Professional Core

M.Tech. Food Technology

[As per Outcome Based Education (OBE) & Choice Based Credit System (CBCS) scheme]

MATHEMATICAL MODELLING AND ANALYSIS IN FOOD TECHNOLOGY

Semester: I

Course Code	**18FDT11**	CIE Marks	40
Number of Lecture Hours/Week	04	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS - 04

Course Learning Objectives:

1. To learn numerical and statistical methods required for analyzing and interpreting the data
2. To use the mathematical tools in problem solving and analysis
3. To evaluate the sensory attributes of food samples by applying fuzzy logic
4. To learn analysis of variance of the statistical data through ANOVA
5. To develop mathematical relationship between the independent and dependent variables affecting the food processing operations

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module 1: Error definition, round off errors and truncation errors. Mathematical modeling and Engineering problem solving: Simple mathematical model, Conservation Laws of Engineering.	10	L1, L2
Module 2: Roots of Equations: False position method, Newton-Raphson method, Horner's Method. Developing mathematical relationship between the independent and dependent variables affecting the food processing operations by using physical and chemical principles governing the process.	10	L2, L3
Module 3: Probability distributions: Binomial, Poisson, Normal Sampling Theory: Testing of hypothesis using t and X^2 test, Goodness of fit.	10	L1, L2,L3
Module 4: F-test, Analysis of Variance: One – way with/without interactions, problems related to ANOVA, Design of experiments, RBD. Statistics: Correlation and Regression analysis.	10	L2, L3,L4
Module 5: Application of fuzzy logic to sensory evaluation and ranking of food, predictive model using neural net work, optimization of processing parameters using genetic algorithms.	10	L3, L4, L5

Course Outcomes: Student will

1. Learn numerical and statistical methods required for analyzing and interpretation.
2. Effectively use the mathematical tools in problem solving and analysis.
3. Evaluate the sensory attributes of food samples by applying fuzzy logic.
4. Learn analysis of variance of the statistical data through ANOVA.
5. Develop mathematical relationship between the independent and dependent variables affecting the food processing operations.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionally reduced to 60.

- The question paper will have 10 full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be 2 full questions (with maximum of 4 sub questions) from each module.
- Each full question will have sub question/s covering all the topics under a module.
- The student will have to answer 5 full questions, selecting 1 full question from each module.

Textbooks:

1. Advanced Engineering Mathematics. C. Ray Wylie and Louis C Barrett, McGraw-Hill, 6th Edition, 1995
2. Introduction to Partial Differential Equations. K Shankar Rao, Prentice - Hall of India Pvt. Ltd, 3rd Edition, 2011
3. Numerical Methods for Engineers. Steven C Chapra and Raymond P Canale, McGraw-Hill, 6th Edition, 2010
4. Food process operations. H. Das, Asian Books Pvt. Ltd., 1st Edition, 2005
5. Neural network modeling of end-over-end thermal processing of particulates in viscous fluids. Yang Meng and Hosahalli S. Ramaswamy, Journal of food process engineering, ISSN:1745-4530, 33:23-47, 2010

Reference Books:

1. Probability and Statistics in Engineering. William W. Hines, Douglas C. Montgomery, David M. Goldsman and Connie M. Borror, 4th Edition, John Wiley and Sons Ltd, 2003
2. Higher Engineering Mathematics. B.S. Grewal, Khanna Publishers, 44th Edition, 1965
3. Numerical methods for scientific and engineering computation. M K Jain, S.R.K Iyengar, R K. Jain, New Age International, 2003
4. Engineering Mathematics. R. R. Singh, M. Bhat, Mcgraw Hill Publication, 1st Edition, 2016
5. Advanced Engineering Mathematics. Erwin Kreyszig, Wiley Publication, 9th Edition, 2011

Professional Core			
M.Tech. Food Technology **[As per Outcome Based Education (OBE) & Choice Based Credit System (CBCS) scheme]** **FOOD MICROBIOLOGY** **Semester: I**			
Subject Code	**18FDT12**	CIE Marks	40
Number of Contact Hours /Week	03+02	SEE Marks	60
Total Number of Contact Hours	50	Exam Hours	03
CREDITS - 04			

Course Learning Objectives:

1. To provide knowledge and understanding of microbial growth and food spoilage
2. To apply microbial knowledge for controlling microbes in foods and using microbes for beneficial effects in foods
3. To evaluate food samples by different methods for microbial contamination
4. To analyze food borne pathogens and their toxins

Modules	Teaching/ Practical Hours	Revised Bloom's Taxonomy (RBT) Level
Module 1: Microbial growth Types of microorganisms, their importance in foods, classification of food borne bacteria, fungi & yeast, their morphology and distinguishing features with examples; Growth of microorganisms in foods; Intrinsic (pH, moisture content, redox potential, nutrient content, antimicrobial constituents and biological structures) and extrinsic factors (temp., RH, presence and concentration of gases) governing growth of microorganisms in food.	10	L1, L2, L3
Module 2: Food spoilage Chemical changes caused by microorganisms in foods (breakdown of proteins, carbohydrates, fats and other constituents during spoilage), specific microorganisms causing spoilage of milk and milk products, meat, fish, egg, cereals, fruits, vegetables and their processed products, quality defects in canned foods, sugar and confectionary products.	10	L1, L2, L3
Module 3: Food fermentations Different types of fermentations (solid -state, submerged, static, agitated,batch, continuous). Starter cultures, Probiotic cultures, Fermented foods - types,methods of manufacture for vinegar, ethyl alcohol, cheese, yoghurt, baker's yeast and traditional Indian foods.	10	L2, L3, L4
Module 4: Microbial foodborne diseases and detection of microbes Types of microbial foodborne diseases (foodborne intoxications and foodborne infections), symptoms and prevention of some	10	L2, L3, L4, L5, L6

commonly occurring foodborne diseases, detecting foodborne pathogens and their toxins- conventional versus rapid and automated methods; genetic and immunologic techniques for detecting foodborne pathogens and toxins.		
Module 5: Food preservation by controlling microbes Principles of preservation, methods of food preservation – high temperature, low temperature, drying, radiation, , antimicrobial agents (types- chemical preservatives, biopreservatives, mode of action and their application), hurdle technology, active packaging, novel processing technologies.	10	L3, L4, L5, L6

Course Outcomes: Student will

1. Understand the factors that influence the microbial growth in foods.
2. Apply his knowledge to control microbes in foods and use microbes for beneficial effects in foods.
3. Learn evaluation of food samples by different methods for microbial contamination.
4. Learn to analyze food borne pathogens and their toxins.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionally reduced to 60.

- The question paper will have 10 full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be 2 full questions (with maximum of 4 sub questions) from each module.
- Each full question will have sub question/s covering all the topics under a module.
- The student will have to answer 5 full questions, selecting 1 full question from each module.

Textbooks:

1. Food Microbiology. W C Frazier & D C Westhoff, McGraw Hill Education; 5th Edition, 2017
2. Modern Food Microbiology, J. M. Jay, CBS Publication, 2005
3. Essentials of Food Microbiology. John Garbutt, Hodder Arnold Publication, CRC Press, 2nd Edition, 1997
4. The Microbiology of Safe Food, S J Forsythe, Blackwell Science Ltd., 2nd Edition, 2010
5. Fundamentals of Food Microbiology. Bibek Ray and Arun Bhunia, CRC Press, 5th Edition, 2013
6. Microbiology of foods. J. C. Ayres, J. O. Mundt, W. E. Sandine, W H Freeman, Wiley Online Library, DOI: 10.1002/jobm.19810210711, 1981

Reference Books:

1. Microbiology. M.J. Pelczar Jr, E.C.S. Chan and Noel R. Krieg, McGraw Hill Inc; 5th Edition, 2001
2. General Microbiology. H.G. Schleigel, Cambridge University Press India, 7th Edition, 2012
3. Microbiology. Prescott, Joanne Willey and Kathleen Sandman and Dorothy Wood, Harley, Klein, McGraw Hill, 8th Edition, 2010
4. General Microbiology. C.B. Powar and H.F. Daginawala, Himalaya Publishing House, 2nd Edition, 2010
5. Practical Microbiology. R.C. Dubey and D.K. Maheswari, S Chand & Company Publication, 1st Edition, 2010

Professional Core			
M.Tech. Food Technology **[As per Outcome Based Education (OBE) & Choice Based Credit System (CBCS) scheme]** **FOOD CHEMISTRY** **Semester: I**			
Subject Code	**18FDT13**	CIE Marks	40
Number of Contact Hours/Week	03+02	SEE Marks	60
Total Number of Contact Hours	50	Exam Hours	03
CREDITS - 04			

Course Learning Objectives:

1. To provide understanding of different chemical components of foods
2. To apply food chemistry knowledge for improving shelf life and attributes of foods
3. To learn analysis of food ingredients
4. To learn evaluation of the levels of food additives

Modules	Teaching/ Practical Hours	Revised Bloom's Taxonomy (RBT) Level
Module 1: Proteins Nomenclature, classification, structure, chemistry and properties of amino acids, peptides, proteins; Essential and non-essential amino acids, Qualitative and quantitative analysis of amino acids and proteins, Changes during food processing. Browning reactions: Enzymatic and nonenzymatic browning, advantages and disadvantages, factors affecting their reaction and control.	10	L1, L2, L3, L4
Module 2: Carbohydrates Nomenclature and classification, structure, physical and chemical properties of polysaccharides and their functions; Qualitative and quantitative analysis of carbohydrates; changes in carbohydrates during food processing.	10	L1, L2, L3, L4
Module 3: Lipids Structure, classification, physical and chemical properties, utilization of fats and oils, margarine, shortenings, salad and cooking oils, importance of fats and oils in diet, introduction to hydrogenation and its importance.	10	L1, L2, L3, L4
Module 4: Nutrient Spplements Vitamins and minerals: Types of vitamins and minerals, chemistry and functions, sources and deficiency diseases; Plant pigments: Importance, structure and properties of plant pigments, chemical changes of in pigments during food processing.	10	L1, L2, L3, L4
Module 5: Food ingredients and additives classification and functions, need for food ingredients and additives, Permitted dosages of food additives , food preservatives, antimicrobial agents, thickeners- polysaccharides, bulking agents;	10	L1, L2, L3, L4, L5, L6

antifoaming agents, synergists, antagonists. Antioxidants (synthetic and natural, mechanism of oxidation inhibition), chelating agents-types, uses and mode of action; Coloring agents-color retention agents, applications and levels of use, natural colorants, sources of natural color (plant, microbial, animal and insects), misbranded colors, color stabilization; Flavoring agents- flavors (natural and synthetic flavors), flavor enhancers, flavor stabilization, flavor encapsulation; Flour improvers- leavening agents, humectants and sequesterants, hydrocolloids, acidulants, pH control agents, buffering salts, anticaking agents; Sweeteners- natural and artificial sweeteners, nutritive and non-nutritive sweeteners, properties and uses of various sweeteners in food products; Emulsifiers: Types, selection of emulsifiers, emulsion stability, functions and mechanism of action.		

Course Outcomes: Student will

1. Understand different chemical components of food.
2. Apply food chemistry knowledge for improving shelf life and attributes of foods.
3. Learn to analyse food ingredients.
4. Learn to evaluate the levels of food additives.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionally reduced to 60.

- The question paper will have 10 full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be 2 full questions (with maximum of 4 sub questions) from each module.
- Each full question will have sub question/s covering all the topics under a module.
- The student will have to answer 5 full questions, selecting 1 full question from each module.

Textbooks:

1. Food Chemistry. Meyer, CBS publication, 1st Edition, 2002
2. Food Chemistry. O.R. Fennema, Marcel Dekker, Inc., 3rd Edition, 1996
3. Food Chemistry. H.D. Belitz, , Werner Grosch, Peter,Schieberle, Springer, 4th revised Edition, 2009
4. Basic Food Chemistry. Frank Lee, Springer, 1st Edition Reprint, 1983
5. Principles of Biochemistry. Albert L. Lehninger, David L. Nelson, Michael M. Cox, W. H. Freeman publisher, 2004
6. Natural food additives, ingredients and flavourings. D. Baines, Woodhead Publishing Series in Food Science, Technology and Nutrition, 1st Edition, 2012
7. Fenaroli's Handbook of Flavor Ingredients. Gerorge A. Burdock, CRC Press, 1st Edition, 2009

Reference Books:

1. Food Antioxidants: Technological, Toxicological and Health Perspective. D.L. Madhavi, S.S. Deshpande, D.K. Salunkhe, CRC Press, 1st Edition, 1995
2. Food Flavours, Part A, B & C. I.D. Morton, A.J. Macleod, Elsevier Science Publishers, 1990
3. A Textbook of Organic Chemistry. Arun Bhal and B.S. Bhal, S. Chand & Company, 22nd Edition, 2016

4. Essential of Physical Chemistry. Arun Bhal, B.S. Bhal and G.D. Tuli, S. Chand Publication, 2010
5. Organic Chemistry. Paula Y. Bruice, Pearson Education Publication, 7th Edition, 2013

Professional Core			
M.Tech. Food Technology **[As per Outcome Based Education (OBE) & Choice Based Credit System (CBCS) scheme]** **FOOD PROCESS ENGINEERING-I** **Semester: I**			
Subject Code	**18FDT14**	CIE Marks	40
Number of Lecture Hours Per Week	04	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03
CREDITS - 04			

Course Learning Objectives:

1. To learn about different food engineering processes
2. To understand principles of different food engineering processes
3. To evaluate merits and demerits of different food engineering processes
4. To apply knowledge of different engineering processes for selecting appropriate process for food processing operations

