CURRICULUM
OF
AGRICULTURAL ENGINEERING

M. Tech. (Agricultural Engineering)
Specialization: Food Process Engineering

M. Tech. (Agricultural Engineering)
Specialization: Food Process Engineering
Course Structure

Semester I

Sl. No	Course Code	Course Name	Teaching Scheme			Credits
			L	T	P	
1.	1AE201	Advanced Food Process Engineering-I	3	0	0	3
2.	1AE202	Transport Processes in Food Engineering	3	0	0	3
3.	1AE2xx	Programme Elective – I	3	0	0	3
4.	1AE2xx	Programme Elective - II	3	0	0	3
5.	1ST101	Research Methodology & IPR	2	0	0	2
6.	1ST1xx	Audit Course - 1	2	0	0	0
7.	1AE203	Food Process Engineering Lab.	0	0	4	2
8.	1AE204	Food Chemistry and Microbiology Lab	0	0	4	2
		Total	**16**	**0**	**8**	**18**

Semester II

Sl. No	Course Code	Course Name	Teaching Scheme			Credits
			L	T	P	
1.	2AE205	Advanced Food Process Engineering-II	3	0	0	3
2.	2AE206	Food Process and Products Technology	3	0	0	3
3.	2AE2xx	Programme Elective - III	3	0	0	3
4.	2AE2xx	Programme Elective – IV	3	0	0	3
5.	2ST1xx	Audit Course - 2	2	0	0	0
6.	2AE207	Advanced Food Process Engineering Lab	0	0	4	2
7.	2AE208	Food Analysis Lab.	0	0	4	2
8.	2AE209	Mini Project	0	0	4	2
		Total	**14**	**0**	**12**	**18**

Semester III

Sl. No	Course Code	Course Name	Teaching Scheme			Credits
			L	T	P	
1.	3AE2xx	Programme Elective – V	3	0	0	3
2.	3ST2xx	Open Elective	3	0	0	3
3.	3AE210	Dissertation Phase - I	0	0	20	10
		Total	**6**	**0**	**20**	**16**

Semester IV

Sl. No	Course Code	Course Name	Teaching Scheme			Credits
			L	T	P	
1.	4AE211	Dissertation Phase - II	0	0	32	16
		Total	**0**	**0**	**32**	**16**

Programme Elective – I

1AE212	Data Structure and Computer Programming in food processing
1AE213	Computer application in food industry
1AE214	Bakery and Confectionary Products

Programme Elective – II

1AE215	Food Plant and Equipment Design
1AE216	Non-thermal Food Processing Technologies
1AE217	Advance refrigeration and air conditioning system

Programme Elective – III

2AE218	Technology of meat, poultry and fish processing
2AE219	Food Extrusion Technology
2AE220	Fruit and Vegetable Processing

Programme Elective – IV

2AE221	Food Handling and Packaging
2AE222	Food Safety and Quality Management
2AE223	Processing of Cereal, Pulse and Oilseed

Programme Elective – V

3AE224	Food Process Modelling
3AE225	Research methodology
3AE226	Milk and Milk Products Technology

Audit Course 1&2

1ST102	English for Research Paper Writing
1ST103	Disaster Management
1ST104	Sanskrit for Technical Knowledge
1ST105	Value Education
2ST106	Constitution of India
2ST107	Pedagogy Studies
2ST108	Stress Management by Yoga
2ST109	Personality Development through Life Enlightenment Skills.

Open Elective Courses

3ST201	Business Analytics
3ST202	Industrial Safety
3ST203	Operations Research
3ST204	Cost Management of Engineering Projects
3ST205	Composite Materials
3ST206	Waste to Energy

CORE COURSES

1AE201, Advanced Food Process Engineering-I

Teaching Scheme

Lectures: 3 hours/week

Course Objectives

The objectives of the course are to introduce in a systematic way the most common food engineering unit operations required to design food processes and the equipment needed to carry them out as well as the economic, sanitation and safety design aspects in food plant operations to successfully produce food products with maximum quality.

Syllabus Contents

Unit-1: Drying technology: principles, methods and equipments, stages of drying, freeze drying, spray drying, solar drying, vacuum drying, hybrid drying systems, moisture content determination methods.

Unit-2: Evaporation: Importance of evaporation in food processing, types of evaporators, heat and mass balance, essence recovery. Kinetics of thermal processing, rate of microbial inactivation, thermal process calculations.

Unit-3: Particulate food solids: size distribution and characterization, size reduction and energy requirement in comminution, methods of size reduction, devices (roller, hammer, plate, ball and attrition mills) used for milling of cereals and spices.

Unit-4: Mixing and agitation: mechanisms and equipments used for mixing and agitation of solids, liquids, powders and pastes. Mixing time, mixing index, and relationship. Homogenization of milk: mechanism of homogenization, working principle of homogenizer.

Unit-5: Extrusion: Single and twin screw extruder, design of screw profile, drag flow, pressure flow, leakage flow, net flow, performance of screw press. Commercial retorts: batch and continuous retorts. Aseptic processing.

References

1) Fellows, P. J. 1988. Food Processing Technology: Principle and Practice. VCH Publ.
2) Geankoplis J. Christie. 1999. Transport Process and Unit Operations. Allyn & Bacon
3) King, C. J. 1980. Separation Processes, Tata McGraw-Hill
4) McCabe, W.L. and Smith, J.C. 1999. Unit Operations of Chemical Engineering. McGraw Hill.34
5) Rao, M.A. 2007. Rheology of Fluid and semisolid Foods: Principles and Applications, Springer
6) Romeo T Toledo, 1997. Fundamental of Food Process Engineering.CBS Pubs.
7) Sahay, K.M. and Singh, K.K. 1994. Unit Operation of Agricultural Processing. Vikas

Publ. House

1AE202, Transport Processes in Food Engineering

Teaching Scheme

Lectures: 3 hours/week

Course Objectives

To understand the transport phenomena that govern the engineering analysis and design of food preservation process in improving processing conditions and the employment of energy resources, and to increase the quality of products.

Syllabus Contents

Unit 1: Heat Transfer- Fourier's law, conduction, convection and radiation heat transfer, steady state and transient heat transfer, heat transfer in Cartesian and cylindrical coordinates

Unit 2: Mass transfer, molecular diffusion, Fick's law, diffusion in solids, liquids and gases, effective moisture diffusion, heat and mass transfer analogy.

Unit 3: Equation of continuity, type of fluid flow and their classifications, Bernoulli's equation, pipe flow, channel flow, flow through porous media, Ergun's equation, and fluidization of solids, analytical and numerical solutions to transient state heat transfer.

