

Revised Syllabus

M. Sc. Food Technology



Centre of Food Technology
University of Allahabad
Allahabad

Regulations for M.Sc. Degree in Food Technology

1. Eligibility for admission:

The eligibility for entry is: B.Sc. Food Technology / Agriculture/ Home Science with Chemistry/ B.Tech. (Food Tech. or Dairy Tech.) / B.Voc degree in Food Technology (NSQF Level 7) or equivalent degree

2. Duration of Programme:

The M.Sc. programme shall extend over a period of 4 consecutive semesters spread over 2 academic years – two semesters constituting one academic year. The duration of each semester shall normally be 15 - 18 weeks excluding examinations.

Eligibility to appear in end semester examination: 75% attendance is compulsory with a provision of relaxation of attendance up to 20% in a paper based on the specific recommendations of the Head of the department/ Dean in case of ill health/ Sports/ NCC/ NSS.

3. Examination and Assessment

- (a) The performance of the students will be evaluated on a comprehensive system of continuous evaluation.
- (b) The award list along with answer sheets of End Semester examination shall be submitted by the Course Coordinator to the Controller of Examinations for consolidation and publication of results.
- (c) There shall be 40% sessional marks and 60% for the end-Semester examination in each theory paper and practical.
- (d) The sessional assessment will be based on tests / assignment / presentations / quiz etc. The best two out of the three tests will be taken for computing the sessional marks.
- (e) The aggregate marks of Sessional and End Semester examination of each paper shall be communicated to the Controller of Examinations.
- (f) For the conduct of the Practical Examination, there shall be a Board comprising of two internal examiners.
- (g) For the conduct of Project/Thesis evaluation, there shall be a Board comprising of external and internal examiners.
- (h) The implementation of the evaluation process shall be monitored by the Departmental Examination Committee.

4. Assessment and evaluation:

- a) Choice Based Credit System of the University of Allahabad will be adopted for assessment and evaluation.
- b) The evaluation of the continuous assessment for each semester shall be made on the basis of credit hour earn by the student.
- c) One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours of practical work/field work per week. Accordingly, one Credit would mean equivalent of 15-18 periods of 60 minutes each or 30-36 hrs of workshops/labs.

5. Revision of Regulations and Curriculum:

The syllabi and course structure of each course shall be developed and formulated by the Programme Committee (PC) of the Centre which shall be free to modify and update the courses from time to time and to amend the Regulations. The changes made by the PC shall be reported to the higher bodies of the university.

Programme Objectives

- To develop knowledge, understanding and skills in areas of Food Technology required to work independently in research and development or equally qualified employment in food technology
- To develop ability to analyze and evaluate critically various technical solutions in the field for establishing own enterprise.
- To demonstrate an ability to acquire new knowledge in the field and to integrate this with existing knowledge.
- To develop ability to choose and design technologies for the industrial manufacture of food products and processes , with regard to raw materials, energy, economics and sustainability in the system of industrial food technology.

M.Sc in Food Technology

Course Structure

Semester	Paper Code	Title of paper	Credits			
			L	T	P	Total (C)
I	FFT 501	Principles of Food Processing	3	1	0	4
	FFT 502	Food Chemistry	3	0	1	4
	FFT 503	Instrumentation and Analytical Techniques	3	0	1	4
	FFT 504	Research Methodology and Statistics	3	1	0	4
	FFT 591	Communication Skills	1	0	1	2
	FFT 592	Basics of Computer Application	1	0	1	2
		TOTAL	14	2	4	20
II	FFT 505	Post Harvest Technology of Horticulture Crops	2	0	1	3
	FFT 506	Food Microbiology	3	0	1	4
	FFT 507	Packaging of Food Materials	3	0	0	3
	FFT 508	Food Engineering	3	1	0	4
	Elective- I (Any two)	FFT 551	2	0	0	2
		FFT 552				
		FFT 553				
		FFT 554				
		FFT 557				
	FFT 593	Communication skills and Scientific writing	1	0	1	2
		TOTAL	16	1	3	20
III	FFT 601	Processing of Cereals, Pulses and Oilseeds	3	0	1	4
	FFT 602	Processing of Milk and Milk Products	3	0	1	4
	FFT 603	Quality Control, Food Standards and Food laws	3	0	0	3
	Elective- II (Any two)	FFT 651	2	0	0	2
		FFT 652				
		FFT 653				
		FFT 654				
		FFT 655	1	0	1	2
	FFT 691	Workplace Skills	1	0	1	2
	FFT 604	Training and Workshop	0	0	2	2*
	FFT 641	Seminar	0	0	1	1
		TOTAL	14	0	6	20
IV	FFT 646	Thesis	0	0	20	20
		Total Credits	44	3	33	80

*Non Credit Requirement

SEMESTER I

Core Course: FFT 501 Principles of Food Processing

Credits: (3-1-0-4)

Level: Post Graduate

Semester: Autumn

Pre-requisite: B.Sc. with Chemistry / Biochemistry as one of the paper/course.

Objective:

To acquaint with principles of different techniques used in processing and preservation of foods.

Course Content

UNIT I (5 lectures)

Introduction: Definition and scope of Food Science and Technology, historical development of food processing and preservation, general principles of food preservation.

UNIT II (15 lectures)

Preservation by heating: Principles of the method, Types of microorganisms, bacterial load, sterilization and commercial sterility, thermal resistance of the microorganisms and enzymes..

Canning and bottling: General aspects of canning and bottling, processing operations exhausting and sealing, retorting, ultra-high temperature processes, determination of thermal process time, processing equipments, canning/ bottling of various food products.

Chemical preservation: Preservation of foods by use of sugar, salt, chemicals and antibiotics and by smoking. Effect of various food processing operations on the nutrients of foods.

UNIT III (15 lectures)

Refrigeration and freezing preservation: Refrigeration and storage of fresh foods, major requirements of a refrigeration plant, controlled atmospheric storage, refrigerated storage of various foods, freezing point of selected foods, influence of freezing and freezing rate of the quality of food products, methods of freezing, storage and thawing of frozen foods.

UNIT IV (13 lectures)

Drying and dehydrations: Sun drying of various foods, water activity and its effect on the keeping quality, sorption isotherms and their use. Characteristics of food substances related to their dehydration behavior, drying phenomenon, factors affecting rate of drying, methods of drying of various food products, type of driers and their suitability for different foods; intermediate moisture foods.

Concentration (Evaporation): Application in food industry, processes and equipment for manufacture of various concentrated foods and their keeping quality, Properties of liquid, single and multiple effect evaporation,

UNIT V (12 lectures)

Radiations: Sources of radiations, effect on microorganisms and different nutrients; Radiation units and doses for foods, dose requirements for radiation preservation of foods, safe limits, irradiation mechanism and survival curve, irradiation of packaging materials. Microwave Heating: Principles and application in food processing.

Learning Outcomes: The students will have knowledge about different processing and preservation methods and principles involved.

Reference Books

- Food Processing Technology by P.J. Fellows, Woodhead publishing ltd.
- Food Science by N.N. Potter, CBS publishing.
- Physical principles of Food Preservation. Vol. II by M. Karel, O.R. Fenema and D.B. Lurd, Maroel, Dekker Inc. New York.

Core Course: FFT 502 Food Chemistry

Credits: (3-0-2-4)

Level: Post Graduate

Semester: Autumn

Pre-requisite: B.Sc. with Chemistry as one paper / course.

Objective: To acquaint with properties and role of various constituents in foods, interaction and changes during processing.

Course Content

UNIT I (4 lectures)

Water: properties, bonding and chemistry.