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module 1: Properties of Foods & Food Processing at ambient temperature **Properties of Foods:** Composition, Physical, Rheological and biochemical properties, Sensory characteristics, Nutritional quality **Food Processing at ambient-temperature:** **Raw Food Processing-** Cooling crops and carcasses; Cleaning- wet and dry cleaning; Sorting and grading- shape and size sorting, weight sorting, colour and machine vision sorting and grading; Peeling **Reduction of Size-** Solid foods- Theory, equipment, developments in size reduction technology, effects on foods and microbes; Liquid foods- Theory, emulsifying agents and stabilizers, equipment, effect on foods and microbes.	10	L1, L2, L3
Module 2: Food Processing at ambient temperature **Mixing and Forming-** Mixing-Theories of solids and liquids mixing, equipment, effect on foods and microorganisms; Forming- Bread moulders, pie, tart and biscuit formers, confectionery moulders and depositors **Separation and Concentration of components of Food:** Theory and equipment for **Centrifugation, Filtration and**	10	L3, L4, L5, L6

Expression; Solvent Extraction- Theory, solvents, supercritical CO_2, Equipment; **Membrane concentration-** theory, equipment and applications, types of membrane system, effect on foods and microorganisms.		
Module 3: Food processing by heat removal **Chilling and modified atmospheres-** theory- refrigeration, modified atmospheres; equipment- mechanical refrigerators, cryogenic chilling, cold storage, temperature monitoring, modified and controlled atmospheric storage; applications- fresh and processed foods; effects on sensory and nutritional qualities of foods & microbes **Freezing-** theory- ice crystal formation, solute concentration, freezing time calculation, thawing; equipment- mechanical freezers, cryogenic freezers, new developments in freezing, frozen storage, thawing; effect on foods- freezing, frozen storage and thawing; effect on microbes **Freeze drying-** Theory, equipment and effect on foods and microbes **Freeze concentration-** Theory, equipment and effect on foods and microbes.	10	L3, L4, L5, L6
Module 4: Food Processing by heat application **Heat Processing –** Theory- Thermal properties of foods, heat transfer; Heat sources and application methods- direct and indirect heating methods, energy use and methods to reduce energy consumption, types of heat exchangers; Effect of heat on microbes, enzymes, nutritional and sensory characteristics of food.	10	L3, L4, L5, L6
Module 5: Food Processing by heat application **Processing by heat using steam or water:** **Blanching-** Theory, Equipment- steam blanchers, hot water blanchers, new blanching methods, effect on food and microbes **Pasteurisation-** Theory, Equipment- pasteurization of packaged and unpackaged foods**,** effect on foods **Sterilization by heat-** In container sterilization- theory, retorting, equipment; Ultra high temperature (UHT)/aseptic processes- theory, processing, equipment; effect on food- canning, UHT processing **Evaporation-** theory, improvement of evaporation economics, equipment, effect on foods and microbes **Distillation-** theory, equipment, effect on foods and microbes **Extrusion-** theory of extrusion cooking- ingredient properties, operating characteristics of extruder; equipment- single and twin screw extruders, control of extruders; food applications- confectionery, cereal and protein based	10	L3, L4, L5, L6

products; effects on sensory characteristics and nutritional value of foods & microorganisms.		

Course Outcomes: Student will

1. Learn different food engineering processes.
2. Understand principles of different food engineering processes.
3. Evaluate merits and demerits of different food engineering processes.
4. Apply his understanding to select appropriate process for food processing operations.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionally reduced to 60.

- The question paper will have 10 full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be 2 full questions (with maximum of 4 sub questions) from each module.
- Each full question will have sub question/s covering all the topics under a module.
- The student will have to answer 5 full questions, selecting 1 full question from each module.

Textbooks:

1. Fundamentals of food engineering. D.G. Rao, PHI Leraning Private Limited, New Delhi, 2010
2. Food processing technology - principles and practice. P.J. Fellows, CRC press, 3rd edition, 2009
3. Handbook of Food Engineering Practice**.** Kenneth J. Valentas, Enrique Rotstein, R. Paul Singh, CRC Press, 1st Edition, 1997
4. Introduction to Food Process Engineering, Albert Ibarz, Gustavo V. Barbosa-Canovas, CRC Press, 1st Edition, 2014
5. Unit Operations in Food Processing. R.L. Earle and M.D. Earle, The New Zealand Institute of Food Science & Technology Inc., 2004

Reference books:

1. Food Process Operations. H. Das, Asian Books Pvt. Ltd., 1st Edition, 2005
2. Unit Operations of Agricultural Processing. K.M. Sahay and K.K. Singh, Vikas Publishing House Pvt. Ltd., 2nd Edition, 2004
3. Food Engineering and Dairy Technology. H.G. Kessler, Verlag A. Kessler, 1st Published, 1981
4. Physical Properties of Food and Food Processing System, M. J. Lewis, Woodhead Publishing Limited, 1st Edition, 1990
5. Introduction to Food Engineering. R Paul Singh & Dennis R Heldman, Amsterdam Elsevier/Academic Press, 4th Edition, 2009
6. Transport Phenomena in Food Process Engineering, Ashis Kumar Datta, Himalaya Publishing House, 1st Edition, 2001

Professional Core			
M.Tech. Food Technology **[As per Outcome Based Education (OBE) & Choice Based Credit System (CBCS) scheme]** **FOOD PACKAGING AND STORAGE ENGINEERING** **Semester: I**			
Subject Code	**18FDT15**	CIE Marks	40
Number of Lecture Hours Per Week	04	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03
CREDITS - 04			

Course Learning Objectives:

1. To understand food packaging materials, food storage and packaging systems
2. To apply knowledge about packaging materials and systems to select appropriate packaging
3. To learn the evaluation of suitability of appropriate storage system
4. To Evaluate bio- films for various food packaging
5. To learn how to test materials for their suitability for packaging

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module 1: Introduction Function of packaging, marketing consideration for a package and types of packaging. Barrier properties of packaging material, gas permeation rates- oxygen transmission rate (OTR), water vapour transmission rate (WVTR), bursting strength, tensile strength, tearing strength, drop test, puncture test, etc.	10	L1, L2, L3
Module 2:Selection of packaging materials, packaging machines and labeling Packaging materials for foods, Selection criteria of packaging materials for raw and processed food products. Machinery for Packaging: Form fill and seal machines, vacuum packaging machine, shrink wrap packaging machine and multilayer packaging system. Package labeling: functions, nutrition labelling, ingredient characterization handling instruction, and regulations; Shelf life of packaged food: water activity and prediction of shelf life. Packaging logistics.	10	L3, L4
Module 3: Storage engineering-I Food Storage: Importance of scientific storage systems, postharvest Physiology of semi-perishables and perishables, climacteric and non-climacteric fruits, respiration, ripening, changes during ripening, ethylene biosynthesis. Product damages during storage. Storage structures: Traditional, improved and modern storage	10	L3, L4, L5

structures; farm silos. Stored grain management and aeration: moisture and temperature changes in stored grains; conditioning of environment inside. Storage, purposes of aeration, aeration theory and aeration system operation.		
Module 4: Storage Engineering-II Storage pests and control: Damage due to storage insects, pests, rodents and its control. Storage of perishables: cold storage, controlled and modified atmospheric storage, hypoboric storage, evaporative cooling storage, conditions for storage of perishable products, control of temperature and relative humidity inside perishable storage.	10	L3, L4, L5
Module 5: Biodegradable packaging Types of packaging, classification, advantages and limitations of each type of packaging, economics of various packaging materials; Specifications for packaging various food products, testing standards, testing agencies and biodegradability; Types of natural polymers used for developing food packaging, properties of natural polymers for food packaging applications, chemical modifications of natural polymers for food applications; Methods of manufacturing biodegradable packaging, testing and evaluation; Synthetic biopolymers used for packaging applications. Properties of the polymers and specifications; Methods of manufacturing synthetic polymer films, testing and evaluation; Practicals- Developing packaging films from starch and evaluating properties; Developing packaging films from synthetic biopolymers; Testing of developed films; Evaluation for the films developed for various food packaging.	10	L3, L4, L5,L6

Course Outcomes: Student will

1. Learn about packaging materials, packaging systems and food storage.
2. Apply his understanding to select appropriate packaging.
3. Learn to evaluate suitability of appropriate storage system.
4. Evaluate bio- films for various food packaging.
5. Learn how to test materials for their suitability for packaging.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionally reduced to 60.

- The question paper will have 10 full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be 2 full questions (with maximum of 4 sub questions) from each module.
- Each full question will have sub question/s covering all the topics under a module.
- The student will have to answer 5 full questions, selecting 1 full question from each module.

Textbooks:

1. Food Packaging: Principles and Practice. Gordon L. Robertson, , CRC Press, 2nd Edition, 2012
2. Handbook of Postharvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. A.

Chakraverty, A. S. Mujumdar, G.S.V. Raghavan, H.S. Ramaswamy, CRC Press, 1st Edition, 2003
3. Food Packaging and Preservation, M. Mathlouthi, Aspen Publishers Inc., United States, 1999

Reference Books :

1. Hermeticity of Electronic Packages. Hal Greenhouse, William Andrew Publishing, LLC, Norwich, New York, U.S.A., 2nd Edition, 2011
2. Storage of Cereal Grains and Their Products. David B. Saucer, Food and Agricultural Organization of the United Nations, 4th Edition, 1992
3. Principles of Agricultural Engineering. A.M. Michael and T.P. Ojha, Jain Brothers-New Delhi, 2nd Edition, 2003
4. Handling and Storage of Food Grains in Tropical and Subtropical Area, David Wylie Hall, FAO, 1970
5. Silos, Theory and Practice: Vertical Silos, Horizontal Silos (retaining Walls), André M. Reimbert, 2nd Edition, 1900
6. Fruit and Vegetables: Harvesting, Handling and Storage. A Keith Thompson 2nd Edition, Wiley-Blackwell, 2003

Professional Core

M.Tech. Food Technology

[As per Outcome Based Education (OBE) & Choice Based Credit System (CBCS) scheme]

FOOD PROCESSING LABORATORY

Semester: I

Subject Code	**18FDTL16**	CIE Marks	40
Number of Practical/Field work Hours Per Week	04	SEE Marks	60
Total Number of Practical/Field work Hours	52	Exam Hours	03

CREDITS - 02

Course Learning Objectives:

1. To learn different food preservation methods
2. To evaluate the performance of different food processing equipments
3. To determine physical properties of different food grains
4. To analyze the energy and material balances of food processes
5. To determine flow properties of different cereal powders

Experiments

1. Preservation of fruits and vegetables by osmotic dehydration, salting and canning
2. Yield and performance evaluation of fruits and vegetable processing equipments
3. Studying the effect of chemical preservatives on the shelf life of juices and pastes
4. Determination of physical properties of grains, cereal and spice seeds
5. Determination of coefficient of static friction for grain against different surfaces and angle of repose
6. Size reduction of cereals and evaluation of energy consumption, yield and performance of respective equipments
7. Determination of flow properties of wheat, rice and maize powders
8. Studies using freeze dryer to find out the freezing time and drying - rehydration characteristics of given food sample
9. Determination of heat and material balances during evaporation of milk
10. Determination of thermal process time for sterilization

Revised Bloom's Taxonomy (RBT) Level: L2,L3,L4,L5,L6

Course Outcomes: Student will

1. Learn different food preservation methods.
2. Evaluate the performance of different food processing equipments.
3. Determine physical properties of different food grains.
4. Analyze the energy and material balances of food processes.
5. Determine flow properties of different cereal powders.

Question paper pattern:

The SEE question paper shall be for 100 marks. The marks scored by the candidate will be proportionately reduced to 60.

Textbooks:

1. Process Equipment Design. Joshi M.V. and Mahajan V.V., Macmillan India Ltd, 3rd Edition,

1994
2. Process Equipment Design. Brownell and Young. Willey publication, 2009
3. Plant Layout and Design by J.M. Moore. The Mcmillan publication, 1st Edition, 1971
4. Introduction to Chemical Equipment Design – Mechanical Aspects. B.C. Bhattacharyya, S. Chand publication, 1st Edition, 2012.
5. Process Plant Design. J.R. Backhusrt and J.H. Harker. Butterworth-Heinemann publication, 1st Edition, 1973

Reference Books:

1. Computer Aided Process Plant Design. M.E. Leesley. Gulf Publishing Company, Houston, 1st Edition, 1982
2. Project Management for Engineers. M.D. Rosenau, Lifetime Learning Publication, 1984
3. Food Process Operations. H. Das, Asian Books Pvt. Ltd., 1st Edition, 2005
4. Unit Operations of Agricultural Processing. K.M. Sahay and K.K. Singh, Vikas Publishing House Pvt. Ltd., 2nd Edition, 2004
5. Textbook of Machine Design. R.S. Khumi and J.P. Gupta, S. Chand Publication, 25th Edition, 2005

Professional Core			
M.Tech. Food Technology **[As per Outcome Based Education (OBE) & Choice Based Credit System (CBCS) scheme]** **RESEARCH METHODOLOGY AND IPR** **Semester: I**			
Subject Code	**18RMI17**	CIE Marks	40
Number of Lecture Hours/Week	02	SEE Marks	60
Total Number of Lecture Hours	25	Exam Hours	03
CREDITS - 02			

Course Learning Objectives:

- To give an overview of the research methodology and explain the technique of defining a research problem
- To explain the functions of the literature review in research.
- To explain carrying out a literature search, its review, developing theoretical and conceptual frameworks and writing a review.
- To explain various research designs and their characteristics.
- To explain the details of sampling designs, and also different methods of data collections.
- To explain the art of interpretation and the art of writing research reports.
- To explain various forms of the intellectual property, its relevance and business impact in the changing global business environment.
  To discuss leading International Instruments concerning Intellectual Property Rights

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module 1: **Methodology:** Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India.	5	L1, L2
Module 2: **Defining the Research Problem:** Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration. **Reviewing the literature:** Place of the literature review in research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed.	5	L1,L2

Module 3: **Research Design:** Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs. **Design of Sample Surveys:** Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs.	5	L1,L2
Module 4: **Data Collection**: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method. **Interpretation and Report Writing:** Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.	5	L1,L2,L3,L4
Module 5: **Intellectual Property:** The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act,1957,The Protection of Plant Varieties and Farmers' Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention on Biological Diversity (CBD) 1992, Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation (WIPO),WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules, Patents, Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights(TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the Right Holder, Layout-Designs of Integrated Circuits, Protection of Undisclosed Information, Enforcement of Intellectual Property Rights, UNSECO.	5	L1,L2,L3,L4

Course Outcomes:

At the end of the course the student will be able to:

- Discuss research methodology and the technique of defining a research problem.
- Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.
- Explain various research designs and their characteristics.
- Explain the art of interpretation and the art of writing research reports.