Unit 4: Introduction of transport processes, viscosity and mechanism moment transport, thermal conductivity and mechanism of energy transport, diffusivity and mechanism of mass diffusivity, energy transport by radiation, different applications

Unit 5: Velocity distributions in laminar and turbulent flows, temperature distributions in solids and laminar and turbulent flows, concentration distributions in solids and laminar and turbulent flows, interphase transport

References

1. Bird, R.B., Stewart, W.E., and Lightfoot, E.N. 2001. *Transport Phenomena*. John Wiley and Sons. New York.
2. Datta, A. and Rakesh, V. 2009. *An Introduction to Modeling of Transport Processes*. Cambridge University Press, UK.
3. Geankoplish, C.J. 2000. *Transport Processes and Unit Operations*. Prentice Hall of India Pvt. Ltd., New Delhi.
4. Jorge, W., Jorge F.V., G.V. Barbosa-Canovas. 2003. *Transport Phenomena in Food Processing*. CRC Press. New York.
5. Jorge, W., Jorge, Fernando, V., and Barbosa-Canovas, G.V. 2003. *Transport Phenomena in Food Processing*. CRC Press, New York.

6. Saravacos, G.D., Zacharias, B. and Maroulis. 2001. *Transport Properties of Foods*. Marcel Dekker, New York.
7. Treybal, R. 1980. *Mass Transfer Operations*. 3rd Edn. McGraw-Hill. New Delhi.
8. Vassilis, G. 1992. *Transport Phenomena of Foods and Biological Materials*.CRC Press, New York.

1AE203, Food Process Engineering Lab

Teaching Scheme
Practical: 4 hours/week

Course Objectives
To provide in-depth understanding of important concepts in food processing, including size reduction, drying, dehydration, high-pressure homogenization, mixing, and chemical preservation methods. Students will conduct experiments to illustrate these food processing principles and be able to apply them.

Syllabus Contents

1. Study of grinding, particle size analysis and energy requirement in comminution.
2. High pressure homogenization of milk and the measurement of fat-globule size before and after homogenization
3. Rheological properties of Newtonian and non-Newtonian liquid food
4. Estimation and measurement of flow rate, power requirement and pressure developed in single screw extruder
5. Establishing the relationship between performance index and mixing time in a planetary mixer
6. Estimation and measurement of cut-off size of milk fat-globules in a disk type centrifugal separator
7. Determination of flow pattern, port arrangement and flow rate-pressure drop relationship in a plate heat exchanger
8. Saturation vapor pressure-temperature relationships for pure solvent and dilute solutions
9. Thermal bactericide to achieve commercial sterility of food in sealed containers
10. Dehydration of vegetables in cabinet tray dryer.
11. Drying of fruits and vegetables in vacuum dryer

References

1. H. Das, 2005. *Food Processing Operations Analysis*. Asian Book Publications, New

Delhi.

2. Jha, S.N. 2012. *Nondestructive Evaluation of Food Quality: Theory and Practice*. Springer.
3. Soojin J. andJ. Irudayaraj. 2008. *Food Processing Operations Modeling: Design and Analysis*. CRC Press, New York.

1AE204, Food Chemistry and Microbiology Lab

Teaching Scheme

Practical: 4 hours/week

Course Objectives

To develop hands-on experience in laboratory techniques and to demonstrate the food chemistry concepts discussed in lecture for developing healthy and nutritious foods. Students will also become familiar with the laboratory methods used in the microbiological analysis of foods, and with the identifying characteristics of the major groups of microorganisms associated with food spoilage, food borne disease, and food fermentations.

Syllabus Contents

1. Quantitative analysis of food for proximate composition
2. Determination of acidity and pH of food sample
3. Determination of ascorbic acid from different food.
4. Determination of reducing and non-reducing sugar in food material.
5. Estimation of mineral content in food sample (Ca, P)
6. Microscopic observation of bacteria, yeasts and moulds
7. Staining of micro-organisms
8. Quantitative estimation of bacteria, yeasts and moulds
9. Isolation and identification of micro organism

References

1. Jha, S.N. 2012. *Nondestructive Evaluation of Food Quality: Theory and Practice*. Springer.
2. S. Ranganna. Handbook of Analysis and Quality Control for Fruit and Vegetable Products. McGraw Hill.

2AE205, Advanced Food Process Engineering-II

Teaching Scheme

Lectures: 3 hours/week

Course Objectives

To acquaint with recent advances of Food Engineering and its Processes and develop an insight among the student about the existing modern techniques so as to aware them about their methodology and applications in food processing.

Syllabus Contents

Unit-1: Psychrometrics: Psychrometric chart, psychrometric properties, processes. Aeration systems in grain storage. Silo design.

Unit-2: Fluid flow: Movement of particulate solid in fluid – Stoke's law, flow of fluid foods through pipes, velocity profiles, pumps selection, pneumatic conveying of granular foods, Fluid flow through porous beds: permeability and Darcy's law, Kozeny-Karman equation, Burke-Plummer equation, fluidization -Ergun equations for pressure drop in packed bed, minimum fluidization velocity.

Unit-3: Filtration: equipments, cake resistance and medium resistance, vacuum and centrifugal filtration. Sieving, solvent extraction, gravity separation, distillation and leaching.

Unit-4: Novel thermal processing: radio frequency, ohmic heating, microwave heating. infrared. Thawing of foods. Commercial canning operations and equipments.

Unit-5: Low temperature preservation: preservation techniques, types of cold preservation, cooling/precooling techniques, refrigerated storage, refrigerant, freezing, freezing methods and equipments, freezing processes, freezing time and rate, freezing time models, temperature quotient, heating and cooling load calculation.

References

1) Fellows, P. J. 1988. Food Processing Technology: Principle and Practice. VCH Publ.
2) Geankoplis J. Christie. 1999. Transport Process and Unit Operations. Allyn & Bacon
3) King, C. J. 1980. Separation Processes, Tata McGraw-Hill
4) McCabe, W.L. and Smith, J.C. 1999. Unit Operations of Chemical Engineering. McGraw Hill.34
5) Rao, M.A. 2007. Rheology of Fluid and semisolid Foods: Principles and Applications, Springer
6) Romeo T Toledo, 1997. Fundamental of Food Process Engineering.CBS Pubs.
7) Sahay, K.M. and Singh, K.K. 1994. Unit Operation of Agricultural Processing. Vikas Publ. House

2AE206, Food Process and Products Technology

Teaching Scheme

Lectures: 3 hours/week

Course Objectives

The main objective of the course is to teach the categories and properties of food commodities and food products, and to outline their health, social and market relations surrounding their production, distribution, preparation and consumption.

