SCHOOL OF COMMUNITY SCIENCE AND TECHNOLOGY
INDIAN INSTITUTE OF ENGINEERING SCIENCE AND TECHNOLOGY, SHIBPUR

Course Structure for Two-Year Four Semesters M. Sc. Program on Food Processing and Nutrition Science (From July, 2019 Onward)

First Semester

Paper No.	Subject Code	Subject Name	Class Load/Week			Total load/ Week	Credit	Marks
			L	T	P			
(Core) - I	CT5101	Basics of Food and Nutritional Science	3	1	0	4	4	100
(Core) – II	CT5102	Microbiology of Food	3	1	0	4	4	100
(Core) - III	CT5103	Food Chemistry and Analysis	3	1	0	4	4	100
(DE) - IV	CT5121	Nutritional Biochemistry	3	0	0	3	3	100
	CT5122	Nutrition and Dietetics						
(OE) - V	CT5161	Community Nutrition	3	0	0	3	3	100
(Lab) - I	CT5171	Food Chemistry and Analysis	0	0	3	3	2	50
(Lab) - II	CT5172	Microbiology of Food	0	0	3	3	2	50
Total			**15**	**03**	**06**	**24**	**22**	**600**

Second Semester

Paper No.	Subject Code	Subject Name	Class Load/Week			Total load/ Week	Credit	Marks
			L	T	P			
(Core) – VI	CT5201	Food Processing Principles and Application	3	1	0	4	4	100
(Core) – VII	CT5202	Food Preservation Principles and Application	3	1	0	4	4	100
(Core) -VIII	CT5203	Nutrition and Human Development	3	1	0	4	4	100
(DE)-IX	CT5221	Microbial Enzyme Technology	3	0	0	3	3	100
	CT5222	Food Toxicology						
(OE)- X	CT5261	Entrepreneurship and Human Resource Management	3	0	0	3	3	100
(Lab)-III	CT5271	Food Processing and Preservation	0	0	3	3	2	50
(TP) - XI	CT5291	Term Paper	0	0	8	8	4	100
(TP) - XII	CT5292	Term Paper Viva					2	50
Total			**15**	**03**	**11**	**29**	**26**	**700**

Third Semester

Paper No.	Subject Code	Subject Name	Class Load/Week			Total load/ Week	Credit	Marks
			L	T	P			
(Core)-XIII	CT6101	Food Safety and Quality Assessment	3	0	0	3	3	100
(Core)-XIV	CT6102	Unit Operation in Food Processing	3	1	0	4	4	100
(Core)-XV	CT6103	Food Bio Technology	3	0	0	3	3	100
(Lab) - IV	CT6171	Unit Operation in Food Processing	0	0	3	3	2	100
(Thesis P-I Report)-XVI	CT6191	M. Sc. Thesis (Progress Report)	0	0	16	16	8	100
(Thesis P-I Viva)-XVII	CT6192	Thesis (Seminar and Viva)	0	0	0	0	2	100
Total			**09**	**01**	**19**	**29**	**22**	**600**

Fourth Semester

Sl. No.	Subject Code	Subject Name	Class Load/Week			Total load/ Week	Credit	Marks
			L	T	P			
(Core)-XVIII	CT6201	Food Industry Effluents and Waste Treatments	3	1	0	4	4	100
(DE) - XIX	CT6221	Food Product Design and Development	3	0	0	3	3	100
	CT6222	Food Packaging						
	CT6223	Nano Technology in Food						
	CT6224	Process Modeling and Simulation						
(Lab)-V	CT6271	Nutrition and Biochemistry (Laboratory-V)	0	0	3	3	2	100
(Thesis P-II Report)-XX	CT6291	M.Sc. Thesis	0	0	16	16	8	200
(Thesis P-II Viva)-XXI	CT6292	Thesis Seminar & Viva voce	0	0	0	0	4	100
Total			**06**	**01**	**19**	**26**	**21**	**600**

Detailed syllabus for Two-Year Four Semester M.Sc. Program in Food Processing and Nutrition Science

1st Semester Paper-I (Core)
Subject: Basics of Food and Nutritional Science (CT 5101)
Contact Period: 4L per week, Full Marks: 100, Pass Marks: 40 [Credit – 04]

Course Objectives:

- Introduce the basic properties of macro-nutrients and their role in human nutrition
- Introduce the importance of fuel value of food.
- Introduce the significance of metabolic pathways for components of food
- Introduce the role of vitamins and minerals and other micro-nutrients in human systems

Expected Learning Outcomes for Course:

- Students will become familiar with the importance of several nutrients along with their importance in food and nutrition
- Students will become familiar with the structure, functions and sources of several nutrients
- Students will become familiar with the metabolic pathways of food components that are comprises of carbohydrates, proteins and fats

Prerequisite: Food and Nutrition, Food Chemistry

Sl. No.	Article	No. of Classes
1.	Importance of nutrition, Function of food and its components, Major and minor food items, Fuel value of foods; Basal energy metabolism; Total energy need of individual engaged in different activities; Determination of food energy	**06**
2.	Carbohydrates: Occurrence, classification, physicochemical and metabolic functions; metabolism of carbohydrates; Glycolysis, lactic acid and alcohol fermentation, Kreb's cycle; Cori cycle, Neuberg second and third form fermentation	**06**
3.	Proteins: Occurrence, classification, importance of proteins in our diet; Primary, secondary, tertiary and quaternary structure of proteins; Conformational stability and adaptability of proteins; physicochemical and metabolic functions, acid pool and nitrogen pool, nitrogen balance, essential amino acids, evaluation of quality of proteins. Protein sparing effect, metabolism of proteins (transamination, oxidative deamination and decarboxylation of amino acids, urea cycle)	**06**
4.	Lipids: Occurrence, classification, biological role of lipids, essential fatty acids, lipoproteins, physicochemical and metabolic functions; metabolism of lipids, breakdown of triglycerides and phospholipids, β-oxidation of unsaturated and odd chain fatty acids, ketosis, biosynthesis of fatty acids, triglycerides and phospholipids	**06**
5.	Hexose-mono-phosphate shunt pathway, oxidative phosphorylation, substrate-linked phosphorylation. Nucleic acids: properties and structure	**06**
6.	Vitamins and hormones: Classification, functions, sources, fat soluble vitamins (A,D,E,K), water soluble vitamins (thiamine, riboflavin, niacin, cyanocobalamin, folic acid, and ascorbic acid, etc); relationship between vitamins and hormones in terms of their biological role	**05**
7.	Minerals: Functions, sources, factors affecting absorption of minerals, absorption promoters (Vitamin C for Fe), absorption inhibitors (phytates, tannins, oxalates)	**05**
Total		**40**

Books:

1. Lehninger Pinciples of Biochemistry: D. L. Nelson and M. M. Cox
2. Biochemistry: J. M. Berg, J. L. Tymoczko and L. Stryer
3. Outlines of Biochemistry: Conn and Stumpf, John Wiley & Sons, New York
4. Biochemistry: Voet and Voet
5. Biochemistry: G.l. Zubay, W.C. Brown Publishers, Boston
6. Hand book of Food and Nutrition: Swaminathan
7. Nutritive Value of Indian Foods: Gopalan, Rama Sastri & Balasubramanium
8. Introduction to Food Chemistry: O.R. Fennema, S. Damodaran, K. L. Parkin
9. Food Chemistry: L.H. Meyer
10. Food- The Chemistry of Its Components: T. P. Coultate, RCS Pub, UK

(For 2 year M.Sc. Program in Food Processing and Nutrition Science)
1st semester Paper-II (Core)
Subject: Microbiology of Food (CT 5102)
Contact Period: 4L per week, Full Marks: 100, Pass Marks: 40 [Credit – 04]

Course objectives:

- Introduce basics of microbiology vis-a-vis food microbiology in particular
- Introduce understanding of factors affecting growth and death of microorganisms
- Introduce understanding role of microorganism in food spoilage, preservation techniques adopted for a wide spectrum of foods
- Introduce understanding beneficial usages of microorganisms in preparation of special class of important foods through fermentation processes

Expected Learning Outcomes for Course:

- Students will understand the microbial diversity, their role and growth kinetics
- Students will understand the microbial and chemical food spoilage and its preventive measures
- Students will understand the microbial metabolism in response to food habitat
- Students will understand the role of microbes in development of different food products