Question paper pattern:

Examination will be conducted for 100 marks. The question paper will contain 10 full questions. Each full question will carry 20 marks.

- Each full question can have a maximum of 4 sub questions
- There will be 2 full questions from each module covering all the topics of the module
- Students will have to answer 5 full questions, selecting one full question from each module
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60

Textbooks:

1. Research Methodology: Methods and Techniques. C.R. Kothari, Gaurav Garg, New Age International, 4th Edition, 2018

2. Research Methodology a step-by-step guide for beginners. Ranjit Kumar, SAGE Publications Ltd., 3rd Edition, 2011

3. Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September 2013

Reference Books:

1. Research Methods: The Concise Knowledge Base. Trochim, Atomic Dog Publishing, 2005

2. Conducting Research Literature Reviews: From the Internet to Paper. Fink A, SAGE Publications, 2009

Professional Core			
M.Tech. Food Technology **[As per Outcome Based Education (OBE) & Choice Based Credit System (CBCS) scheme]** **FOOD PROCESS ENGINEERING-II** **Semester: II**			
Subject Code	**18FDT21**	CIE Marks	40
Number of Lecture Hours Per Week	04	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03
CREDITS - 04			

Course Learning Objectives:

1. To learn about advanced and minimal food engineering processes
2. To understand principles of different food engineering processes
3. To evaluate merits and demerits of different food engineering processes
4. To analyze and differentiate the food processes with and without heat application

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module 1: Food Processing at ambient-temperature **Irradiation-** theory-dose distribution; equipment-radiation dose measurement; applications- radappertisation, radicidation, radurisation, ripening control, disinfection, sprouting inhibition; effect on foods- induced radioactivity, radiolytic products, nutritional and sensory qualities; effect on microbes; effect on packaging; detection of irradiated foods- physical, chemical and biological methods **High pressure processing of Foods-** theory- effect on food components, mechanism of microbial cell inactivation; equipment- batch operation, semi continuous operation, process developments; effect on parasites and microbes- yeasts, moulds, bacteria, viruses; effect on enzymes; effect on foods; combinations of high pressure and other minimal processing techniques	10	L1, L2, L3, L4
Module 2: Food Processing at ambient-temperature **Minimal Food processing methods-** Processing by Pulsed electric field (PEF)- theory, equipment, effects on microbes, enzymes and food components, combinations of PEF and other treatments; Processing by electric arc discharges and oscillating magnetic fields; Processing with pulsed light, UV light and pulsed X-rays- theory, equipment, effects on microbes, enzymes and food components; Processing by ultrasound- theory, processing, effects on microorganisms and foods; Microwave processing.	10	L3, L4

Module 3: Food Processing by heat application **Processing by heat using hot air: Dehydration (Drying)-** theory- drying with heated air and heated surfaces, intermediate moisture foods; equipment- hot air driers, heated surface (contact) driers, control of dryers, rehydration; effect on sensory and nutritional properties of food and microbes. **Smoking-** theory- smoke constituents, liquid smoke; processing equipment; effect on foods and microorganisms**.** **Baking and Roasting-** theory; equipment- batch and semi continuous ovens, continuous ovens, control of ovens; effects on sensory and nutritional qualities of foods & microorganisms **Processing by heat using hot oils: Frying-** theory-heat and mass transfer, frying time and temperature; equipment- atmospheric fryers, vacuum and pressure fryers, fryer operation control, oil filtration and heat recovery; oils used for frying and effect of frying on oils; effect of frying on foods- oil absorption, changes to texture, colour and flavour & nutritional changes; effect of frying on microbes.	10	L3, L4, L5, L6
Module 4: Food Processing by heat application **Heat processing by direct and radiated energy:** **Dielectric heating-** theory, equipment, applications, effect on foods and microbes **Ohmic heating-** theory, equipment, applications, effect on foods and microbes **Infrared heating-** theory, equipment, applications, effect on foods and microbes.	10	L3, L4, L5
Module 5: Extraction & Hurdle Technology **Extraction-** Solid-liquid extraction (Leaching)- types of extraction processes; extraction principles- counter current extraction, McCabe-Thiele method, right angled triangle method; equipment- batch extractor, continuous counter current extractor, multi stage continuous counter current extractor; extraction applications in food processing- extraction of oils & fats, oleoresins, food colours, coffee, flavours and pigments **Hurdle technology-** Basics of hurdle technology – Mechanism	10	L3, L4, L5

Application to foods - Newer Chemical and Biochemical hurdles- organic acids – Plantderived antimicrobials – Antimicrobial enzymes – bacteriocins – chitin / chitosan (only one representative example for each group of chemical and biochemical hurdle).		

Course Outcomes: Student will

1. Learn advanced and minimal food engineering processes.
2. Understand principles of different food engineering processes.
3. Evaluate merits and demerits of different food engineering processes.
4. Analyze and differentiate the food processes with and without heat application.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionally reduced to 60.

- The question paper will have 10 full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be 2 full questions (with maximum of 4 sub questions) from each module.
- Each full question will have sub question/s covering all the topics under a module.
- The student will have to answer 5 full questions, selecting 1 full question from each module.

Textbooks:

1. Introduction to Food Process Engineering**.** Albert Ibarz, Gustavo V. Barbosa-Canovas, CRC Press, 2014
2. Fundamentals of food engineering. D.G. Rao, PHI Leraning Private Limited, New Delhi, 2010
3. Handbook of Food Engineering Practice. Kenneth J. Valentas, Enrique Rotstein, R. Paul Singh, CRC Press LLC, 1997
4. Trends in Food Engineering. Jorge E. Lozano, Cristina Anon, Gustavo V. Barbosa-Canovas, Efren Parada-Arias, CRC Press; 1st Edition, 2000
5. Food Processing Technology-Principles and Practice. P.J. Fellows, 3rd edition, Elsevier publication, 1st Edition, 2009
6. Hurdle Technologies – Combination treatments for food stability safety and quality. L. Leistner and G.W. Gould, Springer US publication, 1st Edition, 2002
7. Novel Food Processing Technologies (Food Science and Technology Series). Gustavo V. Barbosa-Canovas, Maria S. Tapia, M. Soledad Tapia, M. Pilar Cano, Publisher: CRC Press, 1st Edition, 2004
8. Minimal Processing Technologies in the Food Industry. Thomas Ohlsson and Nils Woodhead Publishing Limited, 1st Edition, 2002

Reference Books:

1. Pulsed Electric Fields in Food Processing: Fundamental aspects and applications: a volume in the Food Preservation Technology series. G V Barbosa-Cánovas and Q H Zhang, Woodhead Publishing Limited, 1st Edition, 2001
2. Pulsed electric field technology for the food industry: Fundamentals & applications (Food engineering series). Javier Raso and Volker Heinz, Springer US Publication, 1st Edition, 2006
3. Thermal Technologies in Food Processing. P Richardson, Woodhead Publishing Limited, 1st

Edition, 2001
4. Food Processing Operations Modeling: Design and Analysis. J.M. Irudavarai. CRC Press, 1st Edition, 2001
5. Processing Foods – Quality Optimization and Process Assessment. Fernanda A.R. Oliveira, Jorge C. Oliveira, CRC Press, 1st Edition, 1999
6. Food Processing Hand Book. James G. Brennen, Wiley-VCH Verlag GmbH & Co. KGaA, 1st Edition, 2006
7. Emerging Technologies for Food Processing. Da-wen Sun, Academic Press Imprint, 2015

Professional Core

M. Tech. Food Technology
[As per Outcome Based Education (OBE) & Choice Based Credit System (CBCS) scheme]
FRUIT AND VEGETABLE TECHNOLOGY
Semester: II

Subject Code	18FDT22	CIE Marks	40
Number of Contact Hours Per Week	03+02	SEE Marks	60
Total Number of Contact Hours	50	Exam Hours	03

CREDITS -04

Course Learning Objectives:

1. To understand the importance of fruits and vegetable processing in India
2. To provide technical insights about fruit and vegetable processing
3. To understand advanced processing methods of fruits and vegetables
4. To apply technical knowledge for evaluating different processing methods
5. To apply technical knowledge for selecting appropriate method for processing of fruits and vegetables

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module 1: **Post Harvest Processing** Production of Fruits and vegetables in India, Composition of major fruits and vegetables produced in the country, Post harvest handling and storage of fresh fruits and vegetables Causes for heavy post harvest losses; Spoilage factors; Fruit Ripening and Related Parameters, Changes in Fruit Quality Attributes during Handling Cold Storage and Fruit Quality, cold chain effect on fruit shelf life, Effect of Heat, Calcium, Polyamine and 1-Methylcyclopropene Treatments.	10	L1, L2
Module 2: **Fruits and Vegetables Processing** Canning: Preparation of fruits and vegetables for canning – Washing, peeling, grating, slicing dicing, deseeding, blanching; Common machinery for operations Juice and pulp extraction – extractors, Hydraulic Press, Hot and Cold Break process, Clarification, Clarification centrifuges, Decanters and desludgers; Fruit juice concentrates	10	L3,L4

– methods of concentration, types of evaporators; Fruit Powders - Preparation of Fruit material for powder production, Process operations.		
Module 3: **Drying & Applications of enzymes in processing** Preparation of fruits and vegetables for dehydration, Equipments used for drying, design aspects of dryers, effects of drying, Enzymes in fruits and vegetable processing.	10	L3, L4,L5
Module 4: **Aspetic and other processing methods** Aseptic processing- Aseptic heat exchangers / pasteurizers, Aseptic fillers. Filling systems- Tetra pack for small quantities, Dole system and Scholle system for bulk filling; Hurdle technology with reference to Vegetable and Fruit processing.	10	L3, L4,L5
Module 5: **Novel Processing methods** UV applications, High pressure applications, Ultrasound applications, Membrane applications, High intensity pulsed electric field applications, ozone processing, Irradiation applications in fruit processing, Minimal processing, Storage in Modified Atmosphere, Active Packaging, Freeze concentration applications, Vacuum frying applications, Edible coatings.	10	L3, L4,L5, L6
Course Outcomes: Student will 1. Understand the importance of fruits and vegetable processing in India. 2. Have clear understanding about different processing and preservation methods for fruits and vegetables. 3. Gain insights about advanced methods of fruit and vegetable processing. 4. Apply his understanding to evaluate different processing methods. 5. Apply his understanding to select appropriate method for processing of fruits and vegetables.		
Question paper pattern: The SEE question paper will be set for 100 marks and the marks scored will be proportionally reduced to 60. • The question paper will have 10 full questions carrying equal marks. • Each full question is for 20 marks. • There will be 2 full questions (with maximum of 4 sub questions) from each module. • Each full question will have sub question/s covering all the topics under a module. • The student will have to answer 5 full questions, selecting 1 full question from each module.		
Textbooks:		

1. Fruit and Vegetable Processing. M.E. Dauthy, FAO Agricultural Services Bulletin No.119, Food and Agriculture Organization of the United Nations, Rome, 1995
2. Fruit and Vegetable Preservation; Principles and Practices. R.P. Srivastava and Sanjeev Kumar, CBS; 3rd Edition, 2014
3. Hand Book of Vegetable Preservation and Processing. Y. H. Hui, E. Özgül Evranuz, CRC Press, 2nd Edition, 2015

Reference Books:

1. Handbook of Fruit Science and Technology: Production, Composition and Processing. D.K. Salunkhe and S.S. Kadam, CRC Press, 1st Edition, 1995
2. Handbook of Vegetable Science and Technology. Production, Composition, Storage and Processing. D.K. Salunkhe and S.S. Kadam, CRC Press, 1st Edition, 1998
3. Handbook of Post-harvest Technology. A. Chakraverty, A.S. Mujumdar, G.S.V Raghavan and H.S. Ramaswamy, Taylor and Francis Inc. publisher, 1st Edition, 2003
4. Advances in Fresh-Cut Fruits and Vegetables Processing. Ed. Olga Martin-Belloso, Robert Soliva Fortuny, CRC Press, 1st Edition, 2010
5. Advances in Fruit Processing Technologies. Sueli Rodrigues, Fabiano Andre Narciso Fernandes, CRC Press, 1st Edition, 2016

Professional Core			
M. Tech. Food Technology **[As per Outcome Based Education (OBE) & Choice Based Credit System (CBCS) scheme]** **DAIRY TECHNOLOGY** **Semester: II**			
Subject Code	18FDT23	IA Marks	40
Number of Contact Hours Per Week	03+02	Exam Marks	60
Total Number of Contact Hours	50	Exam Hours	03
CREDITS -04			

Course Learning Objectives:

1. To have clear vision about milk processing and preservation
2. To understand the principles of processing of milk and its products
3. To gain technical insights about advanced methods of milk processing
4. To evaluate different methods for the selection of appropriate method for milk processing

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module 1: **Introduction** Understanding about milk, milk - composition, food and nutritive value, physico-chemical properties; milk reception at dairies, quality and quantity tests at reception Equipments used in liquid milk processing.	10	L1, L2,L3
Module 2: **Unit Operations in Milk Processing** Principles of milk processing: Filtration, milk storage, bulk cooling, stirring and mixing, standardization, pasteurization, sterilization, centrifugation, homogenization, evaporation and condensation.	10	L3,L4
Module 3: **Production of Milk Products** Drying of milk, principle and equipment: spray dryer, cyclone separator. Manufacturing of milk products and principles of processing of cheese, ice-cream, butter, special milk products, casein, whey, curd, butter milk etc. Equipment for indigenous milk products manufacturing. Enzymes and their role in the manufacture of dairy products.	10	L3, L4,L5
Module 4: **Non-thermal processing and packaging** UV, High pressure, Ultrasound, Membrane, High intensity pulsed electric field applications in milk processing	10	L3,L4,L5.L6

Packaging Filling Operations: Principles and working of different types of bottle filters and capping machine, pouch filling machine, pre-pack and aseptic filling. Filling and Packaging machines for milk and milk products, aseptic packaging.		
Module 5: **Dairy plant maintenance** Bulk milk handling system, care and maintenance, Hygienic design concepts, sanitary pipes and fittings, CIP system. Preventive maintenance program for Dairy Plant, Maintenance organization, development of optimum organization planned overhaul and PERT planning, Utilities and sanitation in processing plant. **By-product utilization** By-product utilization from dairy industries.	10	L3, L4

Course Outcomes: Student will

1. Have clear vision about milk processing and preservation.
2. Understand the principles of processing of milk and milk products.
3. Gain technical insights about advanced methods of milk processing.
4. Evaluate different methods for the selection of appropriate method for milk processing.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionally reduced to 60.