UNIT II (8 lectures)

Carbohydrates: Classification, structure and properties of carbohydrates. Role of carbohydrates in food industry. Sugar, starch, cellulose, glucans, hemicelluloses, gums, pectic substances, polysaccharides. Browning reaction in foods: Enzymatic and non-enzymatic browning in foods of vegetable and animal origin during storage and processing of foods.

UNIT III (12 lectures)

Proteins: Classification, structure, properties, purification and denaturation of proteins. Protein interaction and degradation, protein-protein interaction, protein-lipid complexes and protein-carbohydrate complex. Major protein systems and factors affecting them, the nature of interaction in proteins derived from milk. Egg proteins, meat proteins, fish muscle proteins, oil seed proteins and cereal proteins.

Enzymes: Nature, classification and properties of food enzyme, enzyme activity in different food systems, commercial availability. Food enzyme technology. Immobilization of enzymes, removal of toxicants through enzymes, flavor production by enzymes.

UNIT IV (10 lectures)

Lipids: Classification and physico-chemical properties of food lipids. Refining of crude oils, hydrogenation and winterization. Vegetable and animal fat, margarine, lard, butter. Frying and shortening. Flavor changes in fats and oils, lipid oxidation, factors affecting lipid oxidation, auto-oxidation, biological significance of auto-oxidation of lipids.

UNIT V (11 lectures)

Vitamins: Role of vitamins in food industry, effect of various processing treatments and fortification of foods.

Minerals: Role of minerals in food industry, effects of various processing treatments.

Biological changes in foods: Plant pigments and their roles in food industry. Bitter substance and tannins. Flavour Composition of Foods and beverages. Emulsion: Definition, Theory, Emulsifiers: Properties, role & action in stabilizing an emulsion.

Practical

- Preparation of standard solutions for the chemical analysis i.e. HCl, H₂SO₄, KmnO₄, Sodium Thiosulphate and Iodine.
- Determination of pH and acidity of foods
- Determination of proximate composition of Foods: Moisture, Protein, Fat, Total ash, Crude fibre, Carbohydrate, Calorific Value
- Determination of minerals in food products: Calcium by Titration, Phosphorus by Spectrophotometer, Iron by Spectrophotometer
- Estimation of reducing, non-reducing, total sugars in cereals and fruits & vegetable products.
- Determination of starch content in food products.
- Estimation of fats & Oils: Free fatty acid, Peroxide value, Saponification value, RM Number, TBA test, Iodine value, Fat adulteration test
- Determination of NaCl content in food products.
- Determination of trypsin inhibitors.

Learning Outcome: The students will gain information about various food constituents, and changes that occur in them during food processing.

Reference Books

- Belitz HD.1999. Food Chemistry. Springer Verlag.
- DeMan JM. 1976. Principles of Food Chemistry. AVI.
- Fennema OR.1996. Food Chemistry. Marcel Dekker.
- Meyer LH. 1987. Food Chemistry. CBS

Core Course: FFT 503 Instrumentation and Analytical Techniques

Credits: (3-0-2-4)

Level: Post Graduate

Semester: Autumn

Pre-requisite: Graduation in any stream of science.

Objective: To develop an understanding and methodologies of instrumental techniques in food analysis used for objective methods of food quality parameters.

Course Content

UNIT I (3 lectures)

Preparation of chemical solutions: Concept of molar, molal, and normal solutions. pH and Buffers: Importance and measurement of pH.

UNIT II (8 lectures)

Chromatographic techniques: General principles. Partition and adsorption chromatography. Paper, thin layer, gas liquid, ion exchange and affinity chromatography. Gel filtration. Introduction to High Pressure Liquid Chromatography.

UNIT III (5 lectures)

Electrophoretic Techniques: General principles. Paper and gel electrophoresis. Polyacrylamide gel electrophoresis.

UNIT IV (8 lectures)

Spectroscopy: Beers and Lambert's Law. Extinction coefficient. General principles of colorimeters and spectrophotometers, Atomic spectroscopy, Emission spectroscopy, IR spectroscopy.

UNIT V (6 lectures)

Fluorimetry: Spectrofluorimeters. Flame photometry and atomic absorption spectrophotometry.

Use of radioisotopes. Microbiological assays. Microscopy

Practical

- Qualitative analysis of compounds by chromatography techniques: Thin layer Chromatography, Paper Chromatography: Descending, Ascending and Circular Paper chromatography.
- Qualitative analysis of compounds By using High Performance Liquid Chromatography.
- Column chromatography: Separation of beta carotene
- Use of electrophoresis in the determination of proteins.
- Determination of Rheological properties by using texture analyzer.

Learning Outcome: Students will get acquainted with analytical methods used for quality control analysis of raw material and processed food commodities.

Reference Books

- Hand Book of Food Analysis by Nollet & Toldra, CRC publishing ltd.
- Hand Book of Analysis & Quality Control for Fruit & Vegetable Products by Rangana, Tata Mcgraw hill publishing.
- Introduction to the chemical analysis of foods by Nielson, CBS publishing.

Core Course FFT 504 : Research Methodology and Statistics

Credits: (3-1-0-4)

Level: Post Graduate

Semester: Spring

Pre-requisite: Basic knowledge of mathematics

Objective:

The students will be exposed to various statistical tools required to analyze the experimental data in Food Technology.

Course Content

UNIT I 11 lectures

Introduction to Research; Types of Research: (Basic & Applied) and their applications. Formulating a Research Problem; Research Design: Definition, Characteristics & Components. Research Questions, Objectives & Assumptions. Generation of Hypothesis. Data Collection: Tools, Primary & Secondary methods of Data collection.

UNIT II

12 lectures

Sampling methods: Rationale & Characteristics. Types of Sampling: Probability & Non-probability sampling. General consideration in and Scaling Techniques. Consideration and Calculation of Sample Size. Data management & Analytics: Editing & Coding of Data, Tabulation & Graphical Representation of Research Data using MS Excel & Statistical software.

UNIT III

10 lectures

Design of Experiments (DOE): Applications of Randomized Block Design (RBD) and its types, Factorial Design, Fractional Factorial Design, Latin Square Design (LSD), Critical Difference (CD), Split Plot Design.

UNIT IV

15 lectures

Descriptive Statistics: Measures of Central Tendency – (Mean, Mode, and Mode for Grouped and Ungrouped Data). Measures of Variability – Range, Variance, Standard Deviation and Standard Error. Measures of Relative Positions - Sigma Scores, Standard Scores, Percentiles, Percentile Ranks. Measures of Relationships (Correlation and Regression Analysis). Normal Distribution & its applications; Measures of Shape – (Skewness, Kurtosis). Calculations and Interpretation of Statistical Procedures

UNIT V

12 lectures

Hypothesis Testing in Research: Confidence Intervals and Levels of Significance. Degrees of Freedom Tests of Significance . Parametric Tests – Z-test, t-Test, and F-test, ANOVA (One way & Two Way) . Non-Parametric Tests – Chi-Square. Calculations and Interpretation of Parametric and Non-Parametric Tests – use of statistical software.

Learning Outcomes: The students are expected to have learnt statistical tools for analyzing data.

Reference Books

- Jackson SL. 2012. Research Methods and Statistics: A Critical Thinking Approach. Fourth Edition. Wadsworth Cengage Learning.
- Krishnan V. 2011. Statistics for Beginners. Atlantic Publishers and Distributors (P) Ltd.
- Singh YK. 2006. Fundamentals of Research Methodology and Statistics. New Age International Publishers.
- Aggarwal BL. 2003. Basic Statistics. New Age.
- Kothari CR. 1989. Research Methodology. Wiley Eastern.
- Gupta SP. 2004. Statistical Methods. S. Chand & Sons.