Syllabus Contents

Unit-1. Methods for extension of shelf life and value addition in foods, preservation of foods by addition of heat-pasteurization, sterilization, cooking, blanching; Thermal death rate kinetics of microorganism, reverse osmosis, ultrafiltration, hurdle technology, minimally processed foods

Unit-2. Processing of: market milk, butter, ghee, ice cream, cheese, yoghurt, concentrated milk, skim milk powder, whole milk powder, malted milk foods, infant and baby foods, food premixes and blends, milled rice, refined wheat flour

Unit-3. Processing and preservation of foods by: Pickling, Jam, Jelly, marmalade, brining, smoking, fermentation, Chutneys and sauces/ketchups.

Unit-4. Spices: major spices (chillies, turmeric, black pepper, ginger, cardemon) and minor spices (garlic, cinnamon, fenugreek, cloves, onion, coriander, tamarind) of India.

Unit.5. Agricultural wastes and by-products utilization, principles and methods of waste disposal quotient, heating and cooling load calculation.

References

1) Chocolate, Cocoa and Confectionary Science and Technology- Benard W. Minifie
2) Food chemistry (Revised and Expanded Edition) Owen R. Fennama
3) Food Processing Technology Principles and Practice –P. J. Fellows
4) Modern Food Microbiology- James M. Jay
5) Outline of Dairy Technology- Sukumar De
1) Sahay, K.M. and Singh, K.K. 1994. Unit Operation of Agricultural Processing. Vikas Publ. House
6) Technology of Cereals- N. L. Kent
2) The Technology of Food Preservation (iv Edition)- Norman W. Desrosier and James N. Desrosier

2AE207, Advance Food Process Engineering Lab

Teaching Scheme

Practical: 4 hours/week

Course Objectives

To provide in-depth understanding of important concepts in food processing, including heat and mass transfer, extrusion, size reduction, homogenization, and packaging. Students will conduct experiments to illustrate these food processing principles and be able to apply them.

Syllabus Contents

1. Measurement of thermal conductivity, thermal diffusivity, emissivity and absorptiivty of solid and liquid foods.
2. Flow properties of food powders.
3. Food packaging material evaluation for water vapor transmission range, gas permeability (O_2,N_2 and CO_2), oil permeability, impact resistance, dry and wet strength.
4. Study of separation of cream and skim milk using disc bowl centrifugal seperator.
5. J –factor analogy
6. Comparison of energy requirement in vacuum drying and microwave drying
7. Study of spray drying of liquid food.
8. To study about solar drying of food products.
9. To study the canning process of food products.
10. To study the pressure – temperature relationship for solvent and different solution.

References

1. H. Das, 2005. *Food Processing Operations Analysis*. Asian Book Publications, New Delhi.
2. Ibtisam E. Tothill. 2011. *Rapid and On-Line Instrumentation for Food Quality Assurance*. Woodhead Publication, UK.
3. Jha, S.N. 2012. *Nondestructive Evaluation of Food Quality: Theory and Practice*. Springer.
4. Ranganna, S. 2008. *Handbook of Analysis and Quality Control for Fruit and Vegetable Products*. Tata McGraw Hill, New Delhi
5. Robertson, G.L. 2006. *Food Packaging: Principle and Practice*. Taylor and Francis, New York.
6. Singh, R.P., and Augusto G.M. 1989. *Food Properties and Computer-Aided Engineering*

of Food Processing Systems. Kluwer Academic.

2AE208, Food Analysis Lab

Teaching Scheme
Practical: 4 hours/week

Course Objectives
This course is intended to introduce the application of physical, chemical and biological methods and techniques of analysis used for in-line and off-line quality control laboratory measurement for process optimization and product quality assurance in the food industry.

Syllabus Contents

1. Color by reflective spectrophotometer
2. Refractive index of oil by Abbe Refractometer
3. Water activity and construction of MSI by dew point meter
4. Rheological behavior of Newtonian and Non-Newtonian liquids by Rheometer
5. Texture profile analysis by Texturometer
6. Fatty acid profile by Gas-Liquid Chromatograph
7. Flavor components by High Performance Liquid Chromatograph
8. Amylose in starch by Absorption Spectrophotometer
9. Measurement of fat particles after and before homogenization of milk
10. Measurement of whey protein denaturation

References

1. Clifton M & Pomeranz Y. 1988. *Food Analysis - Laboratory Experiments*. AVI Publ.
2. Gruenwedel DW & Whitaker JR. 1984. *Food Analysis Principles and Techniques*. Vol. I. *Physical Characterization*. Marcel Dekker.
3. Gruenwedel DW & Whitaker JR. 1984. *Food Analysis Principles and Techniques*. Vol. II. *Physicochemical Techniques*. Marcel Dekker.
4. Gruenwedel DW & Whitaker JR. 1984. *Food Analysis Principles and Techniques*. Vol. III. *Biological Techniques*. Marcel Dekker.
5. Gruenwedel DW & Whitaker JR. 1984. *Food Analysis Principles and Techniques*. Vol. IV. *Separation Techniques*. Marcel Dekker.
6. H. Das, 2005. *Food Processing Operations Analysis*. Asian Book Publications, New Delhi.
7. Jha, S.N. 2012. *Nondestructive Evaluation of Food Quality: Theory and Practice*. Springer.

8. Leenheer AP, Lambert WE & van Bocxlaer JF. 2000. *Modern Chromatographic Analysis of Vitamins*. 3rd Ed. Marcel Dekker.

9. Nollet LML. 1986. *Handbook of Food Analysis*. Vol. I. Marcel Dekker.

10. Soojin J. andJ. Irudayaraj. 2008. *Food Processing Operations Modeling: Design and Analysis*. CRC Press, New York.

1AE212, Data Structure and Computer Programming in food processing

Teaching Scheme

Lectures: 3 hours/week

Course Objectives

To expose the student with fundamental knowledge on software of computers as especially to 'C' Programming. It will also impart knowledge related to the applications of computation in food industries

Syllabus Contents

Unit 1: Computer- Fundamental: Hardware/Software: Computer & memory system, input/output organization and new tech.

Unit 2: software concepts and terminology/multimedia, operating system concepts, process computer software internet concepts/computer networks

Unit 3: System Analysis of Design: Structural System Design, input design and control, output system design, file and database design, system development, system control and quality assurance, documentation, system implementation Data Structure: Introduction to data structure, arrays, lists, stacks and queue, graphs

Unit 4: Programming preliminaries, some simple programs in C, numeric constants and variables, arithmetic expressions, input and output, conditional statements, loops, arrays, logical expressions, functions,

Unit 5: character strings, enumerated data type and stacks, structures, pointer data type, lists and trees, recursion, bit level operations, files in C, miscellaneous features of C.

References

1. Computer concepts for Agri Business concepts – M.V. Verton, AVI Pub. Corp, West Port, USA.
2. Computer Programming in „C" – E. Balaguruswamy

3. Data Structures – Mark Allen Waise
4. Let us „C‟ – Yeswanth Kanethkar
5. M. S Excel 2000 - Microsoft Corp.
6. M. S. Ofiice – Microsoft Corp

1AE213, Computer application in food industry

Teaching Scheme
Lectures: 3 hours/week

Course Objectives
Students will able to learn about industrial use of computer application in different field such as quality control, logistics, engineering data management, and product documentation. It also support in different industrial process such as design, manufacturing, purchasing, physical distribution, production management and supply chain management.