- The question paper will have 10 full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be 2 full questions (with maximum of 4 sub questions) from each module.
- Each full question will have sub question/s covering all the topics under a module.
- The student will have to answer 5 full questions, selecting 1 full question from each module.

Textbooks

1. Outlines of Dairy Technology. Sukumar De, Oxford University Press, 5th Edition, 2005
2. Dairy Plant System and Layout. Tufail Ahmed, Kitab Mahal, New Delhi, 1996
3. Engineering for Dairy and Food Products. A W Farrall. John Wiley and Sons, 1st Edition, 1963
4. Indian Dairy Products. K S Rangappa, Asia Publishing House, 1st Edition, 1975
5. Milk and Milk Products. Clarence Henry Eckles, Willes Barnes Combs, Harold Macy, McGraw-Hill Book Company Inc., 1943

Reference Books

1. Cheese and Butter by V. Cheke and A. Sheeprd, Agro-Bios, 1st Edition, 1998
2. Dairy Chemistry and Biochemistry. P. F. Fox, T. Uniacke-Lowe, Paul L. H. McSweeney, James A. O'Mahony, 2nd Edition, 2015
3. Dairy Technology: Principles of Milk Properties and Processes. P. Walstra, T.J. Geurts, A. Noomen, A. Jellema, M.A.J.S. van Boekel, 1st Edition, 1999

4. Dairy Chemistry and Biochemistry. P.F. Fox, T. Uniacke-Lowe, P.L.H. McSweeney, J.A. O'Mahony, Springer, 2nd Edition, 2015
5. Milk and Dairy Product Technology. Edgar Spreer, Marcel Dekker INC., CRC Press, 1st Edition, 1998

Professional Elective-1			
M.Tech. Food Technology **[As per Outcome Based Education (OBE) & Choice Based Credit System (CBCS) scheme]** **GRAIN PROCESSING AND BAKING TECHNOLOGY** **Semester: II**			
Subject Code	**18FDT241**	CIE Marks	40
Number of Lecture Hours/Week	04	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03
CREDITS - 04			

Course Learning Objectives:

1.To learn various processes and methods of food grain processing
2.To learn various aspects of bakery and confectionary technology
3. To apply baking knowledge for developing new products
4. To analyze and compare the processing methods of different grains

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module 1: Grain processing and milling Production, Economics, and processing scenario of Food grains. Classification, structure and physicochemical properties and thermal properties of Food grains; Unit operations and equipment for Food Grain Processing, Processing and storage of cereals, pulses and oil seeds. Commercial processing of Paddy, wheat, Corns, Barley, Millets, Pulses and Oil seeds. Dry Milling (Rice and Wheat), Wet Milling (Maize) and parboiling of rice.	10	L1, L2, L3,L4, L5
Module 2: Baking Technology Introduction of bakery products-bread, biscuit, cake, pastries, rusk, crackers. PFA specifications of bakery products. Bread types; role of major and minor ingredients; processes of bread making; problems associated with bread making; equipment for bread manufacturing; processing steps for biscuit, cookies, cracker, cakes and their major and minor ingredients. Nutritional aspect of bakery products; quality evaluation of baked products.	10	L3, L4, L5,L6
Module 3: Confectionary Historical development; classification of confectionary products; basic technical considerations for confectionary products- TS, TSS, pH, acidity, ERH, RH etc. raw materials and their role in confectionary products; traditional confectionary products.	10	L3,L4
Module 4: Chocolate & Vanilla processing historical development in chocolate processing; ingredients and their role in chocolate; Steps of chocolate processing- mixing, refining, conching, tempering, molding, cooling, coating, enrobing, etc.	10	L3, L4,L5

Vanilla- Production, processing and packaging.		
Module 5: Candies and Toffee High boiled sweets/candy-composition, production and preparation of high boiled sweets- traditional, batch and continuous methods; toffee composition, types, ingredient and their role, batch and continuous methods of toffee manufacturing.	10	L3, L4

Course Outcomes: Student will

1. Understand various processes and methods of grain processing.
2. Evaluate the quality of bakery products.
3. Apply baking knowledge for developing new products.
4. Analyse and compare the processing methods of different grains.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionally reduced to 60.

- The question paper will have 10 full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be 2 full questions (with maximum of 4 sub questions) from each module.
- Each full question will have sub question/s covering all the topics under a module.
- The student will have to answer 5 full questions, selecting 1 full question from each module.

Textbooks:

1. Bakery Science & Cereal Technology. Neelam Khetarpaul, Daya Books, 1st Edition, 2005
2. Kent's Technology of Cereals: An Introduction for Students of Food Science and Agriculture. N.L. Kent, Woodhead Publishing Imprint, 4th Edition, 1994
3. Post-Harvest Technology of Cereals, Pulses and Oil Seeds. A. Chakravarty, Oxford & IBH Publishing Co. Pvt. Ltd., 1st Edition, 1989
5. Bakery Products Science and Technology. Weibiao Zhou and Y. H. Hui, Wiley Blackwell, 2nd Edition, 2014
6. The Complete Technology Book on Bakery Products. NIIR Board of Consultants & Engineers, NPCS, Kamla Nagar, New Delhi, 3rd Edition, 2014

Reference Books:

1. Biscuit, Cracker and Cookie Recipes for the Food Industry. Duncan Manley, Woodhead Publishing, 1st Edition, 2001
2. Baking Problems Solved. S.P. Cauvain and L.S. Young, Woodhead Publishing, 1st Edition, 2001
3. Flat Bread Technology. J. Qarooni, Springer US, 1st Edition, 1996
4. Unit Operations in Agricultural Processing. K.M. Sahay and K.K.Singh, Vikas Publishing House Pvt. Ltd., 2nd Edition, 2004
5. Bakery Science and Food Technology. Neetam Khetarpaul, Raj B. Grewal and Sudesh Jood, Daya Publishing House, 1st Edition, 2012

Professional Elective-1			
M.Tech. Food Technology **[As per Outcome Based Education (OBE) & Choice Based Credit System (CBCS) scheme]** **SUGAR, PROTEIN AND OIL TECHNOLOGY** **Semester: II**			
Subject Code	**18FDT242**	IA Marks	40
Number of Lecture Hours/Week	04	Exam Marks	60
Total Number of Lecture Hours	50	Exam Hours	03
CREDITS - 04			

Course Learning Objectives:

1. To learn the production technologies of sugar, protein and oil
2. To learn how to apply lipids for extended uses
3. To analyse the different methods of oil processing
4. To evaluate the different methods of separation of proteins
5. To learn how to select appropriate method for the production of sugar, protein and oil

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module 1: Introduction Structure, properties and functionality of sugars Structure, properties and functionality of proteins Structure, properties and functionality of lipids.	10	L1, L2
Module 2: Sugar Technology, products and by-products Sugarcane and sugarbeet as sugar raw materials; Flow charts for manufacture of Granulated and Liquid sugars; Properties of Granulated sucrose and Liquid Sugars; Invert sugar and their characteristics Extraction of sugar juice from beet and cane; Juice purification; Decolorisation, Evaporating, Crystallization; Centrifugation; Sugar handling after centrifugals Pressed and dried pulp; Bagasse; Molasses; Liquid sugars; Special crystal sugar products.	10	L3, L4
Module 3: Protein processing Protein extraction- different methods Protein separation- different methods Protein concentration- different methods.	10	L3, L4, L5,L6
Module 4: Oil Processing Pressing and Extraction of oils; Chemical, Physical and miscellaneous methods Inter-esterification; Hydrogenation; Fat crystallization.	10	L3, L4
Module 5: Extended Applications of Lipids Food emulsions; Non-aqueous foods; Special food applications-edible coating and film barriers; spray processing of fat containing	10	L3, L4,L5

foodstuffs - spray drying and cooling; low calorie fats; food emulsifiers; lipid emulsions for intravenous nutrition and drug delivery, Fats and oils Formulation; Shortenings; Margarine.		

Course Outcomes: Student will

1. Learn the production technologies of sugar, protein and oil.
2. Learn how to apply lipids for extended uses.
3. Analyze the different methods of oil processing.
4. Evaluate the different methods of separation of proteins.
5. Learn how to select appropriate method for the production of sugar, protein and oil.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionally reduced to 60.

- The question paper will have 10 full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be 2 full questions (with maximum of 4 sub questions) from each module.
- Each full question will have sub question/s covering all the topics under a module.
- The student will have to answer 5 full questions, selecting 1 full question from each module.

Textbooks:

1. Lipid Technologies and Applications. Frank D. Gunstone and Fred B. Padley, CRC Press, 1st Edition, 1997
2. Practical Guide to Vegetable Oil Processing. Monoj K. Gupta, AOCS Press, 1st Edition, 2004
3. Bleaching and Purifying Fats and Oils, Gary R. List, AOCS Press and Academic Press, 2nd Edition, 2009
4. Sugar Technology-Beet and Cane Sugar Manufacture. P.W. van der Poel, H. Schiweck, T.K. Schwartz, Publisher: Verlag Dr Albert Bartens KG, 1998
5. Principles of Sugar Technology. P. Honig, Elsevier, 1st Edition, 1953
6. Encyclopedia of Protein Technology. Josie Mehta, Dominant Publishers And Distributors, 1993

Reference Books:

1. Fats and Oils-Formulating and Processing for Applications. Richard D. O'Brien, CRC Press, 3rd Edition, 2008
2. Beet- Sugar Technology. R.A. McGinnis, Publisher: Beet Sugar Development Foundation, 3rd Edition, 1982
3. A Textbook of Organic Chemistry. Arun Bhal and B.S. Bhal, S. Chand & Company, 22nd Edition, 2016
4. Food Proteins and Their Applications. Ed. Srinivasan Damodaran and Alain Paraf, Markel Dekker Inc. Publication, 1st Edition, 1997
5. Proteins in Food Processing, Ed. Rickey Y. Yada, Woodhead Publishing (Elsevier), 2nd Edition, 2018

Professional Elective-1			
M.Tech. Food Technology **[As per Outcome Based Education (OBE) & Choice Based Credit System (CBCS) scheme]** **MICROBIAL BIOTECHNOLOGY** **Semester: II**			
Subject Code	**18FDT243**	CIE Marks	40
Number of Lecture Hours/Week	04	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03
CREDITS - 04			

Course Learning Objectives:

1. To understand the methods used while handling of microorganisms used in the industries
2. To define the role of microorganisms towards environmental protection and industrial applications
3. To evaluate industrial fermentation processes leading to the production of antibiotics, organic acids, enzymes and vitamins
4. To analyze different microbiological assays
5. To analyze and evaluate different detection methods for pathogens

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module 1: INTRODUCTION The era of the discovery of Microbes, Pasteur and fermentation, The discovery of Antibiotics, Production strains, screening techniques, Industrial Fermentations, Screening Methods, Strain Development.	10	L1, L2, L3
Module 2: PRODUCTION MEDIA Characteristics of an Ideal Production Media, Raw materials for production, Different production Media, Principles of Sterilization, Sterilization equipment.	10	L3,L4
Module 3: PRINCIPAL TYPES OF FERMENTOR IN INDUSTRIES: Introduction to Fermentors, Factors involved in fermentor Design, Fermentor configurations,Principal operating characteristics of fermentors,Computer control of Fermentation Process.	10	L3, L4
Module 4: MICROBIOLOGICAL ASSAYS Microbiological assay of Vitamins, Amino Acids, Antibiotics and Trace elements. Advantages and Disadvantages of Microbiological Assay, Automation of Microbiological Assay, Detection methods for pathogens.	10	L3, L4, L5, L6
Module 5: INDUSTRIAL APPLICATIONS OF MICROBES Food sector- Fermented foods, Production of food related metabolites like organic acids, vitamins by microbes; Enzyme	10	L3, L4, L5, L6

Industries- Production of microbial enzymes used in food processing; Sewage treatment methods by using microbes.		