Prerequisite: Basic food microbiology, Basic integration, Food Chemistry

Sl No.	Article	No. of Classes
1.	Microbial diversity, kinds of microbes, nomenclature and identification of microorganisms. Microscopy and microscopes: Smears and staining, Morphology and details of exterior and interior structure of bacteria, yeast and molds, growth and cultivation of microorganisms and classification based on nutritional requirement; growth kinetics of microbes, Intrinsic and extrinsic factors influencing microbial growth in foods. Role and significance of microorganisms in food, microorganisms important in food microbiology, growth and growth kinetics of microbes, Microbial contamination of food, genetic engineering of microbes	**08**
2.	General principles underlying spoilage and chemical changes of foods caused by microorganisms; Microbiology of milk and milk products. fruits and vegetables, cereal and cereal products, meat and meat products, fish and other sea foods, poultry and eggs, sugar and sugar products. Microbiology of canned foods and spoilage. Food borne diseases; Food sanitation and control; Concept of pasteurization and sterilization	**06**
3.	Energy metabolism of aerobic and anaerobic microbes, Disinfection, Pasteurisation, Sterilisation, Activities of Microorganisms, Enzymes in microbes, usage of microbes in food products, Microorganisms in food, spoilage of food (fruits, vegetables, fish, meat, egg and their products) due to microbe, food base intoxication, fermented foods	**08**
4.	Importance of microorganisms in food and fermentation industries; Different kinds of fermented foods produced from cereals, fruits, vegetables, milk, fish and meat; Probiotic and pre-biotic foods	**06**
5.	Use of microorganisms for industrial uses; concept of bioreactors (fermentors) and its controls; Aerobic and anaerobic fermentation; submerged and solid-sate fermentation; aseptic controls in fermenter; sterilization of medium and air	**06**
6.	Production of Baker's yeast, alcohol, vinegar, acetone-butanol, amino acids, citric acid, lactic acid and vitamins; Production of mushroom by submerged fermentation; Production of algal protein, single cell protein and single cell lipid	**06**
Total		**40**

Books:

1. Biology of Microorganisms: Brock
2. Microbiology: M. J. Pelczar, E.C.S. Chan and N.R. Krieg
3. Prescott's Microbiology
4. General Microbiology: R. Y. Stainier
5. Food Microbiology: W. C. Frazier and D.C. Westhoff
6. Modern Food Microbiology: J. M. Jay
7. Fundamental Food Microbiology:Bibek Ray & A. Bhunia
8. Industrial Microbiology,Mcgraw Hill International: S. C. Prescott & C. G. Dunn
9. Biochemical Engineering Fundamentals –Mcgraw Hill International: J.E. Bailey & D. F. Ollis

(For 2 year M.Sc. Program in Food Processing and Nutrition Science)
1st Semester Paper-III (Core)
Subject: Food Chemistry and Analysis (CT 5103)
Contact Period: 4L per week, Full Marks: 100, Pass Marks: 40 [Credit – 04]

Course Objectives:

- Introduce the basics of chemical composition of foods
- Introduce the details of chemistry of macro-molecules that comprise the foods
- Introduce the role of external factors responsible for changing the physical, chemical and nutritional properties during and after processing the foods
- Introduce the analysis of food components using chemical analysis techniques as well as different analytical instruments

Expected Learning Outcomes for Course:

- Students will become familiar with the chemical composition of foods
- Students will become familiar with several factors affecting several properties during and after processing the foods
- Students will become familiar with the analysis techniques as well as different analytical instruments required for chemical analysis of food products

Prerequisite: Chemistry

Sl. No.	Article	No. of Classes
1.	Basic constituents of foods; Proximate composition of foods; Water in foods; functional properties of water, water activity and sorption isotherm, molecular mobility and foods stability; Physicochemical aspects of food dispersion system (Sol, gel, foam, emulations); Rheology of dispersed systems	**05**
2.	Carbohydrates: Chemistry of starch, glycogen, cellulose, pectin, gums, mucilage, crude fiber; Changes of carbohydrates during ripening (or maturation) and respiration of fruits and vegetables	**05**
3.	Proteins: Protein denaturation; Isolation and purification of proteins; Functional properties of proteins used in various food preparations; Processing induced physical, chemical and nutritional changes in proteins	**04**
4.	Lipids: Physico-chemical properties of lipids; Chemical characterization and analysis of fats & oils; Rancidity and oxidation of fats; Role of antioxidants in controlling oxidative rancidity; Fat substitutes; Non-caloric fats; Processing induced physical, chemical and nutritional changes in lipids	**05**
5.	Natural pigments and flavoring agents: Chemistry and properties of natural pigments like, chlorophylls, carotenoids, anthocyanins, anthoxanthins, flavonoids, tannins: Chemistry of natural volatiles and flavor components in cereals, fruits, vegetables and spices	**04**
6.	Analytical methods for food additives used in foods, Protein analysis in foods, Analysis techniques used for vitamins	**04**
7.	Application of various chromatographic techniques for analysis of food components, like GC, HPLC, TLC, Application of spectrophotometric methods for determination of different food constituents (Absorption spectrophotometer (UV-Vis), Atomic absorption Spectrophotometer). Determination of moisture of foods	**04**
8.	Estimation of sugars; Color measurement by reflective spectrophotometer (Colorimeters); Measurement of refractive index of oil by Abbe refractometer; The fluorometric determination of vitamin A in dairy products. Determination of $SO_3^{"}$ in food. Determination of seven antioxidants in dry food by HPLC	**04**
9.	Determination of methyl bromide in food. Detection of SO_2 in food products. Colorimetric determination of NO_3' and NO_2' in foods. A rapid method for the determination of K, Na. Determination of sorbic acid in fish. Determination of patulin by TLC (Thin layer chromatography). Determination of bioavailability of iron and β- carotene	**05**
Total		**40**

Books:

1. Analytical and Instrumental Techniques in Agriculture, Environmental and Food Engineering, A. Nag.
2. A Laboratory Manual of Food Analysis: Shalini Sehgal, K International Publishing House Pvt. Ltd
3. Methods in Food Analysis: Rui M. S. Cruz, Igor Khmelinskii, Margarida Vieira.
4. Food Chemistry: S. Damodaran, K. L. Parkin and O. R. Fenema
5. Food Chemistry: I. H. Meyer
6. Food-The chemistry of Its Components: T. P. Coultate, RCS Pub, UK
7. Analysis of Pesticides in Food and Environmental Samples (special Indian edition): Jose l. Tadeo, New India Publishing Agency.
8. Bioactive Food proteins and Peptides: Applications in Human Health (Special Indian Edition): Navam S. Hettiarachchy, Kenji Sato, Maurice R. Marshall & Arvind Kannan, New India Publishing Agency.
9. Introduction of Chemical Analysis and Food: S.S. Nielson, CBS.
10. Perfumery Materials: Production and Applications: D.K. Bhattacharyya, Studium press, llc.
11. Chemistry and Technology of Oils and Fats: M.M. Chakraborty, Allied Publishers Private Limited.

(For 2 year M.Sc. Program in Food Processing and Nutrition Science)
1st Semester Paper-IV (DE)
Subject: Nutritional Biochemistry (CT 5121)
Contact Period: 3L per week, Full Marks: 100, Pass Marks: 40 [Credit – 03]

Course Objectives:

- Introduce the different aspects of enzymes involved in food area
- Introduce the bioenergetics and metabolism of carbohydrates, lipids and proteins
- Introduce the role of free radicals, antioxidants, neutraceuticals and functional foods

Expected Learning Outcomes for Course:

- Students will become familiar with structure, function, reaction kinetics and regulation of enzymes
- Students will become familiar with isolation, production and purification of microbial enzymes
- Students will become familiar with metabolism of macromolecules, regulation and integration of metabolism.
- Students will become familiar with free radicals, mechanisms of antioxidants

Prerequisite: Properties of enzymes, Metabolism of macronutrients

Sl. No.	Article	No. of Classes
1.	Definition, nomenclature, classification, structure and functions of enzymes, coenzymes and prosthetic groups in relation to nutrition, active sites, mechanism of enzyme action, effects of temperature, pH, enzyme concentration and substrate concentration on the enzymatic reaction, specificity of enzymes, enzyme inhibition (reversible and irreversible inhibition)	**05**
2.	Regulation of enzymes, nature and functions of enzymes involved in digestion, anabolism, catabolism, isoenzymes, exo-enzymes and endo-enzymes, chromatographic separation techniques of enzymes	**07**
3.	Important groups of microorganisms for production of enzymes, isolation and purification of microbial enzymes utilized in food industry, importance of microbial enzymes for their uses in food and nutraceutical products, immobilization of enzymes and their applications	**07**
4.	Bioenergetics and metabolism, energy rich compounds, metabolism of carbohydrates and its regulation, metabolism of lipids and its regulation including digestion and absorption of lipids, methyl-malonyl CoA pathway, metabolism of proteins and its regulation including digestion and absorption of protein, breakdown of proteins, transamination, deamination, decarboxylation, nitrogen-fixation, urea cycle; Metabolism of ketone bodies and energy balance	**07**
5.	Electron transport chain, oxidative and substrate level phosphorylation, energy balance, regulation of metabolism, integration of metabolism	**04**
6.	Free radicals and antioxidants, mechanism of antioxidants in the oxidation of food, functional foods and neutraceuticals	**05**
Total		**35**

Books:

1. Lehninger Pinciples of Biochemistry: D. L. Nelson and M. M. Cox
2. Biochemistry: J. M. Berg, J. L. Tymoczko and L. Stryer
3. Outlines of Biochemistry: Conn and Stumpf, John Wiley & Sons, New York
4. Biochemistry: Voet and Voet
5. Biochemistry: G.l. Zubay, W.C. Brown Publishers, Boston
6. Enzyme Nutrition: The Food Enzyme Concept: Edward Howell
7. Nutritional Biochemistry: T. Brody
8. Biochemistry and Physiology of Nutrition (vol I & II): G. H. Bourne and G. W. Kidder
9. Biochemistry: R. H. Garrett & C. M. Grisham