Syllabus Contents

Unit 1: Importance of computerization in food industry, operating environments and information systems for various types of food industries, principles of communication. Supervisory Control and Data Acquision (SCADA): Introduction to SCADA, SCADA systems hardware and firmware, SCADA systems software and protocols, landlines, local area network systems, modems, central site computer facilities

Unit 2: Spreadsheet Applications: Data entry, interpretation and solving problems; Cells, cell reference, functions, preparation of charts, use of macros to solve engineering problems; use of add-ins, use of solver etc. Web hosting and Webpage Design: Domain registration, web hosting, webpage design using web publishing software; Introduction to File Transfer Protocol (FTP); Online food process control from centralized server system in processing plant.

Unit 3: Use of Matlabs in Food Industry: Introduction, MATLAB interactive sessions, computing with MATLAB, Script files and editor/debugger; MATLAB help system, problem solving methodologies; Numeric, cell and structure array; Arrays, multidimensional arrays, element by element operations ; Matrix operations, polynomial operations using arrays, cell arrays, structure arrays; Functions and Files in MATLAB: Elementary mathematical functions, user defined functions; Advanced function programming, working with data files; Programming using MATLAB, Program design and development, Relational operators and logical variables, Logical operators and functions, Conditional statements, loops, the switch structure, debugging MATLAB programs, applications to simulations. Plotting and Model Building in MATLAB; XY plotting functions, subplots and overlay plots, special plot types, interactive plotting in

MATLAB, function discovery, regression, the basic fitting interface, three dimensional plots; Introduction to Toolboxes useful to Food Industry: Curve fitting toolbox, Fuzzy logic toolbox, Neural Network toolbox, Image processing toolbox, statistical toolbox

Unit 4: Introduction to CFD Applications in Food Industry: Introduction to Computational Fluid Dynamics (CFD), governing equations of fluid dynamics. Models of flow, substantial derivative, divergence of velocity, continuity, momentum and energy equations. Physical boundary conditions, discretization. Applications of CFD in Food and beverage industry. Introduction to CFD softwares, GAMBIT and Fluent softwares

Unit 5: Use of Software packages for: Summarization and tabulation of data; Descriptive statistics; Graphical representation of data, Exploratory data analysis.

References

1. Chatfield C. 1983. *Statistics for Technology*. 3rd Ed. Chapman & Hall.
2. Da Wen Sun. *Computation Fluid Dynamics in Food Processing*. CRC press
3. David Bailey and Edwin Wright. *Practical SCADA for Industry*. Elsevier
4. Free Statistical Softwares: http://freestatistics.altervista.org/en/stat.php.
5. Fundamentals of Food Process Engineering by R.T.Toledo. Published by Springer
6. http://www.iasri.res.in/design/Analysis of data/Analysis of Data.html.
7. Introduction to Web Design Using Microsoft FrontPage by Glencoe/McGraw-Hill Published by Glencoe/McGraw Hill
8. Jenny Chapman. *Web Design: A Complete Introduction*. John Wiley & Sons
9. Learning Statistics: http://freestatistics.altervista.org/en/learning.php.
10. Statistics Glossary http://www.cas.lancs.ac.uk/glossary_v1.1/main.html.
11. William J. Palm. *Introduction to MATLAB 7 for engineers*. McGraw Hill Professional

1AE214, Bakery and Confectionary Products

Teaching Scheme
Lectures: 3 hours/week

Course Objectives
To impart basic and applied technology of baking and confectionary and acquaint with the manufacturing technology of bakery and confectionary products.

Syllabus Contents

Unit 1: History of Bakery and Confectionery, Raw materials used in Bakery and its

characteristics, use of water, role of salt, yeast production, enzymes and their functions in dough, properties and role of milk and sugar, leavening agents and their functions in bakery industry, spices and their functions in baking, flavouring and their function in bread making.

Unit 2: Food colours, type of setting materials and their function in baking, Cocoa and Chocolate, Bakery unit operation, type of breads, bread faults and remedies, cream crackers, soda crackers, wafer biscuits and matzos, puff biscuits, hard sweet, semi sweet and garibaldi fruit sandwich biscuit, short dough biscuits, wafers.

Unit 3: Cakes – type, ingredients, processing of cakes, problem and remedies. Pizza and Pastries – their ingredients and processing, bakery equipment required – type, selection, maintenance, bakery norms and standards.

Unit 4: Type of confectionery, Technical considerations of confectionery – TSS, pH, Acidity, and ERH. Raw materials – types of sugar and their role in confectionery, alternative bulk sweeteners and their role in confectionery, enzymes used in syrup production, protein and fat related products and their role in confectionery.

Unit 5: Food colors and flavors, ingredients used in chocolate, chocolate processing, caramel, toffee and fudge processing, Processing of liquorices paste, and cream paste, and aerated confectionery products, Tablets, chewing gum, crystallize confectionery.

References

1. Bent A, Bennion EB & Bamford GST. 1997. *The Technology of Cake Making*. 6th Ed. Blackie.
2. Dubey SC. 2002. *Basic Baking*. The Society of Indian Bakers, New Delhi.
3. Francis FJ. 2000. *Wiley Encyclopedia of Food Science & Technology*. John Wiley & Sons.
4. Jackson EB.1999. *Sugar Confectionery Manufacture*. 2nd Ed. Aspen Publ. Junk WR & Pancost HM. 1973. *Hand Book of Sugars for Processors. Chemists and Technologists*. AVI Publ.
5. Manley D. 2000. *Technology of Biscuits, Crackers & Cookies*. 2nd Ed. CRC Press.
6. Matz SA. 1992. *Bakery Technology and Engineering*. 3rd Ed. Chapman & Hall.
7. Pyler EJ. *Bakery Science & Technology*. 3rd Ed. Vols. I, II. Sosland Publ.
8. Qarooni J. 1996. *Flat Bread Technology*. Chapman & Hall.

1AE215, Food Plant and Equipment Design

Teaching Scheme

Lectures: 3 hours/week

Course Objectives

To impart knowledge on design of various equipments used in food industries and theoretical aspect to be considered for plant layout and site selection.

