FACULTY OF ENGINEERING

DEGREE OF

DOCTOR OF PHILOSOPHY
IN
FOOD TECHNOLOGY

DEPARTMENT OF FOOD TECHNOLOGY

(REGULAR PROGRAMME)

CURRICULUM & SYLLABI
(2025 -2026)

Enable | Enlighten | Enrich
KARPAGAM
ACADEMY OF HIGHER EDUCATION
(Deemed to be University)
(Established Under Section 3 of UGC Act, 1956)

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Eachanari, Coimbatore-641 021, India

FACULTY OF ENGINEERING

DEGREE OF DOCTOR OF PHILOSOPHY IN

FOOD TECHNOLOGY (Ph.D.)

REGULAR PROGRAMME

REGULATIONS (2025)

CHIOCE BASED CREDIT SYSTEM

Phone: 0422- 6471113 – 5; Fax No: 0422 – 2980022, 2980023 Email:info@karpagam.com;
Web: www.kahedu.edu.in

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Eachanari Post, Coimbatore -641021, India.

FACULTY OF ENGINEERING

DOCTOR OF PHILOSOPHY (Ph.D.)

REGULATIONS 2025

These regulations are effective from the academic year 2025-2026 and applicable to the candidates admitted to Ph.D. during 2025-2026 and onwards.

I. ELIGIBILITY CRITERIA

First class or 55% marks (50% marks for SC/ST), in M.E / M. Tech degree in Food Technology or in related disciplines.

II. MODE OF SELECTION

The guidelines as given in the Regulations for M. Phil., / Ph.D., of Karpagam Academy of Higher Education are applicable.

III. PROGRAMME STRUCTURE AND RESEARCH WORK

Upon successful completion of the degree, the candidate will be conferred with the degree of Doctor of Philosophy (Ph.D.) in Food Technology under the Faculty of Engineering.

PART – I COURSE WORK SYLLABUS FOR Ph.D. COURSE IN FOOD TECHNOLOGY (2025-2026)

SL.NO	TITLE OF THE COURSE	NO. OF SUBJECT	C	EXAM. HRS	MARKS
1	PAPER I	01	4	3	100
2	PAPER II	01	4	3	100
3	PAPER III	01	4	3	100
	TOTAL	03	12	9	300

PART – I COURSE WORK SYLLABUS FOR Ph.D. COURSE IN FOOD TECHNOLOGY (2025-2026)

SUB.CODE	TITLE OF THE COURSE	CREDITS	EXAM HRS	MARKS	PAGE NO
PAPER - I (COMPULSORY)					
25RFT101	Research Methodology	4	3	100	4
PAPER - II (COMPULSORY)					
25RFT201	Research and Publication Ethics	4	3	100	6
PAPER - III (ANY ONE)					
25RFT301	Advanced Tools and Techniques in Food Analysis	4	3	100	8
25RFT302	Trends in Food Safety and Quality Management Systems	4	3	100	10
25RFT303	Advanced Techniques in Food Processing	4	3	100	12
25RFT304	Advances in Food Chemistry	4	3	100	14
25RFT305	Waste Utilization and By-product Development	4	3	100	16
25RFT306	Food Nanotechnology	4	3	100	18
25RFT307	Advanced Drying Technology	4	3	100	20
25RFT308	Advances in Plant-based Foods	4	3	100	22
25RFT309	Advances in Animal Products Technology	4	3	100	24
25RFT310	Functional Foods	4	3	100	26

25RFT101	**Research Methodology**	**4H- 4C**

Instruction Hours / Week: L: 4 T: 0 P: 0 **Marks External: 100** **Total: 100**

End Semester Exam: 3 Hours

UNIT – I

The hallmarks of scientific research – Building blocks of science in research – Concept of Applied and Basic research – Quantitative and Qualitative Research Techniques – Need for theoretical frame work –Research Strategies – Ethics – code of conduct for research – Health and Safety - IPR.

UNIT – II

Research Events – Networks – Outreach Activities – Best Research Practices – Quality Assurance for Research – Journal Critiques - Laboratory and the Field Experiment – Internal and External Validity – Factors affecting Internal validity. Measurement of variables – Scales and measurements of variables – Validity testing of scales – Reliability concept in scales being developed – Stability Measures.

UNIT – III

Interviewing, Questionnaires. Secondary sources of data collection. Guidelines for Questionnaire Design – Electronic Questionnaire Design and Surveys. Special Data Sources: Focus Groups, Static and Dynamic panels. Review of Advantages and Disadvantages of various Data-Collection Methods and their utility. Sampling Techniques – Probabilistic and non- probabilistic samples. Issues of Precision and Confidence in determining Sample Size. Hypothesis testing, Determination of Optimal sample size.