Foundation Course: FFT 591 Communication Skills**Credits: (1-0-2-2)**

Level: Post Graduate

Semester: Autumn

Pre-requisite: English as a subject at secondary level.

Objective: To equip the students with skills to write, communicate and articulate in English (verbal as well as written).

Course Content**Unit I**

2 lectures

Introduction to communication – Definition, Purpose, Basic communication model, need for effective communication, process & barriers to communication

Unit II

4 lectures

Grammar - Noun, Articles, Adjective & Degrees of comparisons, Preposition, Subject-verb agreement, Present, past & future Tense, Modals & Moods, Active & passive voice, Reported speech

Unit III

4 lectures

Oral Communication –Identification of sounds (Phonetics), Consonant & Vowel sounds, Indianism, Syllable & Syllable Stress, Intonation & modulation, Word stress, Development of Speaking Skills

Unit IV

3 lectures

Written Communication –Formal & informal letter writing, Introduction to Essay writing,

Unit V

2 lectures

Vocabulary building - Learning new words, Synonyms, Antonyms, use of suffix/prefix.

Practical:

- Ice breaker session
- creating new words
- exercise on picture description
- story completion
- oral practice of vowel sounds and syllable stress (phonetics)
- Comprehension Practical
- Dictionary Quiz
- Paragraph writing
- Vocabulary building exercises
- Paragraph Reading

Learning Outcomes: The students are expected to be able to communicate effectively in English after completing the course.

Reference books:

- English Grammar Composition & Usage. J C Nesfield
- Essential Grammar in Use, Raymond Murphy, Cambridge
- Oxford English Grammar , Sidney Greenbaum, Oxford University Press

Foundation Course FFT 592: Basics of Computer Application

Credits: (1-0-2-2)

Level: Post Graduate

Semester: Autumn

Pre-requisite: Graduation in any stream.

Objective: To educate students about the basic use, applications and web applications so as to facilitate learning.

Course Content

UNIT I (2 lectures)

Introduction to Computer (Hardware / Software) (2 lectures)

UNIT II

Microsoft Word and its applications (Documentation and Formatting) (4 lectures)

UNIT III

MS Excel and its applications (Making Tabular data, charts & formatting, Use of general functions & formulae) (4 lectures)

UNIT IV

MS PowerPoint and its applications (Creating own design, design & formatting of a presentation, Use of Image, audio, video in the presentation) (3 lectures)

UNIT V

Use of Internet & Web Applications and Email Services, Industry customer approach.

Practical

- Basics of Computers, usage of short cut keys, taking out print outs, page set ups.
- Making of Power point Presentation
- E- Mail (Subject line, salutation, subscription, how to mark cc, drafting, sending of mails, reverts, forwarding of mails, attaching pictures and documents, attaching ppts
- Differentiation between hardware and software and practical usage of both.
- Diagrammatic representation of pie-charts, tabular presentation of data/info, Etc
- Basic use of MS Excel/Spread Sheets

Learning Outcomes: Learning of basic computer applications and use of web services will be completed after studying the course.

Reference Books

- Fundamentals of Computers by E. Balagurusamy (Author) Publisher: McGraw Hill Education (India) Private Limited
- Ms Office 2007 in a Nutshell by S. Saxena (Author) Publisher: S.Chand (G/L) & Company Ltd

SEMESTER II

Core Course: FFT 505 Post Harvest Technology of Horticultural Crops

Credits: (2-0-2-3)

Level: Post Graduate

Semester: Spring

Pre-requisite: FFT 501

Objective: To acquaint with the proper handling technologies of fruits and vegetables to reduce post harvest losses and acquaint with principles and methods of preservation of fruits and vegetables into various products.

Course Content

UNIT I (4 lectures)

Fruits and vegetables as living products: Chemical composition; pre and post harvest changes, maturity standards for storage, desirable characteristics of fruits and vegetables of processing.

Post harvest handling of fresh fruits and vegetables: Role of plants growth regulators in relation to storage; physical and chemical treatment to increase the shelf-life, conditions for transportation and storage, disease and injuries during marketing.

UNIT II (8 lectures)

Storage of fresh fruits and vegetables. Containers: Tin, glass and other packaging materials used in fruits and vegetables preservations. Canning and bottling: quality of raw materials, preparation of materials, preparation of syrups and brines, canning and bottling, effect of canning and bottling on nutritive value, spoilage of canned foods, detection and control.

Fruit and vegetable juices: Preparation of juice, syrups, squashes, cordials, and nectars; concentrations and drying of juice, packaging and storage and concentrations and powders; fortified and soft drinks.

Preparation of preserve and candied fruits

UNIT III (4 lectures)

Preservation by freezing, general methods for freezing of fruits and vegetables; problem relating to storage of frozen products; standards for frozen food products.

Dehydration of fruits and vegetables: Methods; packaging, storage, quality control during and after dehydration.

UNIT IV (8 lectures)

Pickles and chutneys: Preparation of various types of pickles- theory and practice; preparation of sauces and chutneys; problems relating to the shelf life of pickles and chutneys; quality control.

Tomato products: preparation of various tomato products, food standards and quality control.

Pectin: Raw materials; processes and uses of pectin; products based on pectin manufacture and quality control.

UNIT V (6 lectures)

Food additives: Use in fruit and vegetable preservation.

Vinegar: General methods of preparation, food standards and quality control. Uses

Utilization of waste from fruit and vegetables processing plant.

Practical

- Analysis of canned food products for chemical and microbiological spoilage.
- Tin coating test
 - Tin coating weight measurement (Clarke's Test)
 - Determination of the continuity of tin coating
 - Sulphide stain test and corrosion resistance test
- Determination of Ascorbic acid content in food products.
- Determination of lycopene content
- Determination of tannins in food products.
- Dehydration of fruits and vegetables
- Preparation of tomato products like ketchup, puree & past

- Preparation of Jam, Jelly, marmalade, preserve and fruit candy
- Pectin determination in fruits and vegetable products.
- Determination of chemical preservatives in fruits and vegetables products.
- Preparation and analysis of fruits beverages i.e. Squash and cordial.
- Use of flame photometry in the estimation of trace metals like Sodium and Potassium

Learning Outcomes: Students would have learnt different post harvest handling methods of fruits and vegetables.

Reference Books

- Lal G, Siddapa GS & Tandon GL.1986. Preservation of Fruits and Vegetables. ICAR.
- Salunkhe DK, Bolia HR & Reddy NR. 1991. Storage, Processing and Nutritional Quality of Fruits and Vegetables. Vol. I. Fruits and Vegetables. CRC.
- Thompson AK. 1995. Post Harvest Technology of Fruits and Vegetables. Blackwell Sci.

Core Course FFT 506 : Food Microbiology Credits: (3-0-2-4)

Level: Post Graduate

Semester: Spring

Pre-requisite: Science (Biology) as a subject in Class X.

Objective: To acquaint with different groups of micro-organisms associated with food, their activities, destruction and detection in food.

Course Content

UNIT I

(10 lectures)

General characteristics of microorganisms: Classification and identification of yeasts, molds and groups of bacteria important in food industry. Source of contamination: Air, water, soil, sewage, post processing contamination. Intrinsic and extrinsic factors influencing growth of microorganisms in foods.

UNIT II

(8 lectures)

Classification of foods and general principles involved in their preservation. Effects on microbes of: Low temperature preservation, lethal effects of chilling, freezing and thawing; high temperature preservation. Heat resistance of microorganism, heat penetration and thermal processing. Pasteurization, sterilization, canning and dehydration; chemical preservation and its toxic effects; irradiations.