Syllabus Contents

Unit 1: Physical properties of food materials, mass and energy balance calculations for preliminary estimation of plant capacity and equipment sizes, preparation of flow sheets for material movement and utility consumption in food plant

Unit 2: Selection of materials, design of storage vessels for foods, design of pressure vessels and design of vessel for drum drying, stress and strain calculation, fatigue

Unit 3: Performance characteristics and selection of fans, blowers, ejector compressors and vacuum pumps, performance characteristics and selection of centrifugal and positive displacement sanitary pumps, design of fluid conveyance system; pipe, sanitary pipe fitting and valves

Unit 4: Design of heat exchange equipment-plate, scraped surface and extended surface for heating and cooling of gas and liquid, design of evaporator calandria, vapor separator and condenser

Unit 5: Design considerations for location of food plant, equipment layout and ventilation in food process plants

References

1. Albert, I., and G.V. Barbosa-Canovas. 2002. *Unit Operations in Food Engineering*. CRC Press, New York.
2. Geankoplish, C.J. 2000. *Transport Processes and Unit Operations*. Prentice Hall of India Pvt. Ltd., New Delhi.
3. Kenneth J. V., Enrique R., and Singh, R.P. 1997. *Handbook of Food Engineering Practice*. CRC Press, New York.
4. Oberg, E., Jones, F.D., Horton, H.L., and Ryffel, H.H. 2008. *Machinery's Handbook*.

Industrial Press.

5. Singh, R.P., and Heldman, D.R. 2004. *Introduction to Food Process Engineering*. Academic Press. New York.
6. Zacharias B.M. and Saravacos, G.D. 2005.*Food Process Design*. CRC Press, New York.

1AE216, Non-thermal Food Processing Technologies

Teaching Scheme
Lectures: 3 hours/week

Course Objectives
To acquaint with the methods that do not use heat to retain quality attributes of food while ensuring food safety and functionality of the product. The course deals with key concepts and industrial applications of emerging non-thermal food processing technologies such as high hydrostatic pressure, ultrasound, magnetic electric field, gamma irradiation, and pulsed light. It also provide hands-on practice in operating representative equipment used in non-thermal food processing as well as collecting, analysing and interpreting actual food engineering data.

Syllabus Contents

Unit 1: Introduction to non-thermal processing, comparison of thermal and non-thermal processing, advantages and disadvantages of non-thermal processing

Unit 2: Pulse Electric Filed (PEF) processing of foods, general principles, microbial inactivation kinetics by PEF, changes in enzyme activity, protein conformation, vitamin and flavor stability, PEF assisted juice exertion

Unit 3: High Pressure Processing (HPP) of foods, general principles, type of HPP systems, applications -inactivation of micro-organisms and enzymes, milk and milk products, egg, meat and fish products, fruits and vegetable products, high pressure assisted freezing and thawing

Unit 4: Food irradiation, ultraviolet light microbial inactivation by ultrasound, magnetic field

Unit 5: Non-thermal technology combination with thermal technologies, packaging requirements for non-thermal processed foods, food safety and regulations of non-thermal processed foods.

References

1. Barbosa-Canovas, G. and Zhang, Q. 2001. *Pulsed Electric Fields in Food Processing: Fundamental Aspects and Applications*. Technomic: Lancaster, PA.
2. Barbosa-Canovas, G.V., Pothakamury, U.R., Palou, E. and Swanson, B.G. 1989. *Non-*

thermal Preservation of Food. Mercel Dekker, New York.

3. Barbosa-Canovas, G.V., Tapia, M. S. and Cano, M.P. 2005. *Novel-thermal Food Processing Technologies*. CRC Press, New York.
4. Gould, G.W. 1995a. *New Methods of Food Preservation*. Blackie Academic and Professional, Glasgow, UK.
5. Lozano, J., Anon, M.C., Parada-Arias, E., and Barbosa-Canovas, G.V. 2000. *Advances in Food Engineering*. Technomic Publishing Co., Lancaster, PA.

1AE217, Advance refrigeration and air conditioning system

Teaching Scheme

Lectures: 3 hours/week

Course Objectives

To learn about the principle and different components of refrigeration system. Design of cold storage and calculation of their cooling load for different food products.

Syllabus Contents

Unit 1: Vapour compression refrigeration systems with multiple evaporators and compressors: System components: compressor, Evaporators, Condensers & Expansion Devices and their functional aspects. Methods for improving COP, multiload system with single compressor, complex systems, dual compression system, system calculations, system balancing & controls, installation charging testing and maintenance of refrigeration and air conditioning

Unit 2: Vapour absorption refrigeration system: Ammonia-Water system, Li-Br system, Vapour absorption refrigeration cycle and its representation on enthalpy composition diagram; Absorption system calculations. Heat Pumps: different 'heat pump circuits', analysis of heat pump cycle, Use of heat pumps in plant for energy conservation.

Unit 3: Non-conventional refrigeration systems: Steam jet refrigeration, Thermo electric refrigeration, vortex tube, cooling by adiabatic demagnetization, air refrigeration cycles. Design elements of Refrigeration equipments: compressor condenser, evaporator, cooling tower, spray pond etc. Balancing of different components.

Unit 4: Design of cold storage and air-conditioning systems: types of cooling loads and their calculation, design of cold storage for food products, construction of cold storage, equipment selection, insulating materials, vapour barriers, Ice bank tank.

Unit 5: Control and maintenance of a commercial refrigeration plant: Pressure regulating valves, Thermostatic valves, LP/ HP cutouts, high to low side bypass valve, condenser water regulating valve, capacity control devices, pump down control, defrosting methods, liquid charging;

General preventive maintenance of refrigeration plant. Transport air conditioning system: Introduction, components of different automobile air conditioning systems.

References

1. Andrew D Althhouse & Carl H. Turnquist 1958. *Modern Refrigeration and Air-conditioning*. Good Heart Wilcox Co.
2. Arora CP. 2000. *Refrigeration and Air-conditioning*. Tata McGraw Hill.
3. Carrier Air-conditioning. 1965. *Handbook of Air-conditioning System Design*. McGraw Hill.
4. Domkundwar S. 1980. *A Course in Refrigeration and Air-conditioning*. Dhanpat Rai & Sons.
5. Gunther Raymond C. 1957. *Refrigeration and Air-conditioning and Cold Storage*. Chilton Co.
6. Jordan RC & Priester GB. 1971. *Refrigeration and Air conditioning*. Prentice Hall of India.
7. Langley BC. 1978. *Refrigeration and Air-conditioning*. Reston Publ.
8. New-Comer JL. 1981. *Refrigeration and Air-conditioning*. Venus Trading Co.
9. Ananta Krishnan CP & Simha NN. 1987. *Technology and Engineering of Dairy Plant Operation*. Luxmi Publ.

2AE218, Technology of meat, poultry and fish processing

Teaching Scheme

Lectures: 3 hours/week

Course Objectives

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

Syllabus Contents

Unit 1: Meat composition from different sources; muscle structure and compositions; post-mortem muscle chemistry; meat colour and flavours; meat microbiology and safety.

