- Sea –Swell- internal waves -Wave transformation in shallow waters, effect of bottom friction, phenomena of wave reflection, refraction and diffraction, breakers, littoral currents. Tsunamis- Seiches - Storm surges - measurement of waves. Wave erosion and accretion

Unit 4

Estuaries: General characteristics of estuaries, classification and nomenclature, stratification, estuarine circulation and mixing, tidal prism, entrainment, sedimentation in estuaries, flocculation and turbidity maxima.

Unit 5

Coastal zone management, environmental characteristics and conditions, oceanographic aspects in coastal zone protection, impact assessment for coastal environment, coastal zone of India, EEZ and is importance, law of the sea.

Reference books

Estuary and Coastline Hydrodynamics:A T Ippen
Estuaries: A Physical Introduction:K R Dyer
Estuaries:G H Lauff
Beaches and Coasts:C A M King
Waves and Coast:R E Meyer
The Coast Line:R S K Barnes
Stability of Coastal Inlets :PBrunn and Gerritsen
Shelf Sediment Transport Processes and :D J P Swift

OST 2302 Ornamental Fishes & Aquarium Maintenance 3

Unit I

Ornamental Fishes of India- Feshwater and marine. Status of Indian, ornamental fish sector- Export potential. Ornamental fish as livelihood sector employment, identification of potential ornamental fishes. Benefits of keeping aquarium fishes.

Unit II

Construction of home aquarium- accessories, design and setting up of freshwater and marine aquarium. Principles of a balanced aquarium. Aquarium plants and their role.

Unit III

Water quality maintenance in aquarium- range of water quality parameters. Filters in aquarium- types and principles.

Unit IV

Nutritional requirements for aquarium fishes, types of aquarium fish food, artificial and live feed. Common diseases of aquarium fishes and their control.

Unit V

Breeding techniques for major aquarium fishes- Freshwater and marine. Maintenance of broodstock. Nursery management. Conditioning, packaging and transport of aquarium fishes. Quarantine methods.

Reference books

Anshuman D. Dholakia (2016). Ornamenntal Fish culture and aquariummanagement.
Mary Bailey & Gina Sandford (2015). Ultimate encyclopedia of AquariumFish & Fish care.

OST 2303: Fundamentals of Molecular Biology **3**

Unit 1

Introduction to Cell organelles andGenome organization-Mendels experiments and Chromosomes; Prokaryotes and Eukaryotes- Genetic materials: DNA RNA – Structure and Types, DNA as Genetic material; Molecular mechanism of DNA replication and DNA repair- Prokaryotes and Eukaryotes; DNA Replication; Replication enzymes and functions.

Unit 2

Protein Synthesis: Prokaryotic Transcription and Translation- Genetic Code and mRNA synthesis: Molecular Mechanism of transcription- initiation, elongation and termination; Enzymes and Molecular factors involved. Translation

Unit 3

Cloning: Plasmids, Virus and Bacteriophages as vectors; Types and mechanism of Vector construction- M13 vector, Lambda Phage vector, Phagemids and cosmids; Gene cloning methods: cohesive and blunt end ligation; Electroporation, Transformation, Transfection, Lipofection, viral transformation; Prokaryotic and Eukaryotic Cloning hosts for gene expression.

Unit 4

Techniques and tools in Molecular Biology:DNA and RNA isolation, Agarose Gel Electrophoresis, Restriction Enzymes- Types andDNA digestion, Western Blotting, Southern Blotting, Polymerase Chain Reaction- primer designing methods and optimization of protocols; Common types of PCR methodologies- multiplex PCR, hot-start PCR, colony PCR and real time PCR. Site Directed Mutagenesis: Applications of PCR in molecular diagnostics.

Reference books

Michael R Green and Joseph Sambrook (2012): Molecular Cloning: A laboratory manual Vol: I- III. 7th edition. Cold spring harbour laboratory press

T A Brown. Gene Cloning and DNA analaysis- an introduction Wiley Blackwell

James D Watson et al. Molecular Biology of the Gene. Cold Spring Harbour Laboratory Press.

T A Brown. Genomes .Taylor and Francis, London.

OST 2304 Marine Microbes and Diseases 3

Module I

Human disease—bacteria and viruses; Mechanisms of pathogenicity, Indigenous marine bacteria *Vibrio cholera, Vibrio vulnificus Vibrio parahaemolyticus ,Clostridium botulinum*, Scombroid fish poisoning Pufferfish (Fugu) poisoning; Health hazards from sewage pollution at sea Sewage as a source of bacterial and viral infections Monitoring for potential pathogens—the indicator concept Coliforms and Escherichia coli, Fecal streptococci (entero cocci) Quality standards for recreational marine waters Shellfish hygiene Alternative indicators Direct testing for pathogens Heavy metal mobilization

Module II

Toxic dinoflagellates and diatoms, 'Red tides' and 'harmful algal blooms' Shellfish poisoning Reason for toxin production by dinoflagellates and diatoms,Paralytic shellfish poisoning (PSP) Neurotoxic shellfish poisoning (NSP) Diarrhetic shellfish poisoning (DSP) and azaspiracid poisoning Amnesic shellfish poisoning (ASP) Ciguatera fish poisoning (CFP) Pfiesteria piscicida ,Monitoring and control of HABs

Module III

Diseases of marine mammals, Difficulties of studying these diseases, Effects of microalgal toxins, Virus infections Morbilliviruses, Other viruses Bacterial and fungal infections, Effects of environmental pollution on infectious diseases ,Zoonoses