Course Outcomes: Student will

1. Understand the methods used for the isolation, growth, identification, disinfection and sterilization of microorganisms used in the industries.
2. Define the role of microorganisms towards environmental protection and industrial applications.
3. Evaluate industrial fermentation processes leading to the production of antibiotics, organic acids, enzymes and vitamins.
4. Analyze different microbiological assays.
5. Analyze and evaluate different detection methods for pathogens.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionally reduced to 60.

- The question paper will have 10 full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be 2 full questions (with maximum of 4 sub questions) from each module.
- Each full question will have sub question/s covering all the topics under a module.
- The student will have to answer 5 full questions, selecting 1 full question from each module.

Textbooks:

1. Microbiology. Michael J Pelczar Jr., E.C.S. Chan and Noel R Krieg, McGraw Hill Inc. US, 5th Revised Edition, 2001
2. Microbiology. Prescott, Joanne Willey and Kathleen Sandman and Dorothy Wood, Harley, Klein, McGraw Hill, 8th Edition, 2010
3. Industrial Microbiology. Samuel C Prescott and Cecil G Dunn, Agro bios (India), 2011
4. Palynology and its applications. Shripad N. Agashe, Oxfor and Ibh publishing Pvt. Ltd. 1st Edition, 2006
5. Biotechnological Applications of Microbes. Ajit Verma, I.K. International Publishing House, 1st Edition, 2005
6. Alcamo's Fundamentals of Microbiology. Jeffery C Pommerville, Jones and Bartlett Publisher, 9th Revised Edition, 2010
7. Microbiology, an Introduction, Gerard J. Tortora, Berdell R. Funke, Christine L. Case, Publisher: Pearson, 12th Edition, 2016
8. Principles of Microbiology. Ronald M Atlas, McGraw-Hill Inc., US, 1995
9. Microbiology: Principles and Explorations, Jacquelyn G. Black and Laura J. Black, John Wiley & Sons, 8th Edition, 2012

Reference books:

1. The Air Spora: A Manual for Catching and Identifying Airborne Biological Particles. Maureen E. Lacey and Jonathan S. West, Springer US, 1st Edition, 2006
2. Soil Microbiology. N.S. Subbarao, Oxford and IBH, Science Publishers U.S, 2nd Revised Edition, 1999
3. Palynology and its applications. Shripad N. Agashe, Oxfor and IBH publishing Pvt. Ltd.
4. Text Book of Microbiology. R. Anantahnarayan and C.K. Jayaram Panicker, Universities Press, 8th Edition, 2009
5. Microbial Biotechnology International Student edition: Fundamentals of Applied

Microbiology. Alexander N. Glazer and Hiroshi Nikaido, Student Edition, 2007

Professional Elective-1

M. Tech. Food Technology
[As per Outcome Based Education (OBE) & Choice Based Credit System (CBCS) scheme]
FOOD PRODUCT DEVELOPMENT
Semester: II

Subject Code	**18FDT244**	CIE Marks	40
Number of Lecture Hours Per Week	04	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03
CREDITS -04			

Course Learning Objectives:

1. To understand the process of new product development
2. To analyse the market for new product
3. To analyse availability and cost competitiveness for new products
4. To evaluate economics and commercialization of new product
5. To evaluate process control parameters during scale-up of product

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module 1: **Introduction** Need, importance and objectives of formulation for new product development. Ideas, business philosophy and strategy of new product.	10	L1, L2
Module 2: **Formulation and Standardization** Formulation based on sources availability and cost competitiveness for concept developments of new products. Standardization of various formulation and product design.	10	L3,L4
Module 3: **Product Development** Adaptable technology and sustainable technology for standardized formulation for process development. Process control parameters and scale-up, production trials for new product development at lab and pilot scale.	10	L3, L4,L5,L6
Module 4: **Quality and Market** Quality assessment of newly developed products- nutritional and sensory qualities, shelf-life and safety evaluation as per FSSAI guide lines. Market testing and marketing plan.	10	L3,L4,L5

Module 5: **Economical aspect** Costing and economic evaluation. Economics of food plant construction- estimation of economic plant size (breakeven analysis and optimization) & Estimation of volume of production for each product. Commercialization / product launch.	10	L3,L4,L5,L6

Course Outcomes: Student will

1. Understand the process of new product development.
2. Analyse the market for new product.
3. Analyse availability and cost competitiveness for new products.
4. Evaluate economics and commercialization of new product.
5. Evaluate process control parameters during scale-up of product.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionally reduced to 60.

- The question paper will have 10 full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be 2 full questions (with maximum of 4 sub questions) from each module.
- Each full question will have sub question/s covering all the topics under a module.
- The student will have to answer 5 full questions, selecting 1 full question from each module.

Textbooks:

1. Food Product Development: Maximizing Success. R. Earle and A. Anderson, Woodhead Publishing Series in Food Science, Technology and Nutrition, CRC Press; 1st Edition, 2001
2. New Food Product Development: From Concept to Marketplace, Gordon W. Fuller, CRC Press, 3rd Edition, 2011

Reference Books:

1. Food Product Development: From Concept to the Marketplace. E. Graf and I. Saguy, Springer US, 1st Edition, 1991
2. Nutraceuticals Food Processing Technology: Innovative Scientific Research. Ed. R.P. Shukla, R.S. Mishra, Abhishek Dutt Tripathi, Ashok Kumar Yadav, Manju Tiwari, Raghvendra Raman Mishra, Bharti Publications; 1st Edition, 2017
3. Food Science. B. Shrilakshmi, New Age International (P) Limited Publication, 3rd Edition, 2003
4. Food processing technology - principles and practice. P.J. Fellows, CRC press, 3rd edition, 2009
5. Industrial Economics: An Introductory Textbook. R.R. Barthwal, New Age Publication, 1st Edition, 2010

Professional Elective-2

M.Tech. Food Technology

[As per Outcome Based Education (OBE) & Choice Based Credit System (CBCS) scheme]

FUNCTIONAL FOODS AND NUTRACEUTICALS

Semester: II

Subject Code	**18FDT251**	CIE Marks	40
Number of Lecture Hours/Week	04	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS - 04

Course Learning Objectives:

1. To know about various food ingredients and their functional properties
2. To apply his understanding to select appropriate food for particular disease control
3. To learn how to evaluate functional foods with respect to different regulations
4. To analyse the functional claims with respect to packaging and labeling

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module 1: Introduction Functional foods- concept and definition; nutraceutical-concept and definition. Probiotics, prebiotics and dietary fibres – their functional properties Functional foods-the link between nutrition and medicine, sources and bioavailability of nutraceuticals, chemistry and structure of nutraceuticals.	10	L1, L2
Module 2: Functional food components and their roles in disease prevention Micronutrients, Vitamins, Isoflavones; Flavanoids, Carotenoids and Lycopene; Nutraceuticals – Garlic, Grape, Wine, Tea; Omega 3 Fatty Acids, Antioxidant, Chemoprevention & Functional Food; Single Cell Proteins. Functional foods for treatment of gastrointestinal disorders, Functional Food and Nutraceuticals for the treatment of Coronary Heart Disease, Role of Functional Food and Nutraceuticals in Tumor.	10	L3, L4
Module 3: Nutraceuticals of plant and animal origin Plant secondary metabolites, Animal metabolites, Fat rich functional food and their applications - Functional Fats and Spreads, modified fats and oils. Functional Confectionery and other functional Products**.**	10	L3, L4
Module 4: Functional Food Health Claims Functional claims; packaging and labeling; nutrient modification and specific nutrient claims; disease-specific claims; Dietary Supplement Health and Education Act (DSHEA).	10	L3,L4,L5

Module 5: Marketing and Regulation of Functional foods Market for Functional Food Products: Functional foods and consumers; the role of health in food choice; functional foods market; Regulations and laws for functional food. Regulations in USA, EU and India.	10	L3,L4,L5

Course Outcomes: Student will

1. Have a clear vision about various food ingredients and their functional properties.
2. Apply his understanding to select appropriate food for particular disease control.
3. Learn how to evaluate functional foods with respect to different regulations.
4. Analyze the functional claims with respect to packaging and labeling.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionally reduced to 60.

- The question paper will have 10 full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be 2 full questions (with maximum of 4 sub questions) from each module.
- Each full question will have sub question/s covering all the topics under a module.
- The student will have to answer 5 full questions, selecting 1 full question from each module.

Textbooks:

1. Functional Foods: Principles and Technology. M. Guo, Woodhead Publishing, 1st Edition, 2009

2. Functional Foods Concept to Product. Glenn R. Gibson and Christine M. Williams, CRC Press, 1st Edition, 2004

3. Functional Foods and Nutraceuticals. R.E. Aluko, Publisher: Springer-Verlag New York, 1st Edition, 2012

Reference Books:

1. Functional Dairy Products. T Mattila-Sandholm and M. Saarela, Woodhead Publishing Imprint, 1st Edition, 2003

2. Handbook of Nutraceuticals and Functional Foods. Robert E. C. Wildman, CRC Press, 2nd Edition, 2016

3. Handbook of Fermented Functional Foods. Edward R.(Ted) Farnworth, CRC Press, 2nd Edition, 2008

4. Essentials of Functional Foods. Mary K. Schmidl and Theodore P. Labuza, Springer US, 1st Edition, 2000

5. Biotechnology in Functional Foods and Nutraceuticals. Debasis Bagchi, Francis C. Lau, Dilip K. Ghosh, CRC Press 1st Edition, 2010

Professional Elective-2

M.Tech. Food Technology

[As per Outcome Based Education (OBE) &Choice Based Credit System (CBCS) scheme]

ENZYME AND FERMENTATION TECHNOLOGY

Semester: II

Subject Code	**18FDT252**	CIE Marks	40
Number of Lecture Hours/Week	04	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS - 04

Course Learning Objectives:

1. To introduce different enzymes used in food processing
2. To apply different enzymes during food processing
3. To understand about production and purification of enzymes
4. To evaluate different fermentation technologies for the economic production of enzymes
5. To analyse different fermentor designs

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module 1: Introduction & Enzyme kinetics Nature, Function, classification & nomenclature of enzymes, Specificity, Michaeli's Menton equation, K_m, Lineweaver Berk Plot, Different inhibitors.	10	L1, L2, L3, L4
Module 2: Food related enzymes and applications Amylases, Pectic Enzymes, Proteases, Rennet; Oxidoreductases-Phenolases, Glucose Oxidases, Catalases, Peroxidases, Lipoxygenases, Xanthine Oxidases, Immobilized enzyme, Application of enzymes in food processing; Application of immobilized enzymes and cells.	10	L3, L4
Module 3: Enzyme Purification Ammonium sulphate precipitation, Gel exclusion chromatography, Ion exchange chromatography, Affinity chromatography- GST, His tag, Native PAGE, SDS-PAGE, Zymogram, Coomassie blue and Silver staining.	10	L3, L4, L5
Module 4: Fermentation Technology Sterilization methods of Fermentors; Scale up and scale down; Biomass Production; Enzyme Production; Downstream processing.	10	L3, L4, L5,L6
Module 5: Fermentors Fermentor design and analysis; Aeration and Heat Transfer; Instrumentation and Control; Batch, Fed batch and continuous bioreactors.	10	L3, L4, L5,L6

Course Outcomes: Student will

1. Know different enzymes used during food processing.
2. Learn applications of enzymes during food processing.

3. Understand about the production and purification of enzymes.
4. Evaluate different fermentation technologies for the economic production of enzymes.
5. Analyze different fermentor designs.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionally reduced to 60.

- The question paper will have 10 full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be 2 full questions (with maximum of 4 sub questions) from each module.
- Each full question will have sub question/s covering all the topics under a module.
- The student will have to answer 5 full questions, selecting 1 full question from each module.

Textbooks:

1. Principles of Biochemistry. Lehninger, D.L. Nelson and M.M. Cox, Publisher: W. H. Freeman; 6th Edition, 2013
2. Biochemical Engineering Fundamentals. J.E. Baily and D.F. Ollis, Mcgraw Hill Chemical Engineering Series, 1st Edition, 1986
3. Biochemistry. D. Voet and J.G. Voet, John Wiley & Sons Inc; 4th Edition, 2010
4. Industrial Microbiology. Samuel C Prescott and Cecil G Dunn, Agro bios (India), 2011
5. Principles of Fermentation Technology. P.F. Stanbury and A. Whitaker, Elsevier; 2nd Edition, 2008

Reference Books:

1. Microbiology: Principles and Explorations, Jacquelyn G. Black and Laura J. Black, 8th Edition, John Wiley & Sons, 2012
2. Outlines of Biochemistry. Eric E Conn, P.K. Stumpf, George Bruening, Roy H. Doi, Wiley; 5th Edition, 2006
3. Handbook of Fermented Functional Foods. Edward R.(Ted) Farnworth, CRC Press, 2nd Edition, 2008
4. Enzyme Technology. S. Shanmugam, T. Sathishkumar and M. Shanmugaprakash, I K International Publishing House Pvt. Ltd., 2nd Edition, 2012
5. Enzymes in Food Processing: Fundamentals and Potential Applications. Parmjit S. Panesar, Satwinder S. Marwaha and Harish Kumar, I K International Publishing House, 1st Edition, 2009

Professional Elective-2			
M.Tech. Food Technology **[As per Outcome Based Education (OBE) &Choice Based Credit System (CBCS) scheme]** **LIVESTOCK, FISH AND MARINE PRODUCTS PROCESSING** **Semester: II**			
Subject Code	**18FDT253**	CIE Marks	40
Number of Lecture Hours Per Week	04	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03
CREDITS - 04			

Course Learning Objectives:

1. To learn processing of livestock, fish and marine products
2. To apply the technical knowledge to address practical problems during the processing of livestock, fish and marine products
3. To analyse abattoir design and layout for safe meat processing
4. To learn how to evaluate quality of meat

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module 1: Production, Economics, and processing scenario of meat, fish and poultry. Preservation of meat- dehydration, freezing, pickling, curing, cooking and smoking; preservation of meat using ionizing radiation; preservation of meats using- antibiotics and chemical preservatives.	10	L1, L2, L3
Module 2: Eating quality of meat and discoloration; water-holding capacity and juiciness in cooked and uncooked meat; texture and tenderness- definition and measurement, factors affecting texture and tenderness, artificial tenderizing.	10	L3, L4
Module 3: Abattoir design and layout, meat plant sanitation and safety, by-products utilization. Processing and preservation of eggs, production of egg yolk and egg yellow powder. Poultry processing.	10	L3, L4, L5, L6
Module 4: Unit operations for various poultry products; Fish processing: Unit operations for various fish products.	10	L3, L4, L4, L6
Module 5: Different sea food resources and their postharvest quality changes; bulk handling and chilling; quick freezing; cook-chill processing; modified-atmosphere packaging; retort pouch packaging.	10	L1, L2, L3, L4

Course Outcomes: Student will

1. Learn processing of livestock, fish and marine products.

2. Apply his understanding to address practical problems during the processing of livestock, fish and marine products.
3. Analyze abattoir design and layout for safe meat processing.
4. Learn how to evaluate quality of meat.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionally reduced to 60.

- The question paper will have 10 full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be 2 full questions (with maximum of 4 sub questions) from each module.
- Each full question will have sub question/s covering all the topics under a module.
- The student will have to answer 5 full questions, selecting 1 full question from each module.

Textbooks:

1. Lawrie's Meat Science. Fidel Toldra, Woodhead Publishing, 8th Edition, 2007
2. Egg Science and Technology. W.J. Stadelmen and O.J. Cotterill, CRC Press, 4th Edition, 1995
3. Muscle as Food. P.J. Bechtel, Academic Press, 1st Edition, 1986

Reference Books:

1. Meat Handbook. A. Lavie, AVI, Westport, 4th Edition, 1980
2. Food Science. Norman N. Potter and Joseph H. Hotchkiss, S. Chand Publication, 5th Edition, 2007
3. Handbook of Meat Processing. Ed. Fidel Toldrá, Blackwell Publishing, 1st Edition, 2010
4. Meat Products Handbook. G Feiner, Woodhead Publishing, 1st Edition, 2006
5. Marine and Freshwater Products Handbook, Roy E. Martin, Emily Paine Carter, George J. Flick, Jr., Lynn M. Davis, CRC Press, 1st Edition, 2000

Professional Elective-2

M.Tech. Food Technology

[As per Outcome Based Education (OBE) & Choice Based Credit System (CBCS) scheme]

FOOD INDUSTRY BYPRODUCT AND WASTE MANAGEMENT

Semester: II

Subject Code	**18FDT254**	CIE Marks	40
Number of Lecture Hours Per Week	04	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS - 04

Course Learning Objectives:

1. To apply technical knowledge for the management of different food industry wastes
2. To understand laws and regulations for waste management in food industries
3. To evaluate different waste treatment methods for selecting appropriate one
4. To analyze and evaluate different waste water treatment methods for zero-discharge

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module 1: Byproducts I Various byproducts from Food Processing Industry: By products of cereals, legumes, oil seeds, dairy, fruit and vegetables processing industries and their uses.	10	L1, L2, L3
Module 2: Byproducts II By products of meat and fish processing units and their uses. Uses of byproducts of agro based industries in various sectors.	10	L1, L2, L3
Module 3: Various laws and regulations for waste management in food processing industries.	10	L3, L4, L5
Module 4: Food industry wastes, Waste treatment methods for Cereals, Fruits, vegetables, Meat, Fish, Dairy processing and Brewery Industries.	10	L3, L4, L5,L6
Module 5: Waste water treatment-Preliminary treatment, primary, secondary, advanced and final treatment; zero-discharge and zero-emission system.	10	L3, L4, L5

Course Outcomes: Student will

1. Apply his understanding for the management of different food industry wastes.
2. Understand laws and regulations for waste management in food industries.
3. Evaluate different waste treatment methods for selecting appropriate one.
4. Analyze and evaluate different waste water treatment methods for zero-discharge.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionally reduced to 60.

- The question paper will have 10 full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be 2 full questions (with maximum of 4 sub questions) from each module.
- Each full question will have sub question/s covering all the topics under a module.
- The student will have to answer 5 full questions, selecting 1 full question from each module.

Textbooks:

1. Handbook of Waste Management and Co-Product Recovery in Food Processing. K. Waldron, Woodhead Publishing Limited, 1st Edition, 2007
2. Waste Management for the Food Industries. I.S. Arvanitoyannis, Academic Press, 2008

Reference Books:

1. Utilization of By-Products and Treatment of Waste in the Food Industry. Vasso Oreopoulou and Winfried Russ, Springer US, 1st Edition, 2007
2. Food Science. Norman N. Potter and Joseph H. Hotchkiss, S. Chand Publication, 5th Edition, 2007
3. Food Processing By-Products and their Utilization, Ed. Anil K Anal, Willey Publication, 1st Edition, 2017
4. Waste Management for the Food Industries. Ed. Ioannis S. Arvanitoyannis, Academic Press, 1st Edition, 2008
5. Handbook of waste management and co-product recovery in food processing. Ed. Keith Waldron, Woodhead Publication Limited, 1st Edition, 2007

Professional Core

M.Tech. Food Technology

[As per Outcome Based Education (OBE) & Choice Based Credit System (CBCS) scheme]

FOOD ANALYSIS AND QUALITY CONTROL LABORATORY

Semester: II

Subject Code	**18FDTL26**	CIE Marks	40
Number of Practical/Field work Hours/Week	04	SEE Marks	60
Total Number of Practical/Field work Hours	52	Exam Hours	03

CREDITS – 02

Course Learning Objectives:

1. To analyze different food samples for quality
2. To evaluate food samples for quality
3. To evaluate food samples for chemical and microbial safety
4. To analyze the data for the acceptability of food samples

Experiments

1. Sensory evaluation of fruit juice and analysis of data by fuzzy logic and a method based on simple mathematical calculations (SMC)
2. Determination of protein and sugar concentration in food samples
3. Qualitative analysis of oils and fats
4. Determination of microbial counts in milk samples
5. Analysis of milk for quality
6. Analysis of milk for detection of adulterants
7. Determination of BAR (Brix acid ratio) in beverages
8. Evaluation of food labels of products for PFA standards
9. Identification of food additives by using FTIR or GC or HPLC
10. Verification of packaging material by FTIR method

Revised Bloom's Taxonomy (RBT) Level: L3,L4,L5,L6

Course Outcomes: Student will

1. Analyze different food samples for quality.
2. Evaluate food samples for quality.
3. Evaluate food samples for chemical and microbial safety.
4. Analyze the data for the acceptability of food samples.

Question paper pattern:

The SEE question paper shall be for 100 marks. The marks scored by the candidate will be proportionately reduced to 60.

Textbooks:

1. Pearson's Composition and Analysis of Foods. Ronald S. Kirk and Ronald Sawyer, Addison-Wesley Longman Ltd, 1991

2. Quality Control for Food Industry. A Krammer, Vol. I and II, Avi Pub. Co., 3rd Edition, 1970

3. Food Quality Control. Manoranjan Kalia, Agrotech Publishing Academy, 2010

Reference Book:

1.Handbook of Analysis and Quality Control of fruits & Vegetables Products. S Ranganna, Tata Mc Grow Hill Publications, 2nd Edition, 1986

Professional Core

M. Tech. Food Technology
[As per Outcome Based Education (OBE) & Choice Based Credit System (CBCS) scheme]
FOOD LAWS, REGULATIONS AND CERTIFICATIONS
Semester: III

Subject Code	**18FDT31**	CIE Marks	40
Number of Lecture Hours Per Week	04	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03
CREDITS -04			

Course Learning Objectives:

1. To understand implications of various food laws, regulations and certifications
2. To apply food laws and regulations for smooth running of food industries
3. To learn how to do hazard analysis and evaluate the crtical control points for food production process
4. To appreciate and apply the FSSAI guidelines for food products and process

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module 1: Food Adulteration, Food Safety Management System. Mandatory and voluntary food laws.	10	L1, L2
Module 2: Various laws, regulations and Certifications for food processing, Essential Commodity Act, Prevention of Food Adulteration Act (PFA), Fruit Products Order (FPO).	10	L2,L3
Module 3: Meat Food Products Order (MFPO), Vegetable Oil Control Order, Agricultural Marketing and Grading Standards (AGMARK).	10	L2, L3
Module 4: Bureau of Indian Standards (BIS) and their certifications, Food Safety and Standards Authority of India (FSSAI), Food Safety and Standards Act and Regulations of India.	10	L3,L4

Module 5: Food Codex laws, Food and Drug Administration (FDA), International Organization for Standardization (ISO), Good Manufacturing Practices (GMP), Good Agricultural Practices (GAP), Hazard Analysis and Critical Control Point (HACCP).	10	L3,L4,L5,L6

Course Outcomes: Student will

1. Understand implications of various food laws, regulations and certifications.
2. Apply his understanding for smooth running of food industries.
3. Learn how to do hazard analysis and evaluate the critical control points for food production process.
4. Appreciate and apply the FSSAI guidelines for food products and process.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionally reduced to 60.

- The question paper will have 10 full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be 2 full questions (with maximum of 4 sub questions) from each module.
- Each full question will have sub question/s covering all the topics under a module.
- The student will have to answer 5 full questions, selecting 1 full question from each module.

Textbooks:

1. Food Regulation: Law, Science, Policy and Practice, N.D. Fortin, Wiley Publication, 2nd Edition, 2016
2. A Practical Guide to Food Laws and Regulations. Kiron Prabhakar, Bloomsbury Professional India, 1st Edition, 2016

Reference Books:

1. Food Safety and Standards Act and Regulations, Food Safety and Standards Authority of India, Ministry of Health and Family Welfare, Government of India, 2006
2. A Practical Guide to Food Laws and Regulations. Kiron Prabhakar, Bloomsbury India, 2016
3. International Food Law and Policy. Gabriela Steier and Kiran Patel, Springer International Publishing, 1st Edition, 2016
4. Food Science. Norman N. Potter and Joseph H. Hotchkiss, S. Chand Publication, 5th Edition, 2007
5. Food Safety Implementation: from Farm to Fork. Ed. Puja Dudeja, Amarjeet Singh, Sukhpal Kaur, CBS Publication, 1st Edition, 2016

Professional Elective-3

M.Tech. Food Technology

[As per Outcome Based Education (OBE) & Choice Based Credit System (CBCS) scheme]

PLANTATION PRODUCTS AND SPICES TECHNOLOGY

Semester: III

Subject Code	**18FDT321**	CIE Marks	40
Number of Lecture Hours/Week	04	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS - 04

Course Learning Objectives:

1. To provide a systematic understanding about different spices and their importance
2. To understand different methods of processing of spices & plantation crops
3. To evaluate the properties of spices & plantation crops for various applications
4. To analyze and apply technical knowledge for developing improvised products of plantation crops

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module 1: Introduction Classification, composition, structure and characteristics. Production status of spices in India: major spice producing area in India and worldwide, export potential of processed and raw spice product.	10	L1, L2
Module 2: Spice and Dry Fruit Processing Processing of major and minor spices: Preservation and processing of major and minor spices of India; Processing of whole spice, spice powder, paste and extracts; production and processing of spice mixtures; spice oils and oleoresins, functional role of spices, quality specification for spices Composition, Structure, characteristics & processing of cashew nut and other dry fruits.	10	L3,L4
Module 3: Tea Processing Composition and production of tea leaves; processing of tea leaves; CTC tea, black tea, green tea and Oolong tea, grading and packaging; processing of instant tea.	10	L3,L4,L5,L6
Module 4: Coffee Processing Production and processing of coffee cherries by wet and dry method; processing technology for coffee; preparation of brew; processing technology for instant coffee and decaffeinated coffee.	10	L3, L4, L5,L6
Module 5: Cocoa processing Cocoa bean-introduction, history and composition; processing of cocoa bean; processed products of cocoa.	10	L3,L4

Course Outcomes: Student will

1. Demonstrate a systematic understanding about different spices and their importance.
2. Able to understand methods of processing of different spices & plantation crops.
3. Evaluate the properties of spices & plantation crops for various applications.
4. Analyze and apply his understanding for developing improvised products of plantation crops.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionally reduced to 60.

- The question paper will have 10 full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be 2 full questions (with maximum of 4 sub questions) from each module.
- Each full question will have sub question/s covering all the topics under a module.
- The student will have to answer 5 full questions, selecting 1 full question from each module.

Textbooks:

1. Major spices of India: Crop Management and Post-Harvest Technology. J S Pruthi, Indian Council of Agricultural Research, 1993
2. Coffee Processing Technology. M. Sivetz and H.E. Foote, The AVI Publishing, Co., 1963
3. Production Technology of Spices and Plantation Crops. Swati Barche, New India Publishing Agency, 2016

Reference Books:

1. Modern Production Technology of Plantation Medicinal Aromatic & Spices Crops. Gs Saini, Aman Publishing House, 2011
2. Chemistry and Applications of Green Tea. Takehiko Yamamoto, Lekh Raj Juneja, Djong-Chi Chu, Mujo Kim, CRC Press, 1997
3. Food Science. Norman N. Potter and Joseph H. Hotchkiss, S. Chand Publication, 5th Edition, 2007
4. Handbook on Manufacture of Indian Kitchen Spices (Masala Powder) with Formulations, Processes and Machinery, NIIR Project Consultancy Services; 3rd Edition, 2019
5. Handbook on Spices and Condiments (Cultivation, Processing and Extraction). H. Panda, National Institute of Industrial Research, 2010

Professional Elective-3

M. Tech. Food Technology
[As per Outcome Based Education (OBE) & Choice Based Credit System (CBCS) scheme]
WATER AND BEVERAGE TECHNOLOGY
Semester: III

Subject Code	**18FDT322**	CIE Marks	40
Number of Lecture Hours Per Week	04	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS-04

Course Learning Objectives:

1. To gain technical insights about beverage and water processing
2. To apply technical knowledge to develop new beverage formulations
3. To learn how to evaluate quality of beverages
4. To learn how to analyze quality standards of bottled water

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module 1: **Introduction** Types of beverages and their importance; status of beverage industry in India; Manufacturing technology for juice-based beverages; synthetic beverages.	10	L1, L2
Module 2: **Beverages** Ingredients for beverage preparations, role of various ingredients of soft drinks, carbonation of soft drinks. Technology of still, carbonated, low-calorie and dry beverages; isotonic and sports drinks Specialty beverages based on tea, coffee, cocoa, spices, plant extracts, herbs, nuts, dairy and limitation of dairy-based beverages.	10	L3,L4
Module 3: **Alcoholic beverages** Brewing technology; Alcoholic beverages- types- fermented beverages (beer and wines) & distilled beverages (Cane sugar, sugar beet, honey, fruit, grain based, herbal, plant, seed, tree, vegetable distillations & complex/multiple distillations), manufacture and quality evaluation; the role of yeast in beer and other alcoholic beverages, ale type beer, lager type beer, equipment used for brewing and distillation.	10	L3, L4,L5,L6

Module 4: **Water** Water chemistry, water activity, water purification treatment, Impurities in water and its analysis.	10	L3,L4
Module 5: **Water – Packaging and quality** Packaged drinking water- definition, types, manufacturing processes, quality evaluation and raw and processed water, methods of water treatment, BIS quality standards of bottled water; mineral water, natural spring water, flavoured water, carbonated water.	10	L3, L4,L5,L6

Course Outcomes: Student will

1. Gain technical insights about beverage and water processing.
2. Apply technical knowledge to develop new beverage formulations.
3. Evaluate quality of beverages.
4. Analyse quality standards of bottled water.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionally reduced to 60.

- The question paper will have 10 full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be 2 full questions (with maximum of 4 sub questions) from each module.
- Each full question will have sub question/s covering all the topics under a module.
- The student will have to answer 5 full questions, selecting 1 full question from each module.

Textbooks:

1. Handbook of Brewing. Willliam A. Hardwick, Marcel Dekker, Inc., 1995
2. Handbook of Food and Beverage Fermentation Technology. Y. H. Hui, Lisbeth Meunier-Goddik, Jytte Josephsen, Wai-Kit Nip, Peggy S. Stanfield, CRC Press, 2004
3. Handbook of Brewing. Graham G. Stewart, Fergus G. Priest, CRC Press, 2006
4. Beverages: Carbonated and Non-Carbonated. Jasper Guy Woodroof and G. Frank Phillips, AGRIS, 1981

Reference Books:

1. Commercial Wine Making - Processing and Controls. Vine, Richard, Springer, 1981
2. Beverages: Technology, Chemistry and Microbiology. A.Varnam and J.M. Sutherland, Springer, 1994
3. Water Technology: An Introduction for Environmental Scientists and Engineers. N.F. Gray, Butterworth-Heinemann Publication, 3rd Edition, 2010
4. Water Treatment Plant Design. The American Water Works Association (AWWA), The American Society of Civil Engineers (ASCE), 5th Edition, 2012
5. Innovative Technologies in Beverage Processing. Ed: Ingrid Aguiló-Aguayo Lucía Plaza, Willey Publication, 1st Edition, 2017

Professional Elective-3

M. Tech. Food Technology
[As per Outcome Based Education (OBE) & Choice Based Credit System (CBCS) scheme]
PROCESS CONTROL AND INSTRUMENTATION IN FOOD INDUSTRY
Semester: III

Subject Code	**18FDT323**	CIE Marks	40
Number of Lecture Hours Per Week	04	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03
CREDITS -04			

Course Learning Objectives:

1. To understand instrumentation in food industry
2. To judge about instruments required for analysis of foods
3. To learn to control instruments required for food analysis
4. To apply technical knowledge about instrumentation to develop protocols

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module 1: Instruments for temperature, pressure, humidity measurements - types, calibration. Pressure gauge, basic concept of pneumatic pressure transmitter, pressure current and pressure resistance transducers.	10	L1, L2, L3,L4
Module 2: Positive displacement meter, Weight measurement-mechanical scale, electronic tank scale, conveyor scale, measurement of specific gravity, measurement of humidity, measurement of viscosity, measurement of density, automatic valves. Definition of process control, simple system analysis, dynamic behavior of simple process, Laplace transform.	10	L3,L4
Module 3: Ionization techniques, scanning technique, application of GC/MS, LC/MS and Linked scan techniques. Basic principles of chromatography. Paper chromatography, thin layer chromatography, HPLC (High performance liquid chromatography), Gas chromatography, Application in food analysis.	10	L3, L4, L5, L6
Module 4: Introduction and principles of Spectrophotometry and Atomic	10	L3, L4, L5, L6

absorption spectroscopy. Electromagnetic spectrum – The NMR Phenomenon – Types of information provided by NMR spectra, application of NMR to Food analysis.		
Module 5: Operating procedures and analysis of foods: FTIR, XRF, Differential Scanning Calorimeter, XRD, SEM, TEM, water activity, textural analyzer, e–sensors, biosensors, Nitrogen analyzers.	10	L3, L4, L5, L6

Course Outcomes: Student will

1. Understand instrumentation in food industry.
2. Judge about instruments required for analysis of foods.
3. Learn to control instruments required for food analysis.
4. Apply his understanding of instrumentation to develop protocols.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionally reduced to 60.

- The question paper will have 10 full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be 2 full questions (with maximum of 4 sub questions) from each module.
- Each full question will have sub question/s covering all the topics under a module.
- The student will have to answer 5 full questions, selecting 1 full question from each module.

Textbooks:

1. The Chemical Analysis of Foods. David Pearson, Chemical Publishing Co.,7th Edition, 1976
2. Introduction to Analytical Chemistry: Instrumental methods of chemical analysis. B.K Sharma, Goel Publishing House, 23rd Edition, 2004
3. Process System Analysis and Control. Donald R Coughanowr and Steven E. LeBlanc, Mc-Graw Hill's, 3rd Edition, 2009
4. Principles of Industrial Instrumentation. D. Patranabis, Tata Mc-Graw Hill, 1976
5. Transducers and Instrumentation. D.V.S. Murty, Prentice Hall India, 2nd Edition, 2008
6. Process Control Instrumentation Technology. Curtis D.Johnson , Prentice Hall India, 8th Edition, 2006

Reference Books:

1. Food Processing Handbook. James G. Brennan and Alistair S. Grandison, Wiley-VCH Verlag GmbH & Co. KGaA, 2011
2. Manual for Plant Operators. Anon, Milk Industry Foundation, 1957
3. Introduction to Process Control. Jose A. Romagnoli, Ahmet Palazoglu, CRC Press, 2nd Edition, 2012
4. Principles of Process Control. D Patranabis, McGraw Hill Publication, 3rd Edition,

2017
5. Outlines of Chemical Instrumentation and Process Control. Alapati Suryanarayana, Khanna Publishers, 3rd Edition, 2008

Professional Elective-3

M.Tech. Food Technology

[As per Outcome Based Education (OBE) & Choice Based Credit System (CBCS) scheme]

AGRICULTURAL BIOTECHNOLOGY

Semester: III

Subject Code	**18FDT324**	CIE Marks	40
Number of Lecture Hours/Week	04	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS - 04

Course Learning Objectives:

1. To appreciate and understand the applications of biotechnology in agriculture
2. To analyze the different biotechnologies for the sustainable agricultural development
3. To evaluate different biotechnologies for the development of improved agricultural products
4. To understand how biotechnologies improved agricultural productivity

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module 1: Introduction Staple food, fiber, fuel and fruit crops of India and abroad, Agro-climatic zones and cropping pattern of India. Conventional crop improvement programs- Introduction, Selection and Hybridization, Mutation, Haploidy and Polyploidy Breeding. Modern agriculture biotechnology for foodsecurity and national economy. Green-revolution.	10	L1, L2,L3
Module 2: Applications of plant transformation technology: Productivity and performance, disease resistance, genes and gene constructs used for viral resistance by coat protein mediated production, bacterial resistance by lysozyme gene and fungal resistance by chitinase and beta glucanase genes. Agrobacterium mediated tranformation. Crop improvement to resist adverse soil conditions. Salinity tolerance, drought resistance. Herbicide resistance in commercially important plants. Insecticide resistance through BT-gene.Integrated pest management. current status of BT crops in the world. Effect of transgenic crops on environment.	10	L3,L4,L5
Module 3: plant cell culture: Explant selection, sterilization and inoculation; Various media preparations; MS, B5, SH PC L-2; Callus and cell suspension culture; plant regeneration-organogenesis, somatic embryogenesis; somaclonal variation, its genetic basis and application in crop improvement. Role of tissue culture in rapid clonal propagation, production of pathogen free plants and "synthetic seeds"; haploid	10	L3,L4

production: advantages and methods. Protoplast technology.		
Module 4: Antisense rna technology(ACC synthase gene and polygalacturonase): Delay of softening and ripening of fleshy fruits by antisense RNA for ACC synthase gene in tomato and banana. Use of antisense RNA technology for extending shelf life of fruits and flowers. Protection of cereals, millets and pulses following harvest using biotechnology. **Biotechnology for fortification of agricultural products**-Golden rice, transgenic sweet potatoes. **Importance of biofertlilizers in agriculture**:(Rhizobium azatobacter, Mycorrhiza, Frankia and Blue green algae) current practices and production of biofertilizers.	10	L3, L4, L5,L6
Module 5: An overview of legal and socioeconomic impact of biotechnology: Biotechnology & hunger. Ethical issues associated with labeling and consumption of GM foods. Public perception of GM technology. Biosafety management. Cartagena protocol on biosafety. Ethical implication of BT products, public education, Biosafety regulations, experimental protocol approvals,guidelines for research, environmental aspects of BT applications.	10	L3,L4

Course Outcomes: Student will

1. Appreciate and understand the applications of biotechnology in agriculture.
2. Analyze the different biotechnologies for the sustainable agricultural development.
3. Evaluate different biotechnologies for the development of improved agricultural products.
4. Understand how biotechnologies improved agricultural productivity.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionally reduced to 60.

- The question paper will have 10 full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be 2 full questions (with maximum of 4 sub questions) from each module.
- Each full question will have sub question/s covering all the topics under a module.
- The student will have to answer 5 full questions, selecting 1 full question from each module.

Textbooks:

1. Biotechnology- Expanding Horizons. B.D. Singh, Kalyani Publishers, 4th Edition, 2012
2. Plant Tissue Culture: Theory and Practice. S.S. Bhojwani and M.K. Razdan, Elsevier Science, 1996

Reference Books:

1. Plant biotechnology in Agriculture. K. Lindsey and M.G.K. Jones, Prentice Hall, 1990
2. Crop Biotechnology. K. Rajashekaran, T.J. Jacks and J.W. Finley, American Chemical Society, 1st Edition, 2002
3. Textbook of Agricultural Biotechnology. Ahindra Nag, PHI learning publication, 1st Edition, 2008

4. Plant Biotechnology and Agriculture- Prospects for the 21st Century. Arie Altman and Paul Hasegawa, Academic Press, 1st Edition, 2011
5. Agricultural Biotechnology in Developing Countries: Towards Optimizing the Benefits for the Poor. Ed: Matin Qaim, Anatole F. Krattiger, Joachim von Braun, Springer, 1st Edition, 2000

Professional Elective-4

M.Tech. Food Technology

[As per Outcome Based Education (OBE) & Choice Based Credit System (CBCS) scheme]

FOOD BUSINESS MANAGEMENT AND ENTREPRENEURSHIP DEVELOPMENT

Semester: III

Subject Code	**18FDT331**	CIE Marks	40
Number of Lecture Hours/Week	04	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS- 04

Course Learning Objectives:

1. To understand how to analyze food project cost and techno-economic viability
2. To learn how to evaluate and manage food business
3. To learn how to do food market assessment
4. To learn how to become food business entrepreneur

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module 1: Introduction and definitions related with project management and entrepreneurship; Fundamentals of project management and entrepreneurship development.	10	L1, L2
Module 2: Project formulation: market survey techniques, project identification, project selection, project proposal, work breakdown structure.	10	L3, L4
Module 3: Network scheduling: activity, networks, use of CPM, PERT in project scheduling. Resource planning, resource allocation, project scheduling with limited resources.	10	L3, L4
Module 4: Estimation of project costs, earned value analysis, project techno-economic viability, break-even analysis. Identification of business opportunity in food processing sector. Government policies for promotion of entrepreneurship in food processing.	10	L3, L4,L5
Module 5: Launching and organizing an enterprise, enterprise selection, market assessment, feasibility study, SWOT analysis, resource mobilization. Financial institution in promoting entrepreneurship; Supply chain management.	10	L3, L4,L5,L6

Course Outcomes: Student will

1. Understand how to analyze food project cost and techno-economic viability.
2. Learn how to evaluate and manage food business.
3. Learn how to do food market assessment.

4. Learn how to become food business entrepreneur.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionally reduced to 60.

- The question paper will have 10 full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be 2 full questions (with maximum of 4 sub questions) from each module.
- Each full question will have sub question/s covering all the topics under a module.
- The student will have to answer 5 full questions, selecting 1 full question from each module.

Textbooks:

1. Management in Engineering: Principles and Practice. Gail Freeman-Bell and James Balkwill, Prentice Hall, 1993
2. Economics and Management of the Food Industry. Jeffrey H. Dorfman, Routledge, 1st Edition, 2013

Reference Books:

1. Food Industry: Food Processing and Management. Lisa Jordan, Callisto Reference, 2015
2. Food and Beverage Management. Partho Pratim Seal, Oxford University Press; 1st Edition, 2017
3. Operations Research: An Introduction. Hamdy A. Taha, Pearson Publication, 9th Edition, 2010
4. Project Management. K. Nagarajan, New Age International Pvt Ltd; 8th Edition, 2017
5. Fundamentals of Entrepreneurship. Nandan H., Prentice Hall India Learning Private Limited; 3rd Edition, 2013

Professional Elective-4

M.Tech. Food Technology

[As per Outcome Based Education (OBE) & Choice Based Credit System (CBCS) scheme]

BIOSAFETY AND BIOETHICS

Semester: III

Subject Code	**18FDT332**	CIE Marks	40
Number of Lecture Hours/Week	04	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS - 04

Course Learning Objectives:

1. To learn and apply the principles of biosafety and good laboratory practices
2. To understand the legal issues & bioethics
3. To learn to apply the biosafety regulations in biotech practices
4. To analyze and evaluate the environmental aspects of recombinant organisms and transgenic crops

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module 1: Biotechnology and society: Introduction to science, technology and society, issues of access-Case studies/experiences from developing and developed countries. Ownership, monopoly, traditional knowledge, biodiversity, benefit sharing, environmental sustainability, public vs. private funding, biotechnology in international relations, globalization and development divide. Public acceptance issues for biotechnology, Biotechnology and hunger, Challenges for the Indian Biotechnological research and industries.	10	L1, L2,L3
Module 2: Legal issues & bioethics: Legal, institutional and socioeconomic impacts of biotechnology; biotechnology and social responsibility, Public education to increase the awareness of bioethics with regard to generating new forms of life for informed decision making – with case studies. Principles of bioethics: Legality, morality and ethics, autonomy, human rights, beneficence, privacy, justice, equity etc. The expanding scope of ethics from biomedical practice to biotechnology, bioethics vs. business ethics, ethical dimensions of IPR,technology transfer and other global biotech issues.	10	L3,L4
Module 3: Biosafety concepts: Ethical conflicts in biotechnology - interference with nature, fear of unknown, unequal distribution of risks and benefits of biotechnology, Rational vs. subjective perceptions of risks and benefits, relationship among risk,hazard, exposure and safeguards, Biotechnology and biosafety concerns at the level of individuals, institutions, society, region, country and the	10	L3,L4

world. The Cartagena protocol on biosafety. Biosafety management. Ethical implications of biotechnological products and techniques. Laboratory associated infections and other hazards, assessment of biological hazards and levels of biosafety, prudent biosafety practices in the laboratory/ institution. Experimental protocol approvals, levels of containment.		
Module 4: Regulations: Biosafety assessment procedures in India and abroad. International dimensions in biosafety, bioterrorism and convention on biological weapons. Social and ethical implications of biological weapons. Biosafety regulations and national and international guidelines with regard to recombinant DNA technology. Guidelines for research in transgenic plants. Good manufacturing practice and Good lab practices (GMP and GLP). National and international regulations for food and pharma products.	10	L3, L4,L5
Module 5: Other sectors: The GM-food debate and biosafety assessment procedures for biotech foods & related products, including transgenic food crops, case studies of relevance. Key to the environmentally responsible use of biotechnology. Environmental aspects of biotech applications. Use of genetically modified organisms and their release in environment. Discussions on recombinant organisms and transgenic crops, with case studies of relevance. Plant breeder's rights. Legal implications, Biodiversity and farmers' rights. Biosafety assessment of pharmaceutical products such as drugs/vaccines etc. Biosafety issues in clinical trials.	10	L3,L4,L5,L6

Course Outcomes: Student will

1. Learn and apply the principles of biosafety and good laboratory practices.
2. Understand the legal issues & bioethics.
3. Learn to apply the biosafety regulations in biotech practices.
4. Analyze and evaluate the environmental aspects of recombinant organisms and transgenic crops.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionally reduced to 60.

- The question paper will have 10 full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be 2 full questions (with maximum of 4 sub questions) from each module.
- Each full question will have sub question/s covering all the topics under a module.
- The student will have to answer 5 full questions, selecting 1 full question from each module.

Textbooks:

1. Biotechnology and Safety Assessment. John A. Thomas and Roy L. Fuchs, Academic Press, 3rd Edition, 2002
2. Biological safety Principles and practices. D.O. Fleming and D.L. Hunt, ASM Press, 3rd Edition, 2000

3. Biotechnology: A Multi-Volume Comprehensive Treatise Legal Economic and Ethical Dimensions. H.J.Rehm and G. Reed, Vch Verlagsgesellschaft Mbh, 1995
4. Bioethics: An Introduction for the Biosciences. Ben Mepham, Oxford University Press, 2nd Edition, 2008
5. Bioethics & Biosafety. R. Rallapalli & Geetha Bali, APH Publication, 2007

Reference Books:

1. Bioethics & Biosafety. M.K. Sateesh, I. K. International, 2008
2. Biotechnologies and Development. Albert Sasson, UNESCO Publications, 1988
3. Biotechnologies in Developing Countries: Present and Future Regional and Sub-regional Co-operation and Joint Ventures. Albert Sasson, UNESCO Publishing, 1993
4. Biotechnology and Intellectual Property Rights: Legal and Social Implications. Kshitij Kumar Singh, Springer, 2015
5. WTO and International Trade. M.B. Rao and Manjula Guru, Vikas Publishing House Pvt. Ltd., 2nd Edition, 2003
6. Intellectual Property Rights in Agricultural Biotechnology. F.H. Erbisch and K.M. Maredia, CAB International, 2nd Edition, 2004
7. Biological Warfare in the 21st Century: Biotechnology and the Proliferation of Biological Weapons. Malcolm Dando, Potomac Books Inc, 1st Edition, 1994
8. A Framework for Biosafety Implementation: Report of a Meeting. M.A Mclean, R.J. Frederick, P.L. Traynor, J.I. Cohen, and J. Komen, International Service for National Agricultural Research, 2003

Professional Elective-4

M. Tech. Food Technology
[As per Outcome Based Education (OBE) & Choice Based Credit System (CBCS) scheme]
BIOCHEMISTRY AND HUMAN NUTRITION
Semester: III

Subject Code	**18FDT333**	CIE Marks	40
Number of Lecture Hours Per Week	04	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03
CREDITS -04			

Course Learning Objectives:

1. To understand biochemical and nutritional aspects of foods
2. To apply biochemical and nutritional knowledge to overcome malnutrition
3. To analyze and learn how to restore deficient nutrients by fortification and supplementation
4. To evaluate and correlate the ill-effects of deficiency of different micro nutrients

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module 1: **Introduction to nutrition** Nutrition, malnutrition, functions of food, basic food groups, nutritional needs, requirements and recommended allowances of foods.	10	L1, L2
Module 2: **Enzymology** Mechanism of enzyme action, coenzymes, enzyme kinetics, Derivation of Michaelis-Menten Equation.	10	L2, L3
Module 3: **Metabolism** Sources, functions, digestion, absorption, assimilation and transport of carbohydrates, proteins and fats in human beings. Metabolism of carbohydrates: Respiration, Metabolism of lipids, Metabolism of proteins.	10	L3,L4
Module 4: Functions, sources, factors affecting absorption of minerals, absorption promoters and inhibitors, effect of deficiency of Calcium, phosphorus, iron, zinc, iodine, fluorine and copper. Vitamins and hormones.	10	L3,L4

Module 5: **Nutritional deficiency and food processing** Classification, functions, sources, effects of deficiency. Changes during food processing operations, restoration, enrichment, fortification and supplementation of foods.	10	L3,L4, L5,L6

Course Outcomes: Student will

1. Have better understanding about biochemical and nutritional aspects of foods.
2. Apply his understanding to overcome malnutrition.
3. Analyze and learn how to restore deficient nutrients by fortification and supplementation.
4. Evaluate and correlate the ill-effects of deficiency of different micro nutrients.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionally reduced to 60.

- The question paper will have 10 full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be 2 full questions (with maximum of 4 sub questions) from each module.
- Each full question will have sub question/s covering all the topics under a module.
- The student will have to answer 5 full questions, selecting 1 full question from each module.

Textbooks:

1. Principles of Biochemistry, A.L. Lehninger, D.L. Nelson and M.M. Cox, W. H. Freeman, 4th Edition, 1993
2. Textbook of Biochemistry. E. S. West, W. R. Todd, H. S. Mason, and J. T. Van Bruggen, MacMillan, 4th Edition, 1966
3. Nutrition and Dietetics. Shubhangini A. Joshi, Tata Mc Grow- Hill publishing Company Ltd, 1992
4. General Biochemistry. J.H. Weil, New Age International, 6th Edition, 2005
5. Biochemistry of Foods. N.A.M Eskin, Academic Press, 1st Edition, 1971
6. Food Chemistry. O.R. Fennema, Marcel Dekkar Inc, 3rd Edition, 1996

Reference Books:

1. Essentials of Food and Nutrition. M. S. Swaminathan, Ganesh and Co, 1st Edition, 1974
2. Outlines of Biochemistry. Eric E. Conn and P.K. Stumpf, John Wiley and Sons, 3rd Edition, 1972
3. Fundamentals of Biochemistry. J L Jain, Sunjay Jain and Nitin Jain, S. Chand Publication; 7th Edition, 2016
4. Biochemistry. U Satyanarayana and U. Chakrapani, Elsevier; 5th Edition, 2017
5. Textbook of Nutrition and Dietetics. Kumud Khanna, Sharda Gupta, Santosh Jain Passi, Rama Seth, Ranjana Mahna and Seema Puri, Elite Publishing House Pvt. Ltd., 2nd Edition, 2016

Professional Elective-4

M.Tech. Food Technology

[As per Outcome Based Education (OBE) & Choice Based Credit System (CBCS) scheme]

FOOD SEPARATION ENGINEERING

Semester: III

Subject Code	**18FDT334**	CIE Marks	40
Number of Lecture Hours/Week	04	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS - 04

Course Learning Objectives:

1. To learn to apply separation technologies for solving problems during food processing
2. To learn to evaluate the suitability of super critical fluid **(**SCF) extraction for foods
3. To analyze and apply the membrane technology in food industry
4. To analyze and apply the powder technology in food processing

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module 1: Introduction Introduction to various separation processes; Gas-Liquid, Gas-Solid, Liquid-Liquid, Liquid-Solid separation.	10	L1, L2
Module 2: Phase Equlibrium Concept of phase equilibrium; Impingement separator; Electrostatic precipitation; Distillation-Application of distillation in food processing.	10	L2,L3
Module 3: Membrane separation technology Introduction to microfiltration, ultra-filtration, nano-filtration, reverse osmosis, electro dialysis; Physical characteristics of membrane separation; Factor affecting reverse osmosis process; Concentration of polarization; Design of reverse osmosis and ultra-filtration system; Operation layout of the modules; Electrodialysis; Pervaporization; Fabrication of membrane; Application of membrane technology in food industry.	10	L3,L4,L5
Module 4: Powder Technology Classification of powder; Separation of powder; Sieving; Air classification; Factor affecting air classification; Cyclone application; Air separation; Particle size distribution.	10	L3,L4
Module 5: Super critical fluid (SCF) extraction Introduction; Properties of SCF; Food application of SCF; Application of SCFE during analysis and pharmaceutical applications.	10	L3,L4,L5,L6

Course Outcomes: Student will

1. Learn to apply separation technologies for solving problems during food processing.

2. Learn to evaluate the suitability of super critical fluid **(**SCF) extraction for foods.
3. Analyze and apply the membrane technology in food industry.
4. Analyze and apply the powder technology in food processing.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionally reduced to 60.

- The question paper will have 10 full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be 2 full questions (with maximum of 4 sub questions) from each module.
- Each full question will have sub question/s covering all the topics under a module.
- The student will have to answer 5 full questions, selecting 1 full question from each module.

Textbooks:

1. Mechanical Operations for Chemical Engineers (Incorporating Computer Aided Analysis). C.M. Narayanan and B.C. Bhattacharya, Khanna Publishers, 3rd Edition, 1990

2. Membrane Technology and Applications. Richard W. Baker, John Wiley & Sons, 2nd Edition, 2004

3. Membranes and Membrane Separation Processes, 1. Principles. Heinrich Strathmann, Wiley VCH Verlag GmbH & Co. KGaA., 2011

4. Powder Technology Handbook. Hiroaki Masuda, Ko Higashitani and Hideto Yoshida, CRC Press Taylor and Francis, 3rd Edition, 2006

5. Supercritical Fluid Extraction. J Reedijk, Elsevier Reference Module in Chemistry, Molecular Sciences and Chemical Engineering. Waltham, MA: Elsevier, doi: 10.1016/B978-0-12-409547-2.10753-X, 2014

Reference Books:

1. Mass Transfer Theory and Practice. N. Anantharaman, K.M. Meera Sheriffa Begum, PHI Learning, 2011
2. Membrane Operations. Innovative Separations and Transformations. Enrico Drioli and Lidietta Giorno, WILEY-VCH Verlag GmbH & Co. KGaA, 2009
3. Handbook of Powder Technology: Volume 12, Particle Breakage. Agba Salman, Mojtaba Ghadiri and Michael Hounslow, Elsevier Science, 1st Edition, 2007
4. Transport Processes and Separation Process. Chistie John Geankoplis, Pearson Education India; 4th Edition, 2015
5. Principles of Mass Transfer and Separation Processes. B.K. Dutta, Prentice Hall India Learning Private Limited, 2006