Unit 2: Modern abattoirs, typical layout and features, ante-mortem handling and design of handling facilities; hoisting rail and traveling pulley system; stunning methods; steps in

slaughtering and dressing; offal handling and inspection; inedible by-products; operational factors affecting meat quality; effects of processing on meat tenderization; abattoir equipment and utilities

Unit 3: Modern abattoirs, typical layout and features, ante-mortem handling and design of handling facilities; hoisting rail and traveling pulley system; stunning methods; steps in slaughtering and dressing; offal handling and inspection; inedible by-products; operational factors affecting meat quality; effects of processing on meat tenderization; abattoir equipment and utilities

Unit 4: Poultry industry in India, measuring the yields and quality characteristics of poultry products, microbiology of poultry meat, spoilage factors; lay-out and design of poultry processing plants, plant sanitation; poultry meat processing operations, equipment used – defeathering, bleeding, scalding etc.; packaging of poultry products, refrigerated storage of poultry meat, by products – eggs, egg products, whole egg powder, egg yolk products, their manufacture, packaging and storage.

Unit 5: Commercially important marine products from India; product export and its sustenance; basic biochemistry and microbiology; preservation of postharvest fish freshness; transportation in refrigerated vehicles; deodorization of transport systems; design of refrigerated and insulated trucks; grading and preservation of shell fish; pickling and preparation of fish protein concentrate, fish oil and other by products.

References

1. Forrest, J.C. 1975. *Principles of Meat Science*. Freeman. Govindan,
2. T.K. 1985. *Fish Processing Technology*. Oxford & IBH. Hui, Y.H.
3. 2001. *Meat Science and Applications*. Marcel Dekker. Kerry, J. *et al.*
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5. *Meat Hand Book*. 4th Ed. AVI Publ.
6. Mead, M. 2004. *Poultry Meat Processing and Quality*. Woodhead Publ.

2AE219, Food Extrusion Technology

Teaching Scheme
Lectures: 3 hours/week

Course Objectives
To impart knowledge to the students about extrusion technology, principle of working,

classification of extruders according to process and construction, extruded products and their processing.

Syllabus Contents

Unit 1: Extrusion: definition, introduction to extruders and their principles, types of extruders, Extruders in the food industry: History and uses of extruders in the food industry

Unit 2: Single screw extruder: principle of working, net flow, factors affecting extrusion process, Twin screw extruder: counter rotating and co-rotating twin screw extruder, Process characteristics of the twin screw extruder : feeding, screw design, screw speed, screw configurations, die design, Twin screw extruder: Barrel temperature and heat transfer, adiabatic operation, heat transfer operations and energy balances, Problems associated with twin screw extruder

Unit 3: Pre-conditioning of raw materials used in extrusion process, Pre conditioning operations and benefits of pre-conditioning and devolatilization, Interpreted-flight expanders - extruders, dry extruders, Chemical and nutritional changes in food during extrusion, pre-extrusion processes, cooker extruder Profiling, Practical considerations in extrusion processing: Addition and substraction of materials, shaping and forming at the die, post extrusion processes

Unit 4: Breakfast cereals: introduction, type of cooking - High shear cooking process, steam cookers, low shear, low pressure cookers and continuous staem pre-cooking, available brands, Breakfast cereal processes: traditional and extrusion methods, classification of breakfast cereals - flaked cereals, oven puffed cereals, gun puffed cereals, shredded products

Unit 5: Texturized vegetable protein: Definition, processing techniques, and foods, Snack food extrusion: Direct expanded (DX) and third generation (3G) Snacks: types, available brands, co-extruded snacks and indirect-expanded products

References

1. Fast R.B. and Caldwell E.F. *Breakfast Cereals and How they are made*.(2000) American Association of Cereal Chemists., St. Paul, Minnesota.
2. Frame N.D. *The Technology of Extrusion Cooking*. (1994) Blackie Academic & Professional, New York.
3. Guy R. *Extrusion Cooking, Technologies and Applications*. Wood head Publishing Limited, Abington, Cambridge.
4. Harper J.M. *Extrusion of Foods*. Vol. 1&2 (1991) CRC Press, Inc; Boca Raton, Florida.
5. O'Connor C. *Extrusion Technology for the Food Industry*. (1987) Elsevier Applied Science, New York.

6. Richardson P. *Thermal Technologies in Food Processing*. Wood head Publishers, Cambridge

2AE220, Fruit and Vegetable Processing

Teaching Scheme
Lectures: 3 hours/week

Course Objectives

To acquaint with principles and methods of preservation of fruits and vegetables into various value added products

Syllabus Contents

Unit 1: Production and processing scenario of Fruits and vegetables in India and world, scope of fruit and vegetable processing industry in India - present status, constraints and prospective. Principles of preservation- Drying, dehydration, pretreatments required, factors affecting rate of dehydration, Reconstitution -coefficient of rehydration

Unit 2: Freezing process, type of freezing, changes during freezing, thawing, principle and process of canning, type of concentration, changes during concentration, chemical preservation, hurdle concept, irradiation,

Unit 3: Jam – ingredients and their role, processing of jam, Pectin and its sources, functional properties of pectin, Jelly and marmalades, processing of jelly and marmalades, fruit preserves and candied fruit, preparation of fruits preserves and candied, glazed & crystallized fruit preparation.

Unit 4: Chutneys and its preparation, pickles, type of pickling, sauerkraut, problems in pickle making, sauces and ketchups,

References

1. Barret DM, Somogyi LP &Ramaswamy H. 2005. *Processing of Fruits.CRC Press*
2. FAO. 2007. *Handling and Preservation of Fruits and Vegetables by Combined Methods for Rural Areas- Technical Manual.* FAO Agr. Ser. Bull., 149.
3. Fellows P. 2007. *Guidelines for Small-Scale Fruit and Vegetables Processors*. FAO Agr. Ser. Bull., 127.

4. Lal G, Siddappa GS & Tandon GL. 1998. *Preservation of Fruits and Vegetables*. ICAR.
5. Salunkhe DK & Kadam SS. 1995. *Handbook of Vegetables Science & Technology: Production, Composition, Storage and Processing*. Marcel Dekker.
6. Salunkhe DK & Kadam SS.1995. *Handbook of Fruit Science & Technology: Production, Composition and Processing*. Marcel Dekker.
7. Somogyi LP. et al. 1996. *Processing Fruits - Science and Technology*. Vols I, II. Technomic Publ.
8. Srivastava RP & Kumar S. 2003. *Fruit and Vegetable Preservation - Principles and Practices*. International Book Distributors.
9. Verma LR & Joshi VK. 2000. *Post Harvest Technology of Fruits and Vegetables*. Indus Publ.

2AE221, Food Handling and Packaging

Teaching Scheme
Lectures: 3 hours/week

Course Objectives
To provide knowledge about different conveying systems and development of food packaging materials and technologies aiming at assuring the safety and quality of foodstuffs in order to design an optimized package which satisfies all legislative, marketing and functional requirements sufficiently, and fulfils environmental, cost and consumer demands as well as possible.