Module IV

Diseases of invertebrates Introduction Bacterial and viral diseases of bivalve molluscs Bacterial and viral diseases of crustaceans , Diseases in aquaculture Viruses Rickettsias and mycoplasmas, *Aerococcusviridansvar. homari* Vibrio spp. Control of disease in crustaceans Diseases of corals

Reference books

Colin Munn Marine microbiology Ecology and Application.
Middelboe, M. and Brussaard, C.P. eds., 2018. Marine Viruses 2016. MDPI
Middelboe1, M and C P. D. Brussaard.2017 Marine Viruses: Key Players in Marine Ecosystems Viruses.; 9(10): 302.
Egan and Gardiner. 2016 Microbial Dysbiosis: Rethinking Disease in Marine Ecosystems Frontiers in Microbiology Volume 7 . Article 991
M. Crane and A. Hyatt Viruses of Fish 2011: An Overview of Significant Pathogens (Viruses3: 2025–2046.
P. K. Bienfang et al.,2011 Prominent Human Health Impacts from Several Marine Microbes: History, Ecology, and Public Health Implications (A Review Article). International Journal of Microbiology
P.T.K. Woo. Fish Diseases and Disorders. Vol 3: Viral, Bacterial and Fungal Infections.
Bosch and S.F. Le Guyader(2010) Viruses in Shellfish . Food EnvironmVirol 2: 115-116.
Principle diseases of marine fish and shellfish by Carl J. Sindermann.
Fish disease diagnosis and by Edward C. Noga
Fish diseases and disorders by J. F. Leatherland and PKT Wook

OST 2305 Marine Geology **3**

Unit 1
Ocean floor topography – Shelf, slope, rise, abyssal plains, submarine canyons, mid oceanic ridges, plateaus, sea minerals, sea mounts, guyots, fracture zones, trenches. Seafloor spreading – concepts, hypothesis and mechanisms, evidences of seafloor spreading. Plate tectonics – theories and concepts, major plates and plate motions. Mountain building activity – concepts and hypothesis.

Unit 2
Evolution of oceans – Submarine volcanism, rift system, origin and ages of ocean basins. Active and passive continental margins. Structure and evolution of Pacific, Atlantic and Indian Oceans, Red sea and Mediterranean sea. Sea level changes – causative factors and types of sea level changes; methods of study of sea levels and their changes.

Unit 3
Oceanic sediments – Processes and patterns of sedimentation; turbidity and density currents and their role in marine sedimentation. Sediment distribution in different oceanic regions; distribution in the Arabian Sea and Bay of Bengal. Physical and geotechnical properties – porosity, permeability, bulk density, vane shear and compressibility. Gas charged sediments- special reference to North Indian Ocean.

Unit 4
Marine mineral resources – Beach and nearshore placer deposits. Polymetallic nodules, Sulfides, cobalt rich crusts – genesis, occurrence, distribution, mineralogy and chemistry. Phosphirites – Genesis, occurrence and distribution. Mineral resources of the Indian ocean. Offshore oil and gas – Genesis, accumulation and preservation. Offshore oil and gas fields of India.

Unit 5
Samplers – Grabs, Corers, Dredges. Exploration and Mining techniques of Marine Mineral Resources. Prospects of ocean mining; Environmental aspects of ocean mining.

Reference books
Marine Geology, J. Kennet
Geotectonics, Belonssov V.V.
Plate tectonics and crustal evolution, Condia K.C.
The Geology of Continental margins, C.A. Burk & C.L. Drake
Sea levels, land levels and tide ganges, Emery & Aubrey
Marine Manganese nodules, Wallace

OST 2307 Marine Chemistry **3**

Module I
History of oceanography, important oceanographic expeditions and oceanographic institutions of the world.Origin of seawater, structure of water, ion-water interactions, the polarized water molecule, colligative properties of seawater, comparison of river and sea water.

Module II
Composition of sea water, salinity and chlorinity concepts, the major and minor constituents, constancy of relative composition, residence time, geochemical balance of oceans. Primary, cosmogenic and artificial nuclides, Applications of radioisotopes in oceanography

Module III
Factors affecting the concentration of gases in seawater, pH, alkalinity, specific alkalinity, buffer capacity, sea water - carbon dioxide equilibria, precipitation and dissolution of carbonates, global carbon cycle.

Module IV
Overview of micronutrient cycles-Nitrogen, phosphorus and silicon, their cycles, distribution profiles and their effect on phytoplankton growth, N/P ratio.

Module V
Dissolved and particulate organic matter- Nature, origin and distribution.

Reference books
T. Garrison, Oceanography, 2nd Ed., Wadsworth Publishing, 1995.
F. J. Millero, Chemical Oceanography, 2nd Ed., CRC Press, 1996 or 3rd Ed., CRC Press 2006.
J. P. Riley, R. Chester, Introduction to Marine Chemistry, Academic Press, 1971.
Seawater: Its Composition, Properties and Behaviour, The Open University Oceanography Series, Pergamon, 2nd Ed., 1995.
J. P. Riley, G. Skirrow, Chemical Oceanography, Vols. I to III, Academic Press, 1975.
K. Grasshoff, K. Kremling, M. Ehrhardt Ed., Methods of Seawater Analysis, 3rd Completely revised and extended edition, Wiley-VCH, 1999.
C. Duxbury, A. B. Duxbury, K. A. Sverdrup, An Introduction to World Oceans, 6th Ed., McGraw-Hill, 2000.

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