UNIT III

(9 lectures)

Food fermentations: Bacterial, yeast and mold cultures; single and mixed cultures, propagation, maintenance and evaluation of cultures; factors affecting activity of cultures, bacteriophages, residual antibiotics and chemicals.

UNIT IV

(8 lectures)

Microbiology of fermentation: Fermented milks. Cereal foods, vinegar, oriental foods, alcoholic beverages. Therapeutic value of fermented foods. Food Biotechnology: Use of biotechnologically improved enzymes in food processing industry

UNIT V

(10 lectures)

Food spoilage: Spoilage of fresh and processed fruit and vegetables, spoilage of meat, fish, eggs and poultry products. Microbial toxins.

Pathogens in foods: Microbial infections and intoxications. Growth and survival of pathogens in food.

Food borne diseases. Investigation and control

FFT 605 Food Microbiology Practical

- Determination of microbial counts: Total viable, thermophilic, proteolytic, lipolytic and aerobic spore farmers, coliform counts, yeast and mold count.
- Determination of activity of starter cultures used and dairy industry.
- Dye reduction test.
- Determination of thermal resistance of enzymes and microorganisms

Learning Outcomes: After completing the course, the students will have knowledge about different groups of micro-organisms and their beneficial as well as harmful effects related to food.

Reference Books

- Food microbiology by V. Ramesh, MJP publishing.

- Food microbiology by W.C. Frazier, 1st Edition by McGraw Hill Pub. Co. New York.
- Modern Food Microbiology, J.M. Jay. CBS publisher.

Core Course: FFT 507 Packaging of Food materials

Credits: (3-0-0-3)

Level: Post Graduate

Semester: Spring

Pre-requisite: FFT 501

Objective: To acquaint the students with packaging methods, packaging materials, packaging machineries, modern packaging techniques etc.

Course Content

UNIT I

(11 lectures)

Definitions and functions of packaging and packaging materials. Packaging requirements and selection of packaging materials; Types of packaging materials: paper: pulping, fibrillation and beating, types of paper and their testing methods; Glass: composition, properties, methods of making bottles and jars; Metals: Tin plate containers, tinning process, components of tin plate, tin free steel (TFS), types of cans, aluminum containers, lacquers; Plastics: types of plastic films, laminated plastic materials, coextrusion, edible films and biodegradable plastics.

UNIT II

(11 lectures)

Properties of materials such as tensile strength, bursting strength, tearing resistance, puncture resistance, impact strength, tear strength, their methods of testing and evaluation; Barrier properties of packaging materials: Theory of permeability, factors affecting permeability, permeability coefficient, gas transmission rate (GTR) and its measurement, water vapour transmission rate (WVTR) and its measurement, prediction of shelf life of foods. Different packaging systems for dehydrated foods, frozen foods, dairy foods, fresh fruits and vegetables, meat, poultry and sea foods.

UNIT III

(8 lectures)

Process of Packaging: Material handling, filling, air removal, sealing, retorting, Modified atmosphere packaging, vacuum and gas packaging. Package sterilization techniques, cushioning, unitizing, palletizing, stacking and containerization.

UNIT IV

(8 lectures)

Quality Control: Evaluation of Packaging materials, toxicity, corrosion prevention, shelf life testing, minimization of transport losses, Hazards in handling and storage and packaging and their minimization.

UNIT V

(7 lectures)

Packaging Laws and Regulations, Standards of Weights and Measures Act, Advancement in packaging Technology: Smart packaging, Active packaging, Anti-microbial packaging etc.

Learning Outcomes: Students will have learnt about packaging materials, methods and their applications in food industry.

Reference Books

- Coles R, McDowell D and Kirwan MJ, Food Packaging Technology, CRC Press, 2003
- Robertson GL, Food Packaging – Principles and Practice, CRC Press Taylor and Francis Group, 2012
- Paine FA and Paine HY, A Handbook of Food Packaging, Blackie Academic and Professional, 1992

Core Course FFT 508: Food Engineering

Credits: (3-1-0-4)

Level: Post Graduate

Semester: Spring

Pre-requisite: B.Sc. with Chemistry as one paper.

Objective: To acquaint with basic principle of Food Engineering and its Processes, with importance of various foods process and their evaluation.

Course Content**UNIT I** (9 lectures)

Mass, Energy balance and Heat transfer: Steam injection, steam infusion, plate heat exchangers, tubular heat exchangers and scraped surface heat exchangers, Pasteurization: Theory and application, pasteurization of packaged and unpacked foods, pasteurization calculations, equipments. Thermal processing: Death kinetics, thermal death curve, decimal reduction time. Z-factor, heat penetration curve, process time calculations, mathematical curve, process time calculations. Mathematical and graphical solutions

UNIT II (10 lectures)

Size reduction process: Principles, theories and laws, energy considerations, equipments. Mixing and forming, theory and applications, mixing indices, equipments for solid and liquid. Separation processes: Filtration and centrifugation, theories and mathematical descriptions, constant rate and constant pressure filtration, equipment. Membrane Technology- Reverse osmosis and Ultra filtration, Micro filtration

UNIT III (4 lectures)

Fluid flow, laminar, turbulent and transitional ranges, velocity distribution profiles, basic equations, thermal velocity calculations.

UNIT IV (10 lectures)

Evaporation: heat and mass balance, steam economy, heat recovery, efficiency, process calculations, Food dehydration: constant and falling rate periods, drying rate calculations. Chilling, refrigeration and freezing: theories, characteristics curve, cooling rate calculations.

UNIT V (12 lectures)

Advanced Technologies: Extrusion: Theory and applications, extrusion cookers and cold extrusion, single and twin screw extruders, design considerations., Supercritical gas extraction, Advances in fortification: Synthetic nutrients. Techniques of food fortification. Stability of nutrients in relation to processing. Encapsulations: design and structure of microcapsules, release rate and mechanism. Techniques of micro encapsulation, advantages and application of encapsulation. Non thermal Processing: High pressure processing, Pulsed electric processing, Ohmic heating.

Learning Outcomes: After completing the course the students shall be well acquainted about different food engineering processes and various principles working behind them.

Reference Books

- S. K. Sharma, S.J.Mulvaney, and S.S.H.Rizvi, Food Process Engineering: Theory and Laboratory Experiments, Wiley and Sons, 2000
- H. Pandey, H.K. Sharma, R.C.Chouhan, B.C. Sarkar and M.C. Bera, Experiments in Food Process Engineering, CBS Publishers and Distributors, 2004
- M.A. Rao, S.S. H.Rizvi and A.K.Dutta, Engineering properties of Foods, 3rd ed., Marcel Dekker, 2005

Elective Course FFT 551 : Technology of Meat and meat Products**Credits: (2-0-0-2)****Level:** Post Graduate**Semester:** Spring**Pre-requisite:** Graduate in Science and must have completed a course Food Science / Food Chemistry.

Objective: To provide an understanding of the technology for handling, processing, preservation and bi-product utilization of meat, poultry and fish products processing.

Course Content**UNIT I** (8 lectures)

Scope of meat & meat products industry in India. Structure of meat tissue. Chemical composition and nutritive value of meat Mechanism of muscle contraction and relaxation.

Postmortem changes-factor affecting post-mortem changes, thaw rigor and cold shortening Properties of fresh meat. Meat carcass grading and cuts. Restructured meat products, Pre rigor processing of meat. Meat tenderization -and its techniques.

UNIT II (6 lectures)

Preservation of meat & poultry- chilling, freezing, curing, smoking, canning, dehydration, irradiation, freeze drying, antibiotics, microwave, chemicals

UNIT III

(2 lectures)

Utilization of meat industry by-products.