Syllabus Contents

Unit 1: Overview of material handling system and devices in food processing plants, design of screw, bucket, belt, oscillating and vibratory conveyors

Unit 2: Packaging materials, their characteristics and properties, manufacture of plastic films, foils, laminates, retortable pouches, rigid plastic container paper and corrugated fibre board, design of shipping cartons and containers, rigid packaging using tin plate and aluminium

Unit 3: Design of aerosol container, metal tubes, glass containers and closures, labels and printing in packages, packaging requirement for different processed and unprocessed foods, e.g., cereal grains, baked foods, milk and dairy products, fish and meat, fresh fruits and vegetables

Unit 4: Principles of working of various type fillers: form- fill-seal machine, gas packaging and modified atmosphere package design, shelf life prediction of foods in packages, quality control in food packaging, product safety and packaging regulations.

Unit 5: Novel packaging technologies – edible packaging, smart packaging, active packaging, anti-microbial packaging, CA and MA packaging, nano-packaging

References

1. Ahvenainen, R. 2003. *Novel Food Packaging Techniques*. CRC Press, Boca Raton, FL, New York.
2. Brady, A.L. 1989. *Controlled/Modified Atmosphere/Vacuum Packaging of Foods*. 2nd Edn. Food and Nutrition Press, Trumbull, CT.
3. Coles, R., Mcdowell, D., Kirwan, M. J. 2003. Food Packaging Technology. CRC Press, Blackwell Publishing.
4. Karel, M. and Lund, D.B. 2003. *Protective Packaging, Physical Principles of Food Preservation*, 2nd Ed. Marcel Dekker, New York.
5. Kilcast, D., and Subramaniam, P. 2000. *The Stability and Shelf life of Food*. CRC Press, Boca Raton, FL, New York.
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7. Rockland, L.B. and Beuchat, L.R. 1987. *Water Activity: Theory and Applications to Food*. Marcel Dekker, New York

2AE222, Food Safety and Quality Management

Teaching Scheme

Lectures: 3 hours/week

Course Objectives

To acquaint with food quality parameters and control system and also impart knowledge about various national and international standards for different food. Students will able to know about various acts, rules, regulations, laws and orders related to food articles governing their manufacture, import, export, storage, sale and distributions.

Syllabus Contents

Unit-1: Quality and Assurance: Definition, scope, importance and difference, Total quality control and (TQC) Total quality management (TQM), Statistical quality controls. Definition, importance, scope and difference between food quality and food safety.

Unit-2: Sensory Evaluation: Selection of panel of judges, Prerequisite for sensory analysis, application of consumer tests; control of factors affecting of sensory verdict, Instrumental

measurements of sensory attribute of foods sensory characteristics of foods, types of tests, Texture profile analysis. Correlation between instrumental and Sensory analysis of food quality attributes.

Unit-3: Food standards and laws: International – Concept of Codex Alimentarius, HACCP, GMP, GHP, USFDA, ISO 9000, ISO 22000, ISO 14000. Export Quality Control and Inspection act (1963), Environment Protection Act (1986), WTO & GATT, etc. GMP, GHP. National – Compulsory and voluntary trade and Company standards. Consumer Protection Act (1986), BIS/IS, Food Safety and standards – 2006, FPO, MPO, MMPO, Agmark. GMP, GHP.

Unit-4: Raw materials & Finished product quality: Quality parameters and evaluation procedures: appearance, color, texture, viscosity, consistency, flavour etc. Quality Certification & Accrediation: Introduction and procedure

Unit-5: Prevention of food adulteration Act: Food Adulteration: definition, common adulterants in different foods, contamination, method of detection, Food additives and legislation; PFA specification for food products, Nutritional labeling. Risk and Hazard associated with Food: Food hazards, sources of hazard, classification, Food safety; prevention and control, Statistical quality control. HACCP, Quality costs.

References

1. Early R.1995.*Guide to Quality Management Systems for Food Industries*. Blackie Academic.
2. FSSAI (2011). Food safety and standards (Food product standards and Food Additives) regulation
3. Furia TE.1980. *Regulatory status of Direct Food Additives*. CRC Press.
4. Jellinek G. 1985. *Sensory Evaluation of Food - Theory and Practice*. Ellis Horwoood.
5. Krammer A & Twigg BA.1973. *Quality Control in Food Industry*. Vol. I, II. AVI Publ.
6. Naomi Rees. David Watson. 2000. International standards for food safety, Aspen Publications.
7. Ranganna S. 2001. *Handbook of Analysis and Quality Control for Fruit and Vegetable Products*. 2nd Ed. Tata-McGraw-Hill.

2AE223, Processing of Cereal, Pulse and Oilseed

Teaching Scheme
Lectures: 3 hours/week

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

Syllabus Contents

Unit 1: Objectives and requirements of processing; raw grain characteristics and quality.

Unit 2: Wheat milling - products and by-products; roller flour milling; separation of milled products; manufacture of bakery products, pasta products and various processed cereal-based foods; manufacture of whole wheat *atta*, blended flour and fortified flour.

Unit 3: Rice milling technology; by-products of rice milling and their utilization; parboiling of rice- technology and effect on quality characteristics; processed products based on rice

Unit 4: Corn: Types and nutritive value; dry and wet milling, manufacture of value-added products; processing of barley, oats, sorghum and millets.

Unit 5: Legumes and oilseeds: composition, anti-nutritional factors, processing and storage; processing of oilseeds, construction and working mechanism of different extraction equipments like single stage extraction, multiple stage static bed system, bellman extractor, Hildebrandt extractor; assessment of processed product quality; packaging of processed products .

References

1. A. Chakravarty et al 2003. Handbook of Post Harvest Technology Marcel Dekker.
2. Araullo, E.V., dePadna, D.B. and Graham, Michael. 1976. Rice Post Harvest Technology. International Development Res. Centre, Ottawa, Canada
3. Dendy,DA.V. and Dobraszczyk, B.J. 2001. *Cereal and Cereal Products*. Aspen.
4. Lorenz, K.L.1991. *Handbook of Cereal Science and Technology*. Marcel Dekker.
5. Marshall, W.E.and Wadsworth, J.I. 1994. *Rice Science and Technology*. Marcel Dekker.
6. Mathews, R.H. 1989. *Legumes Chemistry, Technology and Human Nutrition*. Marcel Dekker.

3AE224, Food Process Modelling

Teaching Scheme
Lectures: 3 hours/week

Course Objectives
The students would be exposed to concepts of Design of Experiments so as to enable them to understand the concepts involved in planning, designing their experiments and analysis of experimental data.