(For 2 year M.Sc. Program in Food Processing and Nutrition Science)
1st Semester Paper-IV (DE)
Subject: Nutrition and Dietetics (CT 5122)
Contact Period: 3L per week, Full Marks: 100, Pass Marks: 40 [Credit – 03]

Course Objectives:

- Introduce the fundamental aspects of nutrition to maintain optimal health
- Introduce the role of several nutrients in human nutrition along with their metabolism and mal-absorption
- Introduce the nutritional requirement for several age groups
- Introduce the nutritional aspects of several chronic disorders
- Introduce the preventive and therapeutic measures for protecting malnutrition
- Introduce the Public health nutrition

Expected Learning Outcomes for Course:

- Students will become familiar with role of diet in maintenance of optimal health
- Students will become familiar with nutritional requirement for several age groups
- Students will become familiar with Hypo-metabolism and hyper-metabolism
- Students will become familiar with the interrelationship between hormone and nutrition
- Students will become familiar with nutritional aspects of health threatening diseases

Prerequisite: Food and Nutrition

Sl. No.	Article	No. of Classes
1.	Fundamental aspects of nutrition and dietetics; Nutrition Labelling, Preventive and therapeutic measures for protecting malnutrition	**05**
2.	Overview of metabolism and malabsorption diseases of carbohydrates, proteins and fat, Nutritional aspects of hypo-metabolism and hyper-metabolism; Interrelationship between hormone and nutrition. Bio availability of nutrients	**05**
3.	Nutritional requirement of different age group; Nutrient aspects of expecting mother; Nutrition and ageing	**06**
4.	Nutritional aspects of some specific disorders like Hypertension, Cardiovascular disorder, Diabetics, Osteoporosis, Genetic disorders, Obesity, Kidney disease, Gastrointestinal disease	**08**
5	Nutrition Education; Nutritional Epidemiology; Assessment of Nutritional Status; Public health nutrition	**05**
6.	Dietary fiber, antioxidants, nutraceuticals; Food Allergens; Basics of media usage and educational training; Socio-economic and administrative complexities associated with practical problems on nutrition to mass; Dietetic professional issues and regulatory national and international bodies; Sports Nutrition	**06**
Total		**35**

Books:

1. Food Science: N.M. Potter, CBS
2. Nutrition Science: B. Srilakshmi, New Age International (P) ltd.
3. Human Nutrition and Dietetics (Harcourt Medical): J. S. Garrow, Churchill Livingstone
4. Park Textbook of Preventive and Social Medicine
5. Human Nutrition and Dietetics: Passmore & Eastwood, Churchill Livingstone
6. Nutritional biochemistry: T. Brody, Academic press
7. Biochemistry and Physiology of Nutrition (vol I & II): G. H. Bourne and G. W. Kidder, Academic press
8. Clinical Nutrition: B. Sardesai, CRC press
9. Advancing Dietatics & Clinical Nutrition: A. Payne & H. Barker, Elsevier
10. Clinical nutrition: M. Elia, Olle Ljungqvist, R. J. Stratton & S. A. Lanham-new, Wiley-Blackwell.
11. Nutrition & Dietetics: S. A. Joshi, Tata Mcgraw Hill

(For 2 year M.Sc. Program in Food Processing and Nutrition Science)
1st Semester Paper-V (OE)
Subject: Community Nutrition (CT 5161)
Contact Period: 3L per week, Full Marks: 100, Pass Marks: 40 [Credit – 03]

Course Objectives:

- Introduce the fundamental aspects of community nutrition.
- Introduce the basics of Nutritional Status Assessment.
- Introduce the role of several nutrition and health program for assessing diet in population groups.
- Introduce the importance of Nutritional epidemiology.

Expected Learning Outcomes for Course:

- Students will become familiar with the importance of community nutrition relating to dietary goals and recommendations for populations
- Students will become familiar with several nutrition and health program for assessing diet in population groups and promoting healthy eating at the community level
- Nutritional epidemiology for establishing a link between diet and prevalent chronic disease

Prerequisite: Food and Nutrition

Sl. No.	Article	No. of Classes
1.	Community and community nutrition; Nutrition screening and assessment; Change in eating habits; National and international nutrition program for public health; Healthcare systems and policies	**09**
2.	Global food and nutrition insecurity and food assistance programs; Nutritional issues with mother, infants, children and adolescents; Nutrition programs for aged and ailing people; Malnutrition in pre-school children, working woman; industrial workers	**09**
3.	Nutrition and health program; Marketing and health promotion; Managing community nutrition; Community versus public health; Social and economic trends in community nutrition; Theories and models for health promotion and changing nutritional behaviour	**09**
4.	Community based dietetic professionals; Nutritional epidemiology; Over-nutrition, prevention, management programs; Legislative and non-legislative issues for nutrition policies	**08**
Total		**35**

Books:

1. Park Textbook of Preventive and Social Medicine: K. Park, Bhanot
2. Community Nutrition in Action: An Entrepreneurial Approach: M. A. Boyle, Cengage Learning, USA
3. Community Nutrition: Planning Health Promotion and Disease Prevention: N. A. Ninakwe, Jones Bartlett Learning, USA
4. Community Nutrition: Appying Epidemiology and Contemporary Practice – J. C. Frank, Jones Bartlett Learning, USA
5. Community Nutrition: Planning Health Promotion and Disease Prevention, nweze nnakwe
6. Statistical Aspects of Community Health and Nutrition (Woodhead Publishing India in Food Science and Nutrition): A. K. Nigam
7. Nutrition: Swaminathan
8. Nutritive Value of Indian Foods: Gopalan, Rama Sastri & Balasubramanium

(For 2 year M.Sc. Program in Food Processing and Nutrition Science)
1st Semester Lab I
Subject: Food Chemistry and Analysis (CT 5171)
Contact Period: 3P per week, Full Marks: 50, Pass Marks: 20 [Credit – 02]

Course Objectives:

- Introduce the basics of chemical composition of foods
- Introduce the analysis of food components using chemical analysis techniques as well as different analytical instruments

Expected Learning Outcomes for Course:

- Students will become familiar with the chemical composition of foods
- Students will become familiar with the analysis techniques as well as different analytical instruments required for chemical analysis of food products

Prerequisite: Chemistry

Sl. No.	Article	No. of Classes
1.	Proximate analysis of food	**08**
2.	Measurement of sugar concentration (TSS) in juices by refractometer	**01**
3.	Determination of True Density and Bulk Density of Food Products	**01**
4.	Determination of Specific Gravity of Food Products	**01**
5.	Color measurement by colorimeters	**03**
6.	Estimation of sugars in food Samples	**03**
7.	Measurement of water activity of food	**03**
8.	Measurement of Antioxidant activity of foods	**03**
9.	Estimation of vitamin A, ascorbic acid	**03**
10.	Estimation of fatty acid profile using gas liquid chromatography	**03**
11.	Thin Layer Chromatography	**03**
12.	Storage stability of edible oil	**03**
Total		**35**

(For 2 year M.Sc. Program in Food Processing and Nutrition Science)
1st Semester Lab II
Subject: Microbiology of Food (CT 5172)
Contact Period: 3P per week, Full Marks: 50, Pass Marks: 20 [Credit – 02]

Course Objectives:

- Introduce the application of microbial culture techniques in understanding their role in food processing and preservation.
- Introduce the knowledge of detecting microbes and the study of their growth kinetics and Thermal death point. Development of skills to cultivate pure culture (Pour plate and Streak plate method).
- Introduce the understanding of microbial aspect of food spoilage.
- Introduce basics of fermentation processes for food product development.

Expected Learning Outcomes for Course:

- Students will become familiar with aseptic culture techniques in detection and enumeration of microorganisms in food
- Students will become familiar with the methods for study of microbial growth, obtaining pure culture, Gram staining of microorganisms and biochemical estimation
- Students will become familiar with microbiology of water, milk and food products

Prerequisite: Food Microbiology

Sl. No.	Article	No. of Classes
1.	General procedure for aseptic work	**02**
2.	Study of microscope	**02**
3.	Preparation of media for microbes	**02**
4.	Detection of morphology of bacteria, yeasts and moulds	**02**
5.	Detection of micro-organisms	**03**
6.	Enumeration of micro-organisms in food sample	**04**
7.	Growth curve of bacteria	**04**
8.	Gram staining of bacteria	**04**
9.	Techniques of pure culture (pour plate and Streak plate method)	**02**
10.	Thermal death point and Methylene blue test for milk	**02**
11.	Bacteriological examination of water and milk	**02**
12.	Detection of coliform and *Salmonella* in food samples	**04**
13.	Determination of phenol co-efficient	**02**
Total		**35**

(For 2 year M.Sc. Program in Food Processing and Nutrition Science)
2nd semester Paper-VI (Core)
Subject: Food Processing Principles and Application (CT 5201)
Contact Period: 4L per week, Full Marks: 100, Pass Marks: 40 [Credit – 04]

Course objectives:

- Introduce understanding principles of food processing in the first part followed by processing of specific foods in the subsequent parts.
- Introduce understanding of principles involved in processing of milk and milk products.
- Introduce basics of Extrusion and extruded foods for preparation of hygienic, convenient and ready to eat (RTE) foods.

Expected Learning Outcomes for Course:

- Students will become familiar with fundamental food shorting and grading
- Students will become familiar with milling techniques and product development related to it
- Students will become familiar with the Pasteurization technologies and its advancement
- Students will be able to analyze the different technological challenges in food canning and its subsequent storage
- Students will become understand the extrusion cooking of foods and development of RTE food products

Prerequisite: Basic food microbiology, Basic integration, Food chemistry

Sl No.	Article	No. of Classes
1.	Basic preparation techniques fruit & vegetable products; Concept of aseptic processing, hygiene, plant sanitation, Material of construction for equipments and machineries; Plant layout concept; Inspection of raw materials; Sorting and grading; Handling and storage concept	**05**
2.	Processing of cereals and pulses: Milling of wheat – product and by-products; Flour improvers and bleaching; Rice milling system; Product and by-products of rice milling and their utilization; Parboiling of rice, RTE foods made from rice; Fermented food made from rice flour. Corn: Dry and wet milling of corn; uses of corn flour; Corn starch and its uses; Milling of Pulses	**05**
3.	Oilseeds: Mechanical and solvent oil extraction of oilseeds; Products and by-products from oil extraction plants, Margarine, mayonnaise	**05**
4.	Homogenization, pasteurization and sterilization of milk; Preparation methods for condensed, and evaporated milk; Milk products processing – cream, butter, cheese, ice-cream, fermented milk (curd, yoghurt)	**05**
5.	Processing of meat, fish and eggs, post mortem and antemortem inspection of meat, deboning, tenderization, ageing, pickling, curing and smoking of meat; Canning of meat; sausage, dehydrated meat; Meat analogues, smoking, freezing and dehydration of fishes; Fish sausage, minced fish; Surimi; Fish protein concentrate; Fish oil; Structure, composition, spoilage of egg; dehydrated egg powder	**05**
6.	Cold storage of fruits and vegetables; Canning of fruits and vegetables. Preparation of syrup, cordial and nectar, juice concentrate, fruit leather, jam, jellies, marmalades, pickle, chutney, puree, sauces, paste; Production of non-alcoholic and alcoholic beverages	**05**
7.	Tea, coffee and cocoa: Manufacturing processes for making green, oolong and black tea; CTC process; Coffee powder, Instant coffee; Cocoa powder; cocoa liquor; cocoa butter; Chocolates; Chemistry of spices; Spice powder and spice soluble; Oleoresins and essential oils	**05**
8.	Extrusion cooking of foods; Structured food/Designer food; Production of RTE snacks and cereals; Roasting, baking, frying techniques	**05**
Total		**40**

Books:

1. Food Processing Technology:Dsuza, New India Publishing Agency
2. Food Processing Technology Principles and Practice, 3rd edition, Fellows P J, New India Publishing Agency
3. Food Processing Technology: Principles and Practice: P. Fellows, CRC press
4. Fish Processing and Preservation:Biswas, K. P., Daya Publishing House
5. Food processing &Preservation: B. Sivasankar, Phi Learning
6. Food processing: Principles and Applications:S. Clark, S. Jung and B. Lamsal, Wiley Blackwell
7. Food processing: Principles and Applications:HosahalliRamaswamy and Michele Marcotte
8. Fruits and Vegetable Processing:Bhatti Suman, CBS

(For 2 year M.Sc. Program in Food Processing and Nutrition Science)

2nd semester Paper-VII (Core)
Subject: Food Preservation: Principles and Application (CT 5202)
Contact Period: 4L per week, Full Marks: 100, Pass Marks: 40 [Credit – 04]

Course objectives:

- Introduce basic understanding of underlying principles of food preservation followed by different techniques applied for extension of shelf-life of raw, minimally processed and processed foods.
- Introduce basic understanding of underlying principles of non-thermal processing methods applicable to food preservation.
- Introduce basic understanding of principles of Food Packaging.

Expected Learning Outcomes for Course:

- Students will become familiar with basics of food preservation
- Students will become familiar with dehydration and other chemical and physical methods
- Students will become familiar with the use radiation in food preservation
- Students will become familiar with non thermal preservation techniques which are applied to thermo-labile food items
- Students will understand the basics of food packaging

Prerequisite: Basic food microbiology, Basic integration, Food Chemistry

Sl No.	Article	No. of Classes
1.	Principle and methods of fruits & vegetable preservation, Composition and related quality factors for processing; Basic theory and practices for preservation of fruits & vegetables by addition of heat, removal of heat, removal of moisture, addition of food additives, fermentationand irradiation	**05**
2.	Preservation by addition of heat- Canning and retorting of foods –Constructional features of sanitary cans and retortable pouches, Steps in canning and designs of retorts, Spoilage of canned foods, HTST and UHT processes for liquid foods and aseptic packaging	**06**
3.	Preservation by removal of water- water activity and its effect on keeping quality of foods, sorption isotherms and models for sorption isotherms, Moderation of water activity by dehydration of foods and addition of solutes (intermediate moisture foods). Concentration of liquid food by evaporation, Freeze concentration and freeze drying of food	**06**
4.	Preservation by irradiation – Irradiation mechanism and survival curve of microorganism post irradiation, Sources of radiations, units and doses, Safe limits at regulatory issues	**06**
5.	Preservation by addition of chemicals and chemical modifications: Curing, pickling, smoking, chemical preservatives, fermentation, various food additives used in food as emulsifier, stabilizers, thickeners, coloring agents, flavoring agents, sequestering agent, etc.	**06**
6.	Non thermal processing techniques consisting of high pressure processing, pulsed electric field processing, pulse light treatment, ozone treatment, cold plasma treatment and minimal processing; Oscillating magnetic fields, Photodynamic effects, Ultrasound applications in food preservation	**06**
7.	Basics of food packaging, packaging materials, machinery and equipments used in food packaging, Controlled atmosphere storage and modified atmosphere packaging of foods, Active and intelligent packaging	**05**
Total		**40**

Books:

1. Food Preservation Techniques A volume in WoodheadPublishing Series in Food Science, Technology and Nutrition, Edited:P. Zeuthen and L. Bøgh-Sørensen, Science Direct
2. Food Processing and Preservation:B. Sivasankar
3. The Technology of Food Preservation:N.W.Desrosier&J.N.Desrosier, CBS

(For 2 year M.Sc. Program in Food Processing and Nutrition Science)
2nd Semester Paper-VIII (Core)
Subject: Nutrition and Human Development (CT 5203)
Contact Period: 4L per week, Full Marks: 100, Pass Marks: 40 [Credit – 04]

Course Objectives:

- Introduce the fundamental aspects of malnutrition and different nutritional related diseases
- Introduce the occurrence of different metabolic disorders related to human nutrition
- Introduce the different aspects of microbial infection and food borne diseases
- Introduce the importance and production of nutritionally enriched crops

Expected Learning Outcomes for Course:

- Students will become familiar with the importance of malnutrition and diseases resulted from malnutrition
- Students will become familiar with food related microbial infections and food borne diseases
- Students will become familiar with different metabolic disorders
- Students will become familiar with nutritional enhancement of different crops

Prerequisite: Vitamins and minerals in nutrition, Food related microbial infections

Sl. No.	Article	No. of Classes
1.	Protein and Energy Malnutrition; Nutritional aspects of Obesity, Psychiatric eating disorders, Cardiovascular disease, Kidney Disease, Diabetes, Gastrointestinal Disorder; Food Intolerance	**08**
2.	Nutritional requirement of Micro-nutrient deficiencies; Antioxidants – classification and mechanism	**08**
3.	Food related infections such as salmonellosis, shigellosis, clostridium gastroenteritis, bacillus gastroenteritis, vibrio infection, beta hemolytic, streptococcal infection, poliomyelitis, hepatitis, amaebiosis, trichinosis, tapeworm infection, botulism, staphylococcal gastroenteritis, *E coli* poisoning, mycotoxicosis and biological and chemical poisoning	**08**
4.	Metabolic disorder and different genes involved; Protein deficiency disorder, Control of these maladies for national health development and national economics	**08**
5.	Nutritional enhancement for food including golden rice, protein rich potato and folate rich food crops	**08**
Total		**40**

Books:

1. Food Science 5th edition: N.N. Potter and J.H. Hotchkiss, CBS
2. Nutrition Science: B. Srilakshmi, New Age International (P) Ltd.
3. Human Nutrition and Dietetics (Harcourt Medical): J. S. Garrow, Churchill Livingstone
4. Park's Textbook of Preventive and Social Medicine: K. Park
5. Human Nutrition and Dietetics: Passmore & Eastwood, Churchill Livingstone
6. Principles and Techniques of Biochemistry and Molecular Biology: Keith Wilson, John Walker
7. Nutritional Biochemistry: T. Brody, Academic press
8. Biochemistry and Physiology of Nutrition (vol I & II): G. H. Bourne and G. W. Kidder, Academic press
9. Clinical Nutrition: B. Sardesai, CRC press
10. Advancing Dietatics & Clinical Nutrition: A. Payne & H. Barker, Elsevier
11. Clinical Nutrition: M. Elia, Olle Ljungqvist, R. J. Stratton & S. A. Lanham-new, Wiley-Blackwell
12. Nutrition & Dietetics: S. A. Joshi, Tata Mcgraw Hill

(For 2 year M.Sc. Program in Food Processing and Nutrition Science)
2nd semester Paper-IX (DE)
Subject: Microbial Enzyme Technology (CT 5221)
Contact Period: 3L per week, Full Marks: 100, Pass Marks: 40 [Credit – 03]

Course objectives:

- Introduce basic understanding of underlying principles enzymatic modifications of foods.
- Introduce basic understanding of different facets of enzymes, like basic functions, structure, reactions involving enzymes, industrial production, isolation and purifications.
- Introduce basic understanding of underlying principles behind production of enzymes using different microorganisms, and production of other secondary products using of these enzymes are included in this subject for advance learning.