UNIT IV

(10 lectures)

Eggs - structure, composition, nutritive value and functional properties of eggs. Internal quality of eggs- evaluation, quality troubleshooters in eggs, egg grading. Preservation and maintenance of internal quality of eggs, Egg products-Egg powders, frozen eggs, egg foams, factors influencing foaming.

Poultry -types, factors affecting quality, chemical composition and nutritive value of poultry meat

Poultry dressing - ante and postmortem examination, methods of stunning, slaughter, scalding & dressing.

Tenderness of poultry, problem factors in poultry meat. Utilization of poultry industry by-products.

UNIT V

(4 lectures)

Fish structure and composition. Cold storage, freezing preservation and canning of fish. Picking of fish, fish protein concentrates, fish meal and by products of fish processing industry

Learning Outcome: Students will have learnt about chemistry of meat and various processing methods used for meat, fish, poultry and eggs.

Reference Books

- Govindan TK. 1985. Fish Processing Technology. Oxford & IBH.
- Hui YH. 2001. Meat Science and Applications. Marcel Dekker. 32
- Kerry J. et al. 2002. Meat Processing. Woodhead Publ. CRC Press.
- Pearson AM & Gillett TA. 1996. Processed Meat. 3rd Ed. Chapman & Hall.

Elective Course FFT 552 : Intellectual Property Rights

Credits: (2-0-0-2)

Level: Post Graduate

Semester: Spring

Pre-requisite: Graduation in any stream.

Objective:

To sensitize the students regarding the essentials of Intellectual Property Rights, its fundamentals, legislations and significance to it in the development of agriculture, food and nutritional security.

Course Content

UNIT I

(6 lectures)

Need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPs Agreement.

UNIT II

(7 lectures)

Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties.

UNIT III

(5 lectures)

Fundamentals of patents, copyrights, geographical indications, designs and layout, trademarks.

UNIT IV

(6 lectures)

Protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection;

UNIT V

(6 lectures)

International Treaty on Plant Genetic; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement

Learning Outcome: The course is expected to acquaint the students with different IPR and its their importance in protecting individual rights.

Reference Books

- Erbis FH & Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI, Wallingford.
- Ganguli, Prabudha. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill, New Delhi.

Elective Course FFT 553 : Specialty Foods
Credits: (2-0-0-2)

Level: Post Graduate

Semester: Spring

Pre-requisite: Basic knowledge of Food Science and Nutrition at undergraduate level.

Objective:

To make students understand the need, importance and process of developing healthy and nutritious foods for special category of population groups.

Course Contents

UNIT I (6 lectures)

Need and scope of specialty foods: Specialty food based on ease in preparation cost health benefits; Functional foods, Convenience food, Health care and medical benefits, Nutritional status, Low cost foods.

UNIT II (6 lectures)

Specialty foods based on sources; Cereals and millets, Legumes and pulses, Fruits and vegetables, Animal food sources, By product based, Non conventional foods.

UNIT III (6 lectures)

Specialty foods based on process; Innovative process technology, Food additives basis, Bioactive components, Novel nutraceuticals products, Packaging techniques, Adaptable technology basis, Fast and PET foods.

UNIT IV (5 lectures)

Specialty food based on genetics; Genetically modified foods, Transgenic foods, Biotechnological aspects of detoxification. Proprietary foods. Supplementary foods.

UNIT V (7 lectures)

Therapeutic foods; Modification of diets in disorders, feeding purposes, Disease oriented of different organs ex: digestive tract, liver, cardiovascular system, kidney, metabolic disorders, allergy, endocrine disorders.

Specific consumer oriented foods; Defence persons, Space / astronaut, High altitude mountain climbers, Disaster situation – crises, care, maintenance. Specialty foods based on growing condition -organic, inorganic farming.

Learning Outcome: After completion of course the students would have an understanding of various specialty foods and their development based on variation of sources, process and genetics.

Reference Books

- Gibson GR & William CM. 2000. *Functional Foods - Concept to Product*.
- Robert EC. 2006. *Handbook of Nutraceuticals and Functional Foods*. 2nd Ed. Wildman.
- Manson P. 2001. *Dietary Supplements*. 2nd Ed. Pharmaceutical Press.
- Bamji MS, Rao NP & Reddy V. 2003. *Textbook of Human Nutrition*. Oxford & IBH.

Elective Course FFT 554 : Fundamentals of Nutrition

Credits: (2-0-0-2)

Level: Post Graduate

Semester: Spring

Pre-requisite: FFT 502

Objective: To acquaint the students about importance of nutrition, balanced diets, therapeutic diets for health and role of food and nutraceuticals in health.

Course Content

UNIT I (7 lectures)

Introduction to human nutrition. Macronutrients and micronutrients - Classification and functions. Digestion, absorption and assimilation of nutrients. Energy metabolism- Components of energy expenditure, Basal Metabolic Requirements and Activity, Recommended Dietary Allowances, Food Groups, Concept of a balanced diet, Methods of evaluation of nutritive value of foods.

UNIT II (5 lectures)

Carbohydrates- Types, functions, sources, requirement, storage, Effect of deficiency and excess.

UNIT III (5 lectures)

Proteins- Types, functions, sources, requirement, storage, Effect of deficiency and excess.

UNIT IV (5 lectures)

Fat- Types, functions, sources, requirement, storage, Effect of deficiency and excess.

UNIT V (8 lectures)

Vitamin- Types, functions, sources, requirement, storage, Effect of deficiency and excess.

Minerals- Types, functions, sources, requirement, storage, Effect of deficiency and excess.

Water and electrolytes- Concept and importance. Nutritional assessment and nutritional policies- Salient features, concept of community nutrition

Learning Outcomes: The students would be well informed about human nutrition concepts and various food groups after completing the course.

Reference books

- Nutrition Science by B. Srilakshmi
- Fundamentals of Foods & Nutrition by Sumati R. Mudambi
- Textbook of Nutrition : A Life cycle approach by Ravinder Chadha

Elective Course: FFT 557 Spices and Flavour Technology **Credits: (2-0-0-2)**

Level: Post Graduate

Semester: Autumn

Pre-requisite: FFT 502.

Objective: To impart basic knowledge about the importance and production technology of spices and to know chemistry and physiology of taste, flavouring compounds in foods

Course Content

Unit I (5 lectures)

Spice processing Introduction, classification, composition and functions. Standards specification of spices and flavours, Spice processing, spice reconditioning, spice grinding, post- processing treatments.

Unit II (7 lectures)

Processing of Major Spices: Pepper, cardamom, ginger, onion, garlic, vanilla, cinnamon, chilli and turmeric – method of manufacture; chemistry of the volatiles; enzymatic synthesis of flavour identical.

Unit III (5 lectures)

Processing of Minor Spices, herbs and leafy vegetables: processing and utilization, All spice, Annie seed, sweet Basil, Caraway seed, Cassia, Cinnamon, Clove, Coriander, cumin, Dill seed Fern seed nutmeg mint marjoram, Rose merry, saffron, sage.

Unit IV (5 lectures)

Spice extractives, Value added spice products: Spice volatile oils, spice oleoresins, Use of spice extractives, replacement of spices with oils and oleoresins, alternative products, Ground spices, processed spices, organic spices, curry powders. Packaging of spices and spice products

Unit V (8 lectures)

Chemistry and physiology of taste, flavouring compounds in foods, Separation, purification and identification of natural flavouring materials& Synthetic flavouring agents and their stability: Processing quality control of Savory, Thyme, Ajowan, Curry leaves, Asafoetida, Tea, Coffee, Cocoa, Vanilla and annatto. Flavours of soft drinks, Baking and confectionery industry.