Syllabus Contents

Unit 1: Identification of design, operating and performance parameters in mechanical, thermal and mass transfer operations carried out in food processing such as; particulate size reduction, homogenization, centrifugation, packaging, mixing, conveying, extrusion, storage, heating, cooling, freezing, puffing, frying, distillation, extraction, concentration and drying.

Unit 2: Developing mathematical relationship between the independent and dependent variables affecting the food processing operations by using physical and chemical principles governing the processes.

Unit 3: Factorial, fractional factorial and rotatable central composite experimental design.

Unit 4: Developing empirical equations using experimental data. Developing predictive model using Neural network.

Unit 5: Optimization of processing parameters using Genetic algorithms. Application of Fuzzy logic to sensory evaluation and ranking of foods.

References

1. Dominic, F. 2012. *Recent Advances in Sustainable Process Design and Optimization*. World Scientific Publishing.
2. Das, H. 2005. *Food Processing Operations Analysis*. Asian Book Publications, New Delhi.
3. Soojin J. and J. Irudayaraj. 2008. *Food Processing Operations Modeling: Design and Analysis*. CRC Press, New York.

3AE225, Research methodology

Teaching Scheme
Lectures: 3 hours/week

Course Objectives

To conduct applied research in a scientific manner. Students will learn to develop practical knowledge and skills to design, undertake and report research projects in a systematic way using statistical methods for the qualitative/quantitative analysis of data.

Syllabus Contents

Unit 1: Introduction of research methodology, Statistical analysis, Research Design: Need, Problem Definition, variables, research design concepts, Literature survey and review, Research design process, Errors in research; Research Modeling: Types of Models, Model building and stages, Data consideration and testing, Report Writing: Pre writing considerations, Thesis writing, Formats of report writing, formats of publications in Research journals.

Unit 2 & 3: Design of experiments : objectives, strategies, Factorial experimental design, Designing engineering experiments, basic principles-replication, randomization, blocking, Guidelines for design of experiments, Two factor Factorial Design, Basic definitions and principles, main effect and interaction, General arrangement for a two factor factorial design. Application of Rotatable central composite design (RCCD) and fractional factorial design

Unit 4: Analysis of Variance components (ANOVA) for fixed effect model; Total, treatment and error of squares, Degrees of freedom, Confidence interval; One way ANOVA and two way ANOVA ,Chi square test and its application.

Unit 5: Hypothesis testing : Z test, T test, P test, Application of fuzzy logy, Model fitting, application of curve fitting tool, ANN modeling .

References

1. Kothari, C.K. Research Methodology_ Methods and Techniques, (New Age International, 2004).
2. Krishnaswamy, K.N., Sivakumar, A. I. and Mathiranjan, M. Management Research Methodology; Integration of *Principles, Methods and Techniques* (Pearson Education, 2006)
3. Montgomery, D. C. and Runger, G. C. *Applied Statistics & Probability for Engineers*, (Wiley India, 2007)
4. Montgomery, D. C. *Design and Analysis of Experiments*, (Wiley India, 2007)

3AE226, Milk and Milk Products Technology

Teaching Scheme

Lectures: 3 hours/week

Course Objectives

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

Syllabus Contents

Unit 1: Present status of milk & milk products in India and Abroad; market of milk, composition of milk of various species, quality evaluation and testing of milk, procurement, transportation and processing of market milk, cleaning & sanitization of dairy equipments. Special milks such as flavoured, sterilized, recombined & reconstituted toned & double toned.

Unit 2: Condensed milk- definition, methods of manufacture, evaluation of condensed & evaporated milk; dried milk- methods of manufacture of skim & whole milk powder, instantiation, physiochemical properties, evaluation, defects in dried milk powder.

Unit 3: Cream: Definition, classification, composition, cream separation, sampling, neutralization, sterilization, pasteurization & cooling of cream, evaluation, defects in cream; butter- definition, composition, classification, methods of manufacture, theories of churning, evaluation, defects in butter.

Unit 4: Ice cream: Definition, composition and standards, nutritive value, classification, methods of manufacture, evaluation, defects in ice cream and technology aspects of softy manufacture.

Unit 5: Cheese: Definition, composition, classification, methods of manufacture, cheddar, Gouda, cottage and processed cheese, evaluation, defects in cheese. Indigenous milk products, present status, method of manufacture of *yoghurt, dahi, khoa, burfi, kalakand, gulabjamun, rosogolla, srikhand,chhana, paneer, ghee, lassi* etc; probiotic milk products.

References

1. Aneja, R.P., Mathur, B.N., Chandan, R.C. and Banerjee, A.K. 2002. *Technology of Indian Milk Products*. Dairy India Publ.
2. De, S. 1980. *Outlines of Dairy Technology*. Oxford Univ. Press. Henderson, J.L. 1971. *Fluid Milk Industry*. AVI Publ.
3. Spreer, E. 1993. *Milk and Dairy Products*. Marcel Dekker. Walstra, P. 1999. *Dairy Technology*. Marcel Dekker.
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Food Engineering Specialization. Addressing the growing need for safe, healthy, and affordable food. You will be prepared to design, develop, and implement cost-effective systems and solutions for food manufacturing and processing technologies. Create sustainable solutions to address the global need for food security. Provide safe, high quality, and nutritious food and promote healthy living.Â Our curriculum has a strong foundation in math, science, engineering fundamentals, and food science, including their applications to food processing, biological processes, food quality, food safety, and food security. Follow a 4-year plan to ensure you take courses in sequence (PDF). Take courses and electives taught by internationally-recognized faculty. Food Engineering â€“ It is branch of engineering that deals with design, construction, maintenance and operation of food processing equipment. It can also be defined as t he application of relevant engin eering principles t o food. and other raw materials f or the production of useful edible products and byÂ food science education. 7.2 Specialization- Options in Food and Bioprocess Engineering. Some of t he areas of focus o f Food and Bioprocess Engineering pro fessi on are. stated below Food process engineers may work in other capacities as well; some are responsible for managing or supervising other workers, working in technical sales and service, acting as specialized consultants, or marketing food products. Typical Job Duties. The specific job duties of a food process engineer may vary depending on the sector of the food industry the work within, and the specific responsibilities of their job, although generally they are responsible for performing the following duties: â€¢ Provide process engineering knowledge in the development of new food products. â€¢ Evaluate existing equi This specialisation focuses on the combination of Food Processing with special emphasis on sustainability. This specialisation is mainly aimed for students who would like to work in the food industry.Â Sustainable Food Process Engineering. To explore the potential of nature to improve the quality of life. Wageningen University & Research on Social Media. Food Process Engineering (8338). FOODNS. 96 Units of Credit.Â Study Level refers to the academic level of a program, specialisation or course. Postgraduate. Minimum Units of Credit. 96. Specialisation Type. Specialisation. open_in_new. Fees Information.