Expected Learning Outcomes for Course:

- Students will become Kinetics of enzyme and chemical catalysts
- Students will become familiar recent advances on application of enzyme in different industries
- Students will understand the putative methods of enzyme extraction and challenges associated with it
- Students will understand the operational aspects of immobilized enzymes based reactions
- Students will understand the application of enzymes in biotransformation of chemical which are of pharmacological importance

Prerequisite: Basic food microbiology, Basic integration, Food Chemistry

Sl No.	Article	No. of Classes
1.	Enzymes – importance, structure, functions, nomenclature, specificity, coenzyme and prosthetic groups, mechanism of action. Kinetics of enzymatic reactions, activation of enzymes, regularity enzymes, iso-enzymes, enzymes involved in digestion and metabolism	**06**
2.	Industrial importance of microbial enzymes; Target group of microorganism for production of enzymes; Concept of exo-enzymes and endo-enzymes; Dynamics of microbial growth and different growth models for microbial processes; Dynamics of continuous culture	**06**
3.	Isolation and purification of microbial enzymes; Kinetics of enzymatic reaction; Modulation and regulation of enzymatic reactions; Inhibition kinetics of enzymatic reactions (substrate, competitive, non-competitive and un-competitive inhibitions)	**06**
4.	Immobilization of enzymes and biochemical reactors; Immobilization techniques; Effects of immobilization and kinetics of enzymes in industrial uses; Microbial enzyme reactors and their types and applications	**06**
5.	Commercial importance of microbial enzymes for their uses in food and nutraceutical products; Important groups of microorganisms for production of enzymes; Production systems for some common enzymes using microorganisms, like amylases, proteases, lipases, etc.	**06**
6.	Production of vitamins and sugars, antibiotics by enzymatic technology; Microbial transformation of lipids and steroids	**05**
Total		**35**

Books:

1. Handbook of Algae:Sharma, Sanjay, New India Publishing Agency
2. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry:Trevor Palmer
3. Microbial Enzymes and Biotechnology:W.M. Foga-Rty , C.T. Kelly
4. Microbial Enzyme Technology in Food Applications, Food Biology series
5. Enzyme Nutrition: The Food Enzyme Concept
6. Biotechnology of Microbial Enzymes: Production, Biocatalysis and Industrial applications: C. Brahmachari, A. L. Demain& J. L. Adrio, Academic press, 2017

(For 2 year M.Sc. Program in Food Processing and Nutrition Science)
2nd Semester Paper-IX (DE)
Subject: Food Toxicology (CT 5222)
Contact Period: 3L per week, Full Marks: 100, Pass Marks: 40 [Credit – 03]

Course Objectives:

- Introduce the fundamental aspects of naturally occurring toxicants
- Introduce the occurrence of environmental contaminants and heavy metals responsible for food toxicity
- Introduce the toxicological aspects of food additives and toxicants generated during food processing

Expected Learning Outcomes for Course:

- Students will become familiar with several naturally occurring toxicants and antinutritional factors present in food
- Students will become familiar with derived food toxicants generated during food processing and packaging
- Students will become familiar with toxicological aspects of food additives, genetically modified food and heavy metals

Prerequisite: Food toxicology

Sl. No.	Article	No. of Classes
1.	Definition, scope and general principles of food toxicology; Manifestation of toxic effects; Classification of food toxicants; Factors affecting toxicity of compounds; Methods used in safety evaluation-risk assessment.	**05**
2.	Toxicants and allergens in foods derived from plant, animals, marine, algae and mushroom; Natural sources of toxicants in foods (Alkoloids, cyanogens, goitrogens, lectins, lathyrogens, oxalates, saphonins, etc); Toxicity of foods contaminated with bacteria and fungi; Food poisoning; Food borne infections and disease; Pesticide residues in raw foods; Anti-nutrient compounds in foods; Toxicology of antioxidants in foods.	**07**
3.	Derived food toxicants – Processing and packaging; Toxicants generated during thermal processing (nitrosamines, acrylamide, benzene, dioxans and furans, carcinogenic compounds); Heavy metal contamination during processing (from metal utensils) and leaching from packaging systems; Persistent organic pollutants; Toxicity of irradiated foods.	**08**
4.	Toxicology & food additives – Toxicological aspects of nutrients, supplements, colorants, artificial sweeteners, anti-oxidants, glutamates, other functional improvers; Chemicals used in extension of shelf-life of foods, such as antibiotics, fumigants, chlorinated solvents, pesticides, fungicides and insecticides.	**06**
5.	Hyper-vitaminosis, Toxicity from food adulterants; Toxicity of genetically modified foods	**04**
6.	Heavy metal toxicity in food and aquatic foods, Food and endocrine toxicology, toxicity of heated fats and natural oils	**05**
Total		**35**

Books:

1. Introductory Food Toxicology: Lokesh Kumar Mishra
2. Principles of Food Toxicology, 2nd edition CRC Press, Taylor & Francis group: Tõnu Püssa
3. Food and Nutritional Toxicology: Stanley T. Omaye
4. Food safety and toxicity: John de Vries, CRC press
5. Introduction to Food Toxicology: Takayuki Shibamoto, Leonard Bjeldanes, Academic press
6. Food Toxicology: edited by Debasis Bagchi, Anandswaroop, CRC press
7. Food Toxicology- edited by William Helferich, Carl K. Winter, CRC press
8. Food Toxicology: Current Advances and Future Challenges, edited by Ashish Sachan, Suzanne Hendrich, CRC press
9. Food Allergy: Adverse Reaction to Foods and Food Additives, edited by Dean D. Metcalfe, Hugh A. Sampson, Ronald A. Simon M.D., Gideon Lack, Wiley
10. Food additives: Toxicology, Regulation, and Properties, by Fergus M. Clydesdale, CRC press

(For 2 year M.Sc. Program in Food Processing and Nutrition Science)
2nd semester Paper-X (OE)
Subject: Entrepreneurship and Human Resource Management (CT 5261)
Contact Period: 3L per week, Full Marks: 100, Pass Marks: 40 [Credit – 03]

Course objectives:

- Introduce basic understanding of underlying food laws and regulations affecting food at different stages of processing.
- Introduce basic understanding of entrepreneurial competencies along with marketing strategies are covered.
- Introduce basic understanding of managing Institutional food service and human resource planning.

Expected Learning Outcomes for Course:

- Students will understand the basics required for beginning an enterprise.
- Students will become familiar with marketing strategy and consumer behaviour.
- Students will become familiar with human recourse planning.
- Students will become familiar with nutritional epidemiology and its management

Prerequisite: Basic food microbiology, Basic integration, Food Chemistry

Sl No.	Article	No. of Classes
1.	Food laws and regulations that provide federal/state laws and regulations affecting food productions, processing, packaging, marketing and distribution of food products. CODEX Alimentarius Commission: History, Members, Standard setting and Advisory mechanisms: JECFA, JEMRA, JMPR WTO agreements: SPS/TBT; Role of OIE, IPPC; Good Manufacturing Practices (GMP);; Advanced institutional food service management includes principles of management applied to institutional food services and advanced certification curriculum	**12**
2.	Marketing strategy that comprises advanced case approach to current marketing management problems including research, techniques and decision making. Instruction technology in adult education for application of theory, principles and practice in providing instructions to adult learners	**08**
3.	New venture creation for entrepreneurial competencies, developing venture teams, recognizing business opportunities, gathering resources, licensing, regulating requirements, patents, copyrights and product liability. Human resource planning and staffing that will focus on creation of competitive advantage including job analysis, preparing candidate specification, recruitment, assessment and placement	**08**
4.	Principles of management in dietetics and current practice issues, Nutritional epidemiology including epidemiologic methods and their application to the study of nutrition, human health and diseases	**08**
Total		**36**

Books:

1. Entrepreneurial Development:Khanka S.S.
2. Strategic Management and Entrepreneurship:Amitabh Nanda, DebiduttaAcharya

(For 2 year M.Sc. Program in Food Processing and Nutrition Science)

2nd Semester Lab III
Subject: Food Processing and Preservation (CT 5271)
Contact Period: 3P per week, Full Marks: 50, Pass Marks: 20 [Credit – 02]

Course objectives:

- Introduce the basic underlying principles of food processing and food preservation along with different techniques applied for extension of shelf-life of raw, minimally processed and processed foods.

Expected Learning Outcomes for Course:

- Students will become familiar with basics of food processing and food preservation concepts.
- Students will become familiar with several chemical and physical methods in food processing and preservation methods.