Learning Outcomes: The students are expected to have learnt importance and production technology of spices and flavours.

Reference Books:

- Spices – vol. II Parry J. W.
- Spice and condiments Pruthi J. S.
- Herbs and spices by Rosemary Hemphill
- The book of spices by Rosen garten, F. and Livingston Jr.
- Spices and herbs for the Food Inudstry by Lewies, Y.S.
- Spices Vol. I and II by Tropical Agril. Series. Purseglove, J. W. Brown E. G.,

- Green C. L. And Robbins SRJ. Food Flavours P. R. Ashurst.
- Food Flavouring composition, manufacture and uses. by J. Merrory

Foundation Course: FFT 593 Communication Skills & Scientific Writing

Credits: (1-0-2-2)

Level: Post Graduate

Semester: Spring

Pre-requisite: Knowledge of basics of communication skills.

Objective:

To educate the students about kinds of communication, enhance their vocabulary and teach them types of formal writing used in academic research.

Course Content

Unit I

3 lectures

Advance Communication- Types of communication, Mass Communication, Levels of professional communication, Role of newspapers, radio, Cinema and TV, role of social media and networking

Unit II

2 lectures

Audio Visual Communication – Nature and scope of visual aids, use of Power Presentations in professional life

Unit III

3 lectures

Grammar usage and Word power – Phrase and Clauses, Idioms, Proverbs, Homophones, Homonyms, Reading and Comprehension.

Unit IV

2 lectures

Advance writing skills – Movie review, Book review

Unit V

5 lectures

Scientific Writing – Introduction to Technical writing, definition, types, characteristics, Report Writing, CV & Resume making, plagiarism

Practical:

- Sentence framing exercises - revision
- Writing descriptive paragraphs
- Dictionary consulting activities-Spell bee,
- Role Plays
- Movie viewing Sessions
- Book Reading sessions
- Impromptu Presentations
- Listening Practice
- Creating audio visual (AVs) using photographs
- Reading Scientific Texts
- Outlining a research

Learning Outcome: The course would have equipped the students with advance communication skills and basics of technical writing.

Reference Books

- Test your English Vocabulary in use, Michael McCarthy, Felicity O'Dell, Cambridge
- Wren & Martin, High School English Grammar and Composition, S.Chand, Paperback, 2005
- Oxford English Grammar Use, Micheal Swan & Catheirne Walter, Oxford University Press
- Using English in Science & Technology, Singh, R.K., Prakash Book Depot, Bareilly, 2000.

SEMESTER III

Core Course FFT 601 : Processing of Cereals, Pulses and Oilseeds

Credits: (3-0-2-4)

Level: Post Graduate

Semester: Autumn

Pre-requisite: FFT 501 and FFT 502

Objective: To acquaint with production and consumption trends, structure, composition, quality evaluation, and processing technologies for product development and value addition of various cereals, pulses and oilseeds.

Course Contents:

UNIT I (8 lectures)

Wheat Technology: Composition of grain and environmental effects on its processing quality, enzymes of wheat and their role in the manufacture of wheat products; principles of wheat milling and its effect on composition of flour, aging of flour, byproducts, chemical improvers- bleaching and maturing agents, property of dough and its rheology, manufacture of wheat products bread, biscuits etc.; formulation of premixes for bakery products; pasta goods and processed cereal foods for infants.

UNIT II (10 lectures)

Rice Technology: Composition, type of proteins, starch content, amylose and amylopectin fractions; presence and effect of lipases; distribution of vitamins; minerals, and proteins in rice grain and its relation to milling; rice milling operations and its effect on nutritive value; cooking quality; byproducts of rice milling and their utilization; processed and prepared mixes based on rice.

UNIT III (8 lectures)

Legumes: Composition, anti-nutritional factors, processing methods, methods of cooking.

UNIT IV (10 lectures)

Corn Technology: Composition, processing of corn for manufacture of corn grits, meal and flour; manufacture of corn flakes, corn syrup, cornstarch, corn steep liquor, corn oil and canned corn. Composition and Processing of millets like barley, sorghum, oats etc.

UNIT V (9 lectures)

Oilseeds: Composition, processing of oilseeds as protein concentrations, properties and uses of oilseeds meals, technology vegetable protein isolates; Barrier compounds in the utilization of oil seed proteins. Low cost protein foods from oilseeds.

Practical

- Physico-chemical and rheological examination of wheat and its products test weight, kernel hardness, gluten content, milling tests.
- Evaluation of rice amylose and amylopectin determination, gelatinization temperature, water absorption tests.
- Experimental parboiling and assessment of degree of polishing.
- Experimental baking of selected cereals products bread, biscuits.
- Preparation of protein concentrates and isolates and their evaluation for protein content and solubility.
- Determination of Yeast activity used in fermented cereal products.
- Quality test for wheat flour used in the baked products.
 - Maltose Number
 - Water Absorption
 - Sedimentation value
 - Alcohol Acidity
- Texture profile analysis of baked cereal food products by texture analyzer.

Learning Outcome: The students will have learnt about composition and processing of various cereals, pulses and oilseeds.

Reference Books

- Chakrabarty MM. 2003. Chemistry and Technology of Oils and Fats. Prentice Hall.
- Dendy DAV & Dobraszczyk BJ. 2001. Cereal and Cereal Products. Aspen.
- Hamilton RJ & Bhati A. 1980. Fats and Oils - Chemistry and Technology. App. Sci. Publ.
- Hoseney RS. 1994. Principles of Cereal Science and Technology. 2nd Ed. AACC.

Core Course FFT 602 : Processing of Milk and Milk Products
Credits: (3-0-2-4)

Level: Post Graduate

Semester: Autumn

Pre-requisite: FFT 501

Objective: To acquaint with techniques and technologies of testing and processing of milk into various products and by products.

Course Contents:

UNIT I (12 lectures)

Introduction: Physicochemical properties of milk, Platform tests, Chemical composition and nutritive value of milk, Factors affecting composition of milk. Importance of milk industry in India: Collection, chilling, transportation, cream separation, standardization, pasteurization, sterilization, homogenization, packaging, storage and distribution of fluid milk, Ultrahigh temperature processed milk.

Preparation of various types of milks: Toned, homogenized, fortified, reconstituted and flavored milk.

UNIT II (12 lectures)

Technology of fermented milk products: Principles and practices of manufacture, packaging, storage and marketing of Dahi, cultured butter milk, acidophilus milk etc. Preparation of soft curd milk, vitaminized milk, standardized milk, filled milk and imitation milk.

Cheese: Manufacture of hard, semi hard, soft and processed cheeses. Storage, grading and marketing of cheese, cheese defects and their control. Butter: Manufacture, packaging, storage and marketing of butter; butter defects and their control, margarine.

UNIT III (8 lectures)

Technology of frozen milk products: Classification, manufacture, packaging, storage and marketing of ice cream, ices, sherbets etc. defects of frozen products and their control. Technology of evaporated and dried milk: Manufacture of evaporated milks and milk powders. Packaging storage defects and their control.

Technology of condensed milk: Manufacture of condensed milks, Packaging storage defects and their control.

UNIT IV (8 lectures)

Technology of dairy by products: Utilization of skim milk, buttermilk and whey for the manufacture of casein, lactose etc. Technology of indigenous milk products: Principles and practices of manufacture, packaging, storage and marketing of ghee, Khoa, Chhena, shrikhand, paneer, rasogulla, gulabjamun and Milk based foods.