UNIT – IV

Introduction to Statistics – Probability Theories - Conditional Probability, Poisson Distribution, Binomial Distribution and Properties of Normal Distributions, Estimates of Means and Proportions; Chi-Square Test, Association of Attributes - t-Test –ANOVA- Standard deviation - Co-efficient of variations. Co-relation and Regression Analysis. Purpose of the written report - Concept of audience - Basics of written reports. Research Report: Types of reports- contents - styles of reporting - steps in drafting reports - editing the final draft - Evaluating the final draft.

UNIT – V

Objectives and roll of higher education – important characteristics of an effective lecture – Quality teaching and learning – lecture preparation – characteristics of instructional design – Methods of teaching and learning : large group – Technique – Lecture, Seminar, Symposium, Team Teaching, Project, Small group Technique – Simulation, role playing demonstration, Brain Storming, Case Discussion, assignment, methods of evaluation – Self Evaluation, student evaluation, Diagnostic testing and remedial teaching – Question Banking – Electronic media in education: e-learning researches – web based learning.

SUGGESTED READINGS:

1. Cooper, D. R., Schindler, P. S., & Sun, J. (2006). Business research methods (Vol. 9). New York: McGraw-Hill Irwin.
2. Sekaran, U., & Bougie, R. (2016). Research methods for business: A skill building approach. John Wiley & Sons.
3. Kothari, C. R. (2004). Research methodology: Methods and techniques. New Age International.
4. McBurney, D. H., & White, T. L. (2009). Research methods. Cengage Learning.
5. Ticehurst, G.W. & Veal, A.J. (2000). Business Research Methods, Managerial approach. Pearson Education.
6. Kumar Ranjit. (2005). Research Methodology. 2nd Edition. Pearson Education.
7. Thietart, R. A. (2001). Doing management research: a comprehensive guide. Sage.

25RFT201 **Research and Publication Ethics** **4H- 4C**

Instruction Hours / Week: L: 4 T: 0 P: 0 **Marks External: 100** **Total: 100**
End Semester Exam: 3 Hours

UNIT I PHILOSOPHY AND ETHICS

Introduction to philosophy: definition, nature and scope, concept, branches - Ethics: definition, moral philosophy, nature of moral judgements and relations.

UNIT II SCIENTIFIC CONDUCT

Ethics with respect to science and research - Intellectual honest and research integrity – Scientific misconducts: falsification, fabrication, and plagiarism - Redundant publications: duplicate and overlapping publications, salami slicing - Selective reporting and misrepresentation of data.

UNIT III PUBLICATION ETHICS

Publication ethics: definition, introduction and importance - Best practices/standards setting initiatives and guidelines: COPE, WAME - Conflicts of interest - Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types - Violation of publication ethics, authorship and contributor ship - Identification of publication misconduct, complaints and appeals - Predatory publishers and journals.

UNIT IV PUBLICATION MISCONDUCT

Group Discussions: Subject specific ethical issues, FFP, authorship - Conflicts of interest - Complaints and appeals: examples and fraud from India and abroad Software tools - Use of plagiarism software like Turnitin, Urkund and other open-source software tools.

UNIT V DATABASES AND RESEARCH METRICS

Databases: Indexing databases - Citation databases: Web of Science, Scopus. Research Metrics: Impact Factor of journal as per journal citation report, SNIP, SJR, IPP, Cite Score - Metrics: h-index, g index, i10 index, altmetrics.

UNIT VI DEVELOPMENT OF E-CONTENT & IPR

Integrated Library Management System (ILMS): e-journals – e-books – e-sjodhsindu – shodhganga – Database – e-content development – Learning Management System (LMS) – ePG Pathshala – CEC (UG) SWAYAM – MOOCs – NPTEL – NMEICT. IPR: Patent – copyrights – Trademark – Geographical Indication.

PRACTICE

Open Access Publishing

Open access publications and initiatives - SHERPA/RoMEO online resource to check publisher copyright and self-archiving policies - Software tool to identify predatory publications developed by SPPU - Journal finder/ journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester.

SUGESSTED READINGS

1. Best Practice Guidelines on Publishing Ethics: A Publisher's Perspective, Second Edition, 2014 John Wiley & Sons, Ltd.
2. Wager E. The Committee on Publication Ethics (COPE): Objectives and achievements 1997-2012. Presse Med. 2012.
3. Carlson RV, Boyd KM, Webb DJ. The revision of the Declaration of Helsinki: Past, present and future. Br J Clin Pharmacol. 2004.
4. Kambadur Muralidhar, Amit Ghosh & Ashok Kumar Singhvi "ETHICS in Science Education,Research and Governance",
5. Indian National Science Academy, New Delhi 2019.
6. Publishing Ethics: Academic Research, Cambridge University Press, Version 2.0, May 2019.

25RFT301 Advanced Tools and Techniques in Food Analysis 4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0 **Marks External: 100** **Total: 100**
End Semester Exam: 3 Hours

UNIT I BASIC CHROMATOGRAPHIC TECHNIQUE

Basic principles of chromatography. Thin layer chromatography - introduction, principle, procedure, general application. Column liquid chromatography and Gas-liquid chromatography- general procedure, qualitative analysis, separation and resolution, quantitative analysis- immuno affinity chromatography- trouble shooting components and interpretation.