Prerequisite: Food and Nutrition

Sl. No.	Article	No. of Classes
1.	Preparation of Bakery & Confectionary Food Products	**06**
2.	Preparation of Fermented Food Products	**06**
3.	Preparation of Cereal & Pulse based Food Products	**03**
4.	Preparation of Dairy and Non-dairy Food Products	**03**
5.	Preparation of Extruded Food Products	**03**
6.	Preparation of Dehydrated Food Products	**03**
7.	Preparation of Fish based Food Products	**03**
8.	Preparation of Meat based Food Products	**03**
9.	Preservation of Foods by using several preservatives	**03**
10.	Quality Assessment of several food products	**02**
Total		**35**

(For 2 year M.Sc. Program in Food Processing and Nutrition Science)

3rd Semester Paper-XIII (Core)
Subject: Food Safety and Quality Assessment (CT6101)
Contact Period: 3L per week, Full Marks: 100, Pass Marks: 40 [Credit – 03]

Course Objectives:

- Introduce the Safety and quality, the basic parameters for considering any food fit for human consumption.
- Introduce the Safety of raw and processed foods
- Introduce the importance of safety of food additives and food packaging
- Introduce the significance of Food laws and standards.

Expected Learning Outcomes for Course:

- Students will become familiar with the fundamental properties required for considering the safe food
- Students will become familiar with Several quality attributes and their assessments
- Students will become familiar with safety of essential nutrients and non -nutrients
- Student will become familiar with proper assessment and suitable management concerning food safety

Prerequisite: Food and Nutrition

Sl. No.	Article	No. of Classes
1.	Quality of raw materials: Physical, chemical and microbial quality. Quality of products during processing and after processing: Color, taste, texture, flavor, appearance. Factors influencing the food qualities: Soil, field practices, harvesting practices, packaging, transportation, processing conditions, packaging and storage conditions of the finished products. Recording and reporting of quality. Quality inspection, quality control. Quality management and quality assurance: Total quality management, good manufacturing practices, good agricultural practices, good laboratory practices	**09**
2.	Measurement details for different quality parameters using objective methodology (instruments) and subjective methodology (sensory evaluation); Factors influencing sensory measurements: Attitudinal factors, motivation psychological errors in judgment, relation between stimulus and perception adaptation; Correlation of sensory and instrumental analysis	**09**
3.	Definition of safe food; Safety of raw foods; Pesticide residue; Safety of processed foods; Safety of food additives; Safety of packaging materials used in foods; Food Adulteration and its detection	**09**
4.	Risk assessment and management during food preparation: HACCP concept, limitations of HACCP. Food safety objective (FSO), International standards: FAO, Codex Alimentarius, ISO, Indian food laws and standards (FSSAI); Certification, certification procedures, certifying bodies, accrediting bodies, international bodies. Good Hygienic Practices (GHP); Food Safety Plan; Food Safety Management Risk Analysis	**08**
Total		**35**

Books:

1. Introduction of Chemical Analysis and Food: S.S. Nielson, CBS
2. Prescott, Herley, Klein (2nd ed.): Microbiology
3. Stainier: General Microbiology
4. Bacteriology: Salley
5. Industrial Microbiology: Prescott & Dunn
6. Microbial Food Safety and Preservation Techniques: V Ravishankar Rai & Jamuna A. Bai
7. Biosensors in Food Processing, Safety, and Quality Control (Contemporary Food engineering): Mehmet Mutlu.
8. Ilbco's Food Safety and standards Act, International Lae Book Co.
9. Food Quality and Standards (vol I & II): R. Lasztity, Eolss pub
10. Processing Effects on Safety and Quality of Foods- E. Ortega-Rivas, CRC press
11. Food Quality Assurance: Principles & Practice: I. Alli, CRC press
12. Fssai (http://www.fssai.gov.in/home)
13. Codex Alimentarius: International Food Standards (http://www.fao.org/fao-who-codexalimentarius/en)

(For 2 year M.Sc. Program in Food Processing and Nutrition Science)

3rd semester Paper-XIV (Core)

Subject: Unit Operation in Food Processing (CT 6102)

Contact Period: 4L per week, Full Marks: 100, Pass Marks: 40 [Credit – 04]

Course objectives:

- Introduce basic understanding of underlying principles of Unit operations based on some engineering principles.
- Introduce basic understanding of underlying principles of transport phenomena and specific operations (mechanical, thermal and mass transfer) related to aspects of food processing viz., handling, sterilization, drying, packaging and storage of foods.

Expected Learning Outcomes for Course:

- Students will become familiar with fundamental heat and mass transfer
- Students will become familiar with screening separation and homogenization techniques
- Students will become familiar with the Pasteurization technologies and its advancement
- Students will be able to analyze the fundamentals of Newton law of cooling and its application in food processing
- Students will understand the application of conventional and non-conventional drying methods

Prerequisite: Basic food microbiology, Basic mathematics, Food chemistry

Sl No.	Article	No. of Classes
1.	Basic concept of fluid flow, viscosity of liquid, Pumps and blowers, Mechanisms for heat transfer and theory of heat transfer, Heat exchangers, mass transfer and molecular diffusion in solid foods, packaging systems, biological solutions and gel	**08**
2.	Classification of separation processes for solid and liquid foods, separation by settling under gravity, centrifugal field, hindered settling, size separation used for grains (screening), fruits and vegetables (grading and sorting devices); Filtration systems for separation of suspended solids and membrane separation techniques (Reverse osmosis, ultrafiltration and dialysis); Theory of size reduction, size reduction of solids (grinding) and liquid (homogenization); Mixing and agitation of foods	**08**
3.	Extraction, Drying and Crystallization: Liquid-liquid equilibrium, liquid extraction, stage-wise contact, liquid-solid equilibria, leaching, batch drying and mechanism of batch drying, principle and operation of a spray drier, preliminary idea of crystallization	**08**
4.	Cooling and freezing foods, Refrigeration and cold storage, Refrigerated transport systems	**08**
5.	Vapour-Liquid equilibrium, Rayleigh's equation, flash and differential distillation, continuous rectification, McCabe-Thiele method, bubble cap and sieve distillation column	**08**
Total		**40**

Books:

1. Introduction to Food Engineering: R. P. Singh & D. R. Heldman, Academic Press
2. Food Process Engineering & Technology: Z. Berk, Academic Press
3. Fundamentals of Food Process Engineering: R. T. Toledo, Springer
4. Food Process Engineering Operations: G. D. Saravacos& Z. B. Maroulis, CRC Press
5. Transport Processes & Separation Process Principles – C. J. Geankoplis, Phi
6. Introduction to Food Process Engineering: A. Ibraz& G. V. Barbosa-Canovas – CRC Press
7. Introduction to Food Process Engineering: P. G. Smith, Springer
8. Postharvest Technology and Food Process Engineering:AmalenduChakraverty& R. Paul Singh, CRC Press
9. Unit Operations of Chemical Engineering: W.L. Mccabe, J. C. Smith & P. Harriott, Mcgraw Hill International

(For 2 year M.Sc. Program in Food Processing and Nutrition Science)

3rd semester Paper-XV (Core)
Subject: Food Biotechnology (CT 6103)
Contact Period: 3L per week, Full Marks: 100, Pass Marks: 40 [Credit – 03]

Course objectives:

- Introduce basic concept of genetic engineering and altering the characteristics of commercially important crops to improve their quality.
- Introduce basic understanding of Nucleic acid approaches for the rapid and dependable detection and characterization of food microorganisms are also covered.
- Introduce basic understanding of Nutrigenomics.

Expected Learning Outcomes for Course:

- Students will understand the basics of genetic engineering and its application in Food Technology
- Students will become familiar with downstream processing and challenges associated with it
- Students will understand fermentation techniques and its application in food preservation
- Students will be able to analyze thechallenges in development of GMO and their application in Food industries
- Students will understand the technologies used to study food spoilage or adulteration through genetic methods
- Students will understand the Nutrigenomics techniques for managing mammalian diseases

Prerequisite: Basic food microbiology, Food chemistry, Molecular biology

Sl No.	Article	No. of Classes
1.	History and development of biotechnology; Techniques of genetic engineering (restriction enzymes, vectors, gene transfer, Ti plasmid, genetic markers, replica plating, method of molecular cloning, PCR, DNA probes, antisense genes); Application of genetics to food production	**07**
2.	Principles of downstream processing; Small, medium and large scale processing; Immobilization of microbial and cultured plant cells	**07**
3.	Biotechnological processes for manufacturing foodstuffs and improvement of processed foods by various biotechnological processes; Fermented based food products from cereals, legumes, fruits, vegetables, milk, fish & meat; Microbial production of cheese; Microbial production of flavours and colors and polysaccharides	**08**
4.	Genetically modified foods for nutritional enhancement – principles, techniques, problems, prospects and ethics; Challenges in safety assessment of GM foods in relation to human health; Development of Beta-carotene enhanced food crops, long life tomatoes, insect-resistant crops, virus- resistant crops, herbicide-resistant crops, crop improvement	**08**
5.	Nutrigenomics and nutrigenetics; Application of nutrigenomics in the management of mammalian diseases	**05**
Total		**35**

Books:

1. Food Biotechnology: Principles and Practices Paperback: Vinod K. Joshi (Editor), R. S. Singh
2. Fundamentals of Food Biotechnology, 2nd Edition: Byong H.
3. Practical Methods in Molecular Biology: Robert F. Schleif, Pieter C. Wensink
4. Fundamentals of Food Biotechnology: Byong H. Lee, Wiley Blackwell
5. Food Biotechnology Edited by S. Bielecki, J. Polak, J. Tramper, Elsevier
6. Food Biotechnology: S.C. Bhatia, Woodhead
7. Food Biotechnology: Advin BiochemEngg/Biotechnology, Edited by Ulf Stahl, Ute E.B. Donalies, ElkeNevoigt, David B. Archer, Springer-Verlag
8. Food Biotechnology, Second Edition Edited by Anthony Pometto, Kalidas Shetty, GopinadhanPaliyath, Robert E. Levin, Taylor & Francis
9. Food Science and Food Biotechnology by Gustavo F. Gutierrez-Lopez, CRC Press
10. Food Biotechnology Edited by R. D. King, Elsevier Appl. Sci.

(For 2 year M.Sc. Program in Food Processing and Nutrition Science)

3rd Semester Lab IV
Subject: Unit Operation in Food Processing (CT 6171)
Contact Period: 3P per week, Full Marks: 50, Pass Marks: 20 [Credit – 02]

Course Objectives:

- Introduce the application of physical techniques for the estimation of screening (separation) efficiency of a screen/separator.
- Introduce the techniques involved in the homogenization of milk and measurement of the size of fat globules.
- Introduce the basic understanding of dead-end filtration and cross-flow filtration techniques.
- Introduce the basic understanding of the heat and mass transfer changes in a laboratory evaporator using a drying curve.
- Introduce the basics of working of plate freezer.
- Introduce the mechanism behind transport of proteins and gases through synthetic membranes.

Expected Learning Outcomes for Course:

- Students will become familiar with the working of principle of sieve shaker and estimation of particle size
- Students will understand the techniques of milk processing and its challenges
- Students will become familiar different types of filtration regime
- Students will understand the effect of heat loss in food packaging
- Students will understand the kinetics of drying and its effect on food

Prerequisite: Basic food microbiology, Basic mathematics, Food chemistry

Sl. No.	Article	No. of Classes
1.	Size reduction; Estimation of screening (separation) efficiency of a screen/separator; Determination of mixing	**03**
2.	Homogenization of milk and measurement of size of fat globules before and after homogenization; Estimation of cut off size of milk fat globule in homogenization and centrifugal separation	**07**
3.	Estimation of filter medium and cake resistance of a pressure filtration system; Determination of terminal velocity of food particles (Stokes law) in static fluid; Determination of hindered settling velocity	**04**
4.	Study of working principle and constructional details of steam jacketed kettle (SJK), Mass and energy balance in an laboratory evaporator	**03**
5.	Determination of slowest heating point in a can; Estimation of thermal processing time of food by graphical method	**03**
6.	Estimation of water activity of a foods and construction of MSI; Estimation of constants of BET and GAB models using water activity data of a specific foods	**03**
7.	Construction of drying curve of a food and evaluation of constant and falling rate periods using tray dryer, fluidized bed dryer	**03**
8.	Construction of an equilibrium curve for a leaching (oil from oil-bearing material) system	**03**
9.	Drying characteristics of foods in freeze drying system; Determination of freezing time of a food using a plate freezer	**03**
10.	Determination of water vapour permeability and gas permeability of a packaging film; Experiment with dialysis of protein	**03**
Total		**35**

(For 2 year M.Sc. Program in Food Processing and Nutrition Science)

4th semester Paper- XVIII (Core)
Subject: Food Industry Effluents and Waste Treatments (CT 6201)
Contact Period: 4L per week, Full Marks: 100, Pass Marks: 40 [Credit – 04]

Course objectives:

- Introduce basic understanding of effluent treatment before disposal and reuse.
- Introduce basic understanding of physical, chemical and biological treatments involved in several upstream and downstream unit operations
- Introduce basic understanding of concept of bioreactors and valuable by-products recovery

Expected Learning Outcomes for Course:

- Students will understand the methods used for characterization of wastewater
- Students will understand the different methods of wastewater treatment
- Students will understand the methods used for characterization of solid waste and its management

Prerequisite: Microbiology, Food Chemistry, Biochemical engineering

Sl No.	Article	No. of Classes
1.	Characteristics of wastewater from food industries – Physical, chemical and biological characteristics; Physical (Screening, mixing, flocculation, flotation, filtration methods), Chemical (coagulation, chelating and precipitation, adsorption, disinfection methods) and Biological unit processes (growth kinetics aerobic and anaerobic microorganisms in wastewater) for wastewater treatments	**15**
2.	Methods of wastewater treatments: Primary, secondary, tertiary and quaternary treatments; Biological methods of domestic and food industrial waste water treatment methods; Artificial methods of waste water treatment; - Aerated lagoon, trickling filter and activated sludge process; Anaerobic biological treatment, contact digesters, packed column reactors, waste management (waste storage and composting)	**14**
3.	Classification of solid and liquid wastes from different food industries; Solid waste management; By-products and waste generated in different cereal, milk, fruits, vegetable, oilseed, fish, meat, egg processing industries; Recovery processes of the by-products with case studies	**11**
Total		**40**

Books:

1. Waste Treatment in The Food Processing Industry:Nce K. Wang, Yung-Tse Hung, Howard H. Lo, Constantine Yapijakis, CRC Press
2. Waste Management for the Food Industries:Ioannis S. Arvanitoyannis, Dr, Ph.D, Science Direct
3. Waste Water Engg, Metcalf and Eddy Inc., Tata Mc Graw Hill Book Company Ltd.
4. Waste Treatments in The Food Processing Industries: L. K. Wang, Y. T. Hung, H. H. Lo and C. Yapijackis, Crc Press
5. Utilization of By-Products and Treatment of Waste in The Food Industry: V. Oreopoulou and W. Russ, Springer
6. Food and Agricultural Wastewater Utilization and Treatment: S. X. Liu, Wiley-Blackwell (2nd Ed)
7. Wastewater Treatment and Reuse in The Food Industry: M. Barberaand G. Gurnari, Springer 2018
8. Valorisation of Food Processing By-Products: M.Chandrasekharan, CRC Press
9. Wastewater Engineering: Treatment, Disposal Reuse:Metcafe& Eddy Inc – G. Tchobanoglous, Tata Mcgraw Hill Company

(For 2 year M.Sc. Program in Food Processing and Nutrition Science)

4th Semester Paper-XIX (DE)
Subject: Food Product Design and Development (CT 6221)
Contact Period: 3L per week, Full Marks: 100, Pass Marks: 40 [Credit – 03]

Course Objectives:

- Introduce the basics regarding the practical and needed interface between industry and the consumers
- Introduce the concept of product life cycle, repositioning and reformulation of existing products
- Introduce the importance factors affecting product development, cost analysis, sustainability, optimization and simulation

Expected Learning Outcomes for Course:

- Students will become familiar with thefundamentalpropertiesregarding the interrelation between several industries and probable consumer.
- Students will become familiar with need for new product development.
- Students will become familiar with optimization of design and development to make product better.
- Student will become familiar with Statistical design, Future trends and directions.

Prerequisite: Marketing, Management, Food and Nutrition

Sl. No.	Article	No. of Classes
1.	Introduction to product development and formulation. Need for product development. New food product: Definition, general characteristics of new food product, classes of new food products. Line extensions - Repositioning of existing products - New form of existing product - Reformulation - New packaging - Innovative products, creative products and value added products. Production of low calorie foods and low fat foods	**09**
2.	Difference between Market and Market places; Customers and Consumers; Marketing Characteristics of the product, Product life cycle - profit picture. Factors affecting food product development. Stages/Phases of new product development. Generation of Food product Ideas	**09**
3.	Organizing for new product development, Concepts of research and development. Development of strategy from marketing perspective. Market testing - methods of testing – Evaluation, Quality assessment of new developed products. Costing/pricing and economic evaluation of the product; Product launch and commercialization of the product	**09**
4.	Optimization of design and development to make product better, cheaper and faster. Simulations of operations for better designed products and faster and complete processes. Statistical design, Future trends and directions	**08**
Total		**35**

Books:

1. Spice Science and Technology: Hirasa, Kenji & M. Takemasa, New India Publishing Agency.
2. Flavour Chemistry and Technology: Heath H., Reineccius, Gary CBS
3. Chemistry and Technology of Cerelas as Food and Feed: S.A. Matz, CBS
4. Bakery Technology and Engineering: S.A. Matz, CBS
5. Food Product Development: From Concept to Marketplace: Saguy and Graf CBS
6. Accelerating New Food Product Design and Development *editors* Jacqueline H. Beckley, M. Michele Foley
7. Concept Research in Food Product Design and Development: Howard R. Moskowitz, Sebastiano Porretta, Matthias Silcher
8. Functional Food Product Development: edited by Jim Smith and Edward Charter, Blackwell
9. New Food Product Development from Concept to Marketplace: by Gordon W. Fuller, CRC press
10. Packaging Research in Food Production Design and Development: Howard R. Moskowitz, Michele Reisner, John Ben Lawlor, Rosires Deliza, Wiley-Blackwell
11. Guidelines for Sensory Analysis in Food Product Development and Quality Control: edited by David H. Lyon, Marik O A. Francomb E, Terry A. Hasdel Land Ken Lawso N, Chapman & Hall
12. Sensory and Consumer Research in Food Product Design and Development by howard R. Moskowitz, Jacqueline H. Beckley, and Anna V. A. Resurreccion., Blackwell

(For 2 year M.Sc. Program in Food Processing and Nutrition Science)

4th Semester Paper-XIX (DE)
Subject: Food Packaging (CT 6222)
Contact Period: 3L per week, Full Marks: 100, Pass Marks: 40 [Credit – 03]

Course Objectives:

- Introduce the fundamental aspects of food packaging
- Introduce the properties of packaging materials and food packaging machineries
- Introduce the environmental interactions and new developments in food packaging

Expected Learning Outcomes for Course:

- Students will become familiar with several types of packaging materials and different processes of food packaging
- Students will become familiar with food package interactions and evaluation of package performance
- Students will become familiar with different equipments and machineries for food packaging

Prerequisite: Food packaging

Sl. No.	Article	No. of Classes
1.	Introduction to packaging, Packaging operation, Package-functions and design, Principle in the development of protective packaging, types of packaging materials	**05**
2.	Manufacturing process and properties (mechanical, optical and barrier properties like, WVTR, GTR), test procedures for packaging materials, packaging requirements vis-à-vis food types, primary packaging materials (paper, paper-based plastic, aluminium foil, tin and TFS, glass) Secondary packaging materials (folding carton, Corrugated fibre board boxes, Ancillary packaging materials)	**07**
3.	Process of packaging (bottling, canning, capping and cartooning machineries), Vacuum and gas packaging, retort packaging, CAP, MAP, active packaging, Shrink packaging, PET, perform, tetra pack, Flash process, Bio-composite and alternative packaging, TTI, active and intelligent packaging, Flexible packaging materials and their properties. Food packages-bags, pouches, wrappers, carton and other traditional packages, Aseptic and retortable pouches, Flexible and laminated pouches, Biodegradable packaging, Packaging standards and regulations	**08**
4.	Food- package interactions, Deteriorative changes in food stuff and packaging methods for its prevention, shelf life of packaged foodstuff, methods to extend shelf life. Physical and mechanical failures of food containers (rigid containers), Corrosion of containers (Tin plate), Leaching of undesirable components from packages to foods	**06**
5.	Special problems in packaging of perishables and processed foods. Evaluation of packaging material and package performance	**04**
6.	Different equipments and machineries used for packaging of foods, and their operations; Edible films and edible packaging	**05**
Total		**35**

Books:

1. Fundamentals of Food Process Engineering: R. T. Toledo, CBS
2. Food Packaging Science and Technology: Lee, Dong Sun; K L Yam et.al, new India Publishing Agency

(For 2 year M.Sc. Program in Food Processing and Nutrition Science)

4th semester Paper-XIX (DE)
Subject: Nano Technology in Food (CT 6223)
Contact Period: 3L per week, Full Marks: 100, Pass Marks: 40 [Credit – 03]

Course objectives:

- Introduce basic understanding of general development of nano science and nano technology and its relation with food industry.
- Introduce basic understanding of Nano science based food processing and applications along with application of nano-bio-technology in food.

Expected Learning Outcomes for Course:

- Students will understand the importance and scope of nanotechnology in food processing
- Students will understand the different synthesis techniques for nano particles
- Students will understand the application of nano particles in food preservation, processing and product development
- Students will understand the application of nano-emulsion, gel, foam, and liposome in food processing

Prerequisite: Microbiology, Chemistry, Material Sciences

Sl No.	**Article**	**No. of Classes**
1.	General development of nano science and nano technology in food and food processing process. Overview of nano- food industry and marketing	**10**
2.	Nano structure and food industry. Nano biotechnology and food industry: basics of nanobiotechnology. Nano science based food processing and applications; process technology, packaging technology, automation and quality management, technological process materials and ingredients, nano- bio- engineering and nano –designing	**10**
3.	Synergic development of food. Application of nano-bio-technology in food industry; food production, food processing, food preservation, food colour and flavour improvement, food safety, Matrix design and synthesizing	**10**
4.	Processing technology: for emulsion, gel, foam, and liposome. Nano-hygienic aspect	**05**
Total		**35**

Books:

1. Nanotechnology and Functional Foods; John Wiley & Sons Inc.
2. Textbook on Fundamentals and Applications of Nanotech-Nology; 2018; K S, K Raja and M Kannan Subramanian.
3. Basic Applications of Nanotechnology on Food Production; 2013; Shiva Hullavarad, Dr Mark Branchk

4th semester Paper-XIX (DE)
Subject: Process Modelling and Simulation (CT 6224)
Contact Period: 3L per week, Full Marks: 100, Pass Marks: 40 [Credit – 03]

Course Objectives:

- Introduce basic understanding of process modelling, different computational techniques for simulation. Modelling of biochemical engineering processes, parameter estimations and application of numerical methods for solution of models.
- Introduce basic understanding of tools involved in simulation, development of models, classification of models, unit models of unit process, models of heat transfer equipment, separation processes and reactors, and application of numerical methods for solutions of models.

Expected Learning Outcomes for Course:

- Students will understand process simulation, tools of simulation, parameter estimation and models.
- Students will understand the classification of models and alternate classification of models
- Students will understand mathematical modeling based on transport phenomena, population balance, principles of probability and experimental data.
- Students will analyze the detailed mathematical models of heat transfer equipment, separation processes, reactors,
- Students will understand the Unit models of unit processes, numerical methods for solution of mathematical models in the form of partial differential equations.

Prerequisite: Basic knowledge of Courses on Material & Energy Balance; Transport Phenomena and Numerical methods.

Sl.No	Article	No. of Classes
1.	Introduction to process modeling and simulation, tools of simulation, approaches of simulation, planning of calculation in a plant simulation	**03**
2.	Parameter estimation techniques in theoretical as well as numerical models	**03**
3.	Models, need of models and their classification, models based on transport phenomena principles, alternate classification of models, population balance, stochastic, and empirical models, unit models	**07**
4.	Development of detailed mathematical models of evaporators, use of NewtonRaphson method for solving evaporator problems	**04**
5.	Separation of multicomponents mixtures by use of a single equilibrium stage, flash calculation under isothermal and adiabatic conditions. Tridigonal formulation of componentmaterial balances and equilibrium relationships for distillation, absorption and extraction of multicomponents. Thiele and Geddes method plus θ - method and Kb method, models of absorbers, strippers and extractors	**08**
6.	Classification of fixed bed reactor models, one dimensional and two dimensional fixed bed reactor models, fluidized bed reactor models, bioreactor models	**04**
7.	Classification of partial differential equations (PDE's), solution of PDEs by Finite difference techniques, method of weighted residuals. Orthogonal collocation to solve PDEs with their application to chemical engineering systems models	**06**
	Total	**35**

Books:

1. Process Modeling, Longman: Denn M. M.
2. Fundamentals and Modeling of Separation Processes", Prentice Hall: Holland C. D.
3. Process Modeling Simulation and Control for Chemical Engineers", 2nd Ed., McGraw Hill: Luyben W. L.
4. Process Modeling and Control in Chemical Engineering", CRC: Najim K.
5. Mathematical Modeling,Vol. 1:A Chemical Engineering Perspective (Process System Engineering) Academic Press: Aris R.

4th Semester Lab V
Subject: Nutrition and Biochemistry (CT 6271)
Contact Period: 3P per week, Full Marks: 50, Pass Marks: 20 [Credit – 02]

Course Objectives:

- Introduce the basic understanding in the estimation of errors and accuracy in biochemical analysis of nutritional food
- Introduce the process of determining micronutrients in food samples
- Introduce the process of identifying different enzymes in food processing
- Introduce the evaluation mechanism of different parameters of enzyme kinetics
- Introduce the process of preparing different fermented food products
- Introduce the application of molecular genetics in nutrition

Expected Learning Outcomes for Course:

- Students will become familiar with different analytical techniques for estimation of micronutrients in food
- Students will become familiar with estimation of different food enzymes and evaluation of different parameters
- of enzyme kinetics
- Students will become familiar with development of different fermented food products
- Students will become familiar with methods for screening of antibiotic and enzyme producing microorganisms
- Students will become familiar with study of molecular genetics of nutrition

Prerequisite: Biochemistry, Enzyme Technology, Fermentation

Sl. No.	Article	No. of Classes
1.	Detection and estimation of amino acids, chlorophyll and carotinoids by different chromatography	**04**
2.	Estimation of activities of different enzymes in food area (amylase, β-galactosidase, lipase, cellulose, protease, diastase, pectinase, phosphatase)	**05**
3.	Experiments on the effects of temperature, pH, substrate concentration, enzyme inhibition on enzymatic activity. Evaluation of Michalis constant	**06**
4.	Production, recovery and control tests of the following fermentation products: alcohols, baker's yeast, vitamin B, amino acids (glutamic acids, lysine and valine, antibiotics). Analysis of ferment gas including carbon balance experiments	**10**
5.	Modern methods of screening antibiotic producing and enzyme secreting organisms	**04**
6.	Experiments on molecular genetics of nutrition, Serial Analysis of Gene Expression (SAGE) and its application techniques in microbial enzyme technology	**06**
Total		**35**