UNIT V (5 lectures)

Sanitary aspects: of dairy plant building, equipment and their maintenance. Disposal of dairy plant waste. Application of membrane technology in dairy industry.

Practical

- Plat form test for raw milk
- Determination of moisture content in milk
- Determination of fat content in Milk powders and ice-cream products.
- Determination of Milk adulterants: Starch, Urea, Formaldehyde and Sugar,
- Hydrogen peroxide, salt and detergent
- Operation, cleaning and sterilization of dairy plant machinery involved in fluid milk processing
- Preparation of toned, homogenized, fortified, reconstituted and flavored milks
- Manufacture of fermented milks.
- To study the kinetics of enzymes and manufacture of cheeses.
- Manufacture of butter
- Manufacture of ice- cream, ices, sherbets.
- Manufacture of casein, ghee, khoa, chhena.
- Sensory analysis of food products: Paired comparison test, Duo-trio test, Hedonic test, Triangle test, Ranking test, Single sample test, Composite scoring test,
- Analysis of water used in food industries i.e. Alkalinity, Acidity, Hardness, pH, TPC and Coliform count

Learning Outcomes: After completion of course students are expected to have an understanding of processing methods of milk in a dairy industry and manufacturing of dairy products.

Reference Books

- Aneja RP, Mathur BN, Chandan RC & Banerjee AK. 2002. Technology of Indian Milk Products. Dairy India Publ.
- De S.1980. Outlines of Dairy Technology. Oxford Univ. Press.
- Rathore NS et al. 2008. Fundamentals of Dairy Technology - Theory & Practices. Himanshu Publ.

Core Course: FFT 603 Quality control Food Standards and Food Laws

Credits: (3-0-0-3)

Level: Post Graduate

Semester: Autumn

Pre-requisite: FFT 601

Objective: To acquaint with food quality parameters and control systems, food standards, regulations, specifications.

Course contents:

UNIT I (5 lectures)

Quality Assurance: Introduction, Importance and Difference. Food Quality and Food Safety: Scope and difference.

UNIT II (12 lectures)

Raw materials & Finished product quality: Quality parameters and evaluation procedures: Appearance, color, texture, viscosity, consistency, flavor.

Sensory evaluation: Selection of panel of judges, sensory characteristics of foods, types of tests.

UNIT III (12 lectures)

Food standards and laws: International – Concept of Codex alimentarius, HACCP, GMP, GHP, USFDA, ISO 9000, ISO 22000, ISO 14000. National – Introduction of BIS/IS, Food Safety and standards – 2006, Food Safety and standard regulation 2010, FPO, MPO, MMPO, Agmark. Prevention of food adulteration Act: Food Adulteration: definition, common adulterants in different foods, contamination, methods of detection. Food additives and legislation; coloring matter, preservatives, poisonous metals, antioxidants and emulsifying and stabilizing agents, insecticides and pesticides. PFA specification for food products, Nutritional labeling

UNIT IV (6 lectures)

Quality Certification & Accrediation: Introduction and procedure.

UNIT V (10 lectures)

Water Quality: Water standards and Analysis physical, chemical and microbiological characteristics of water analysis. Waste treatment: Fundamentals of Physical, Biological & Chemical waste treatments

Learning Outcome: The students must have an understanding about food laws and standards, quality parameters and sensory evaluation of food.

Reference Books

- Early R.1995.Guide to Quality Management Systems for Food Industries. Blackie Academic.
- Krammer A & Twigg BA.1973. Quality Control in Food Industry. Vol. I, II. AVI Publ

Elective Course FFT 651 : Entrepreneurship in Food Processing

Credits: (2-0-0-2)

Level: Post Graduate

Semester: Autumn

Pre-requisite: Completed basic course on Food Processing.

Objective: To enable the student to plan and prepare a project report for food processing unit and to provide capability to execute and evaluate the same and to introduce students to the methodology of project formulations and the implementation procedures and strategic planning of new projects.

Course contents:

UNIT I (6 lectures)

Aggregate Planning-: General design considerations, Financial Analysis, plant location and plant layout, Flowcharts and their design, equipment selection

UNIT II	(4 lectures)
Design of service facilities	
UNIT III	(4 lectures)
Human resource planning: Planning and design of marketing system, worker's safety and plant hygiene	
UNIT IV	(6 lectures)
Introduction to Marketing and economics: Demand, Supply, Sample survey techniques, marketing information, consumer trends, consumer behavior.	
UNIT V	(10 lectures)
Introduction to Operations Research: Definition, applications. Inventory control, Linear Programming. Queuing Theory, Transportation and Assignment. Forecasting	
Learning Outcome: The students would have been acquainted with designing and planning of food plant layout and operations research.	

Reference Books

- Chandra P. 2005. Project Management. Tata McGraw Hill.
- Gopal Krishan P & Nagarajan K. 2005. Project Management. New Age.
- Hisrich RD & Peters MP. 2002. Entrepreneurship. Tata McGraw Hill.
- Kaplan JM. 2003. Patterns of Entrepreneurship. John Wiley & Sons.
- Nandan H. 2007. Fundamentals of Entrepreneurship Management. Prentice Hall.

Elective Course: FFT 652 Food Fermentation and Microbial Technology

Credits: (2-0-0-2)

Level: Post Graduate

Semester: Autumn

Pre-requisite: Must have completed one course / paper on Microbiology / Food Microbiology.

Objective: To familiarize about the various microbial processes/systems/activities which have been used for the development of industrially important products/processes.

Course Content

Unit I	(6 lectures)
Fermentation: History, definition and types. Study of a Bio fermentor – its design and operation, Down Stream Processing and Product recovery. Its measurement and control in fermentation, Aeration and agitation in fermentation: Oxygen requirement, sterilization of air and media; scale up in fermentation.	
Unit II	(6 lectures)
Recovery of particulate matter, product isolation, distillation, centrifugation, whole broth processing, filtration, aqueous two-phase separation, solvent extraction, chromatography and electrophoresis.	
Unit III	(8 lectures)
Production of alcoholic beverages, organic acids, enzymes and immobilization of enzymes. Biological waste treatment.	
Unit IV	(4 lectures)
Dairy Fermentations-starter cultures and their types, concept of probiotics.	
Unit V	(6 lectures)
Microbial enzymes, role in various industrial processes, Bio-transformations, Immobilized enzymes based bioreactors; production of antibiotics, vaccines, and biocides; Bioconversion of substrates, anti-nutritional factors present in feeds; Microbial detoxification of aflatoxins; Bioinsecticides; Biofertilizers.	

Learning Outcome: The course will make the students learn about fermentation techniques and industrial microbiology.

Reference Books

- Huffnagle GB & Wernick S. 2007. The Probiotics Revolution: The Definitive Guide to Safe, Natural Health. Bantam Books.
- Nout RMJ, de Vos WM and Zwietering MH. 2005. Food fermentation. Wageningen Academic Publishers, Netherlands.

Elective Course: FFT 653 Food Rheology
Credits: (2-0-0-2)

Level: Post Graduate**Semester:** Autumn**Pre-requisite:** FFT 508

Objective: To explain the basics of food rheology and to familiarize the students with rheological instruments and their use in relation to food products.

UNIT I (6 lectures)

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

UNIT II (6 lectures)

Flow and functional models for rheological properties of fluid foods: Time independent flow behaviour, Apparent viscosity- shear rate relationships of shear- thinning foods, models for time dependent flow behaviour, role of solids fraction in rheology of dispersions, affect of temperature on viscosity, treatment of rheological data using models.