UNIT II SPECTROPHOTOMETRIC TECHNIQUES

Spectrophotometry introduction and principles. Ultra violet and visible absorption spectroscopy- basis of absorption spectroscopy, deviations from Beer's law, procedural consideration, calibration curves. Instrumentation and instrument design, application. Fluorimetry introduction, principle and techniques, instrumentation and application. Atomic spectrophotometry- introduction, principles and techniques.

UNIT III ADVANCED CHOROMOTOGRAPHY

Introduction, principle of separation, components of an HPLC system. Pump, injector, column (column hardware and column packing materials in brief) detector and different types of detectors, recorder, Application of HPLC- Minimum Response Performance level- operation quotient and performance quotient. Attributes in analytical techniques- Repeatability, reproducibility, co-efficient of variation. Statistical attributes. Gas chromatography- introduction, sample preparation, principle of separations, components gas supply system, injection port, oven, column and stationary phases, types of columns, detectors different types of detectors, recorder, types of carrier gases used.

UNIT IV ADVANCED ANALYTICAL TECHNIQUES

Microbial techniques- ELISA-Types, PCR, RTPCR, Complement fixation techniques, gel documentation, flow cytometry. Immuno affinity techniques- Radio immuno assay, electrophoresis, definition, types of electrophoretic methods, free solution electrophoresis, agar gel electrophoresis, PAGE.

UNIT V ADVANCED ANALYTICAL INSTRUMENTATION IN TRACE ANALYSIS

Radiotracer techniques, radioactive counters, solid, gas and liquid scintillation. Measurement of enzyme activity. Principles and applications of NIR, NMR, X-ray diffraction analysis in food systems. E sensors, e-nose and e-tongue- instrumentation, application and working principles. Non-invasive non-destructive methods of analysis- MS-FTIR analysis in food, ICPMS, HRMS, AAS.

SUGGESTED READINGS:

1. AOAC International. (2003). Official methods of analysis of AOAC International (17th ed.). Gaithersburg, USA: Association of Analytical Communities.
2. Leo, M. L. (2004). Handbook of food analysis (2nd ed.) New York, USA: Marcel Dekker. Linden, G. (1996).
3. Pearson, D. The Chemical Analysis of Foods. Churchill Livingstone, New York. 2002.
4. Sharma, B.K. Instrumental Methods of Chemical Analysis. Goel Publishing House, New Delhi. 2004
5. Analytical techniques for foods and agricultural products. New York, USA: VCH.
6. Pomeranz, Y., & Meloan, C. E. (1996). Food analysis- theory and practice (2nd ed.). New Delhi, India: CBS Publisher.

25RFT302 Trends in Food Safety and Quality Management Systems 4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0 **Marks External: 100 Total: 100**
End Semester Exam: 3 Hours

UNIT I GENERAL PRINCIPLES FOR FOOD SAFETY AND HYGIENE

Concept of food quality and food safety, need for food safety, major challenges to food safety, major consumer concerns and issues regarding food safety and quality, food safety scenario in India, food safety and quality measures techniques in India, FPO, MFPO, MMPO, AGMARK

UNIT II STANDARD OPERATING PROCEDURE

Principles of food safety management: good hygienic practices (GHP), good manufacturing practices (GMP), food safety hazards, hazard analysis, HACCP principles and implementation in food industry. Good laboratory practices- concept, present status and future need for food industry, concept of food traceability and its need for food safety management system.

UNIT III FOOD SAFETY STANDARDS

Food safety management systems, food safety standards- purpose, classification and types of food standards, standards setting organizations, ISO 15161: 2001, ISO 15161:20002, ISO 22000, legal aspects of food safety management systems, global laws on food safety. Food Safety and Standards Act of India (FSSA)- prospects and problems.

UNIT IV CERTIFICATION AND ACCREDITATION

Quality assurance and management systems in food industry, principles of quality control, quality standards, ISO standards for food industry, total quality management (TQM) in food industry, certification for food safety and quality management systems, certification criteria, selection of certification bodies, role of accreditation in food industry, accreditation agencies, benefits of certification and accreditation.

UNIT V IMPLEMENTATION AND AUDIT

Conduct a hazard analysis, CCP identification, establish critical limits for each CCP, establish CCP monitoring procedures, establish corrective actions procedures, establish procedures for HACCP verification and validation, documenting the HACCP Program. Conducting of open meeting and close meeting in auditing, preparation of audit reports for different department- audit exercise.

SUGGESTED READINGS:

1. Arora, K. C. (2000). TQM and ISO 14000. New Delhi, India: Kataria Publications.
2. Alli, I. (2003). Food quality assurance: Principles and practices. Boca Raton