UNIT III (6 lectures)

Tube viscometry, Rotational viscometry: introduction

UNIT IV (6 lectures)

Viscoelasticity: introduction, transient tests for viscoelasticity, oscillatory testing. Rheology of food gum and starch dispersions: effect of heating, effect of sugar and protein, rheological behaviour of starch, rheology of starch- gum dispersions.

UNIT V (6 lectures)

Rheological behaviour of processed fluid, semisolid foods and food gels: rheological tests to evaluate properties of gel systems, gel point and sol-gel transition by rheological measurements. Application of rheology to fluid food handling and processing

Learning Outcome: It is expected that the students would have learnt concepts of rheology and structure of food systems.

Reference Books

- Bourne MC. 2002. Food Texture and Viscosity: Concept and Measurement. Academic Press
- Deman JM. et al. 1976. Rheology and Texture in Food Quality. AVI Publ.
- Mohsanin NN. 1989. Physical Properties of Plant and Animal Material. Vol. I, II. Gordon and Breach Science Publ.
- Steffe JF. 1992. Rheology and Texture in Food Quality. AVI Publ.

Elective course: FFT 654 Food Product Development
Credits: (2-0-0-2)

Level: Post Graduate**Semester:** Autumn**Pre-requisite:** Basic knowledge of Food Science.**Objective:**

To acquaint the students about the need, types, basic technique and details of food product development to plan nutritious products.

Course Content

UNIT I (6 lectures)

Concept of product development - product success and failure, factors for success, process of product development, managing for product's success. Innovation strategy - possibilities for innovation, building up strategy, product development programme.

UNIT II (5 lectures)

The product development process - product strategy, product design and process development, product commercialization, product launch and evaluation.

UNIT III (6 lectures)

The knowledge base for product development technology - knowledge and the food system, knowledge management, knowledge for conversion of product concept to new product, technological knowledge (product qualities, raw material properties, processing, packaging requirement, distribution and marketing.

UNIT IV (5 lectures)

Role of consumers in product development - consumer behaviour, food preferences, avoiding acceptance, integration of consumer needs in product development and sensory needs.

UNIT V (8 lectures)

Managing the product development process, - principles of product development management, people in product development management, designing the product development process, key decision points, establishing outcomes, budgets and constraints, managing and organizing

product development process, innovative matrices, striving for continuous improvement, Improving success potential of new products, market exploration and acquisition, Legal aspects of new product launch.

Learning Outcome: The course must have acquainted the students with principles of food product design and development.

Reference Books:

- Clarke & Wright W. 1999. Managing New Product and Process Development. Free Press.
- Earle R, Earle R & Anderson A. 2001. Food Product Development. Woodhead Publ.
- Fuller 2004. New Food Product Development - from Concept to Market Place. CRC.

Elective Course: FFT 655 Advanced Food Analysis

Credits: (1-0-1-2)

Level: Post Graduate

Semester: Autumn

Pre-requisite: Must have completed one course / paper on Basic Food Analysis.

Objective: To develop an understanding of instrumental techniques in food analysis used for determination of food quality parameters.

Course Content

Unit I (2 lectures)

Concepts of food analysis. Rules and regulations of food analysis. Sample preparation for food analysis. Measurement of colour and water activity of raw and processed foods.

Unit II (3 lectures)

Determination of browning reaction in foods, food additives, residues and deleterious factors in raw and processed foods. Measurement of enzymatic changes in foods. Sugar profiling of foods through Bioscan.

Unit III (3 lectures)

Measurement of viscosity/texture in food products. Rheological techniques and instrumentation in food. Microscopic, Fluorimetric and polarimetric techniques in food analysis.

Unit IV (4 lectures)

Application and operating parameters of spectrophotometer, AAS (Atomic absorption spectroscopy), Inductively coupled plasma optical emission spectroscopy (ICP-OES), NMR (nuclear magnetic resonance), FTIR (Fourier transform infrared spectroscopy)

Unit V (3 lectures)

Application and operating parameters of GC (Gas chromatography), HPLC (high performance liquid chromatography), GC-MS (gas chromatography- mass spectroscopy), LC-MS (liquid chromatography-mass spectroscopy).

Practical

- Sample preparation of food analysis
- Measurement of enzymatic changes in foods
- Sugar profiling of foods through Bioscan.
- Determination of Rheological properties by using texture analyzer

- Pasting properties of foods through RVA
- Working and operation of UV Visible Spectrophotometer
- Determination of Minerals through AAS
- Determination of heavy metals through ICP-OES
- Working and operation of HPLC, GC
- Qualitative analysis of compounds by chromatography techniques: Thin layer Chromatography, Paper Chromatography

Learning Outcome: The students would have been acquainted with application and working of Advance food analysis techniques.

Reference Books:

1. Nielson S S(2017). Food Analysis.Fifth edition. Springer, New York.
2. Clifton M and Pomeranz Y (1988)Food Analysis - Laboratory Experiments. AVI Publ.
3. Leenheer AP, Lambert WE and van Bocxlaer JF (2000)Modern Chromatographic Analysis of Vitamins. 3rd Ed. Marcel Dekker, New York.
4. Nollet LML (2004) Handbook of Food Analysis. Vol. I. Marcel Dekker, Switzerland.
5. Handbook of Analytical Techniques by Helmut Gunzler and Alex Williams
6. The Chemical Analysis of Foods and Food products By Morris b. Jacobs

Foundation Course: FFT 691 Workplace Skills
Credits: (1-0-2-2)

Level: Post Graduate

Semester: Autumn

Pre-requisite: Understanding of basics of communication skills.

Objective: To enable students to have firm grounding in English to be able to use it effectively in professional as well as social contexts and have good job seeking skills to work in the fiercely competitive job market.

Course Content:

Unit I 3 lectures

Business communication - Job Application, Business Letters, Cover letter, Writing Emails, Minutes writing, Project report

Unit II 2 lectures

Effective job seeking skills - Needed documentation, Application process, Preparing for the interview, Post interview process, Job interview question model,.

Unit III 3 lectures

Professional Practices and Ethical Codes- Work Ethics, Code of Conduct, Protocol, Motivation, Leadership, Formal writing

Unit IV 2 lectures

Presentation & public speaking skills – The art of listening, active listening, Presentation skills, public speaking

Unit V 5 lectures

Behavioral skills – Teamwork, Time management, Problem-solving Skills, Interpersonal & negotiation skills, building customer relations, Body language, Stress & Anger management

Practical:

- Oral presentations
- Using visual aids while presentations
- Critical Reading & Writing
- Mock interview
- Group discussions
- Team building exercises
- Proofreading and editing emails
- Cover letter drafting
- Resume-making
- Drafting reports

Learning Outcome: The course must have acquainted the students with communication and public speaking skills specially for interviews and group discussions.

Reference Books

- Barun K Mitra, Personality Development and Soft Skills, Oxford Higher Education
- Gopalawamy Ramesh and Mahadevan Ramesh, The Ace of Soft Skills, Pearson Education
- T. Anchukandam and J. Kuttainimathathil (Ed) Grow Free Live Free, Krisitu Jyoti Publications, Bangalore (1995)
- Mani Jacob (Ed) Resource Book for Value Education, Institute for Value Education, New Delhi 2002.
- T.N. & L.A. Olson Technical Writing & Professional Communication for Non-native speakers of English, McGraw-Hill, NY, 1991.

Core Course FFT 604 Training and Workshop
Credits: (0-0-4-2)*

Level: Post Graduate

Semester: Autumn

Pre-requisite: Completed basic course in Food processing

*** Non Credit requirement**

FFT 641 Seminar (0-0-2-1)

SEMESTER IV

FFT 646 Thesis (0-0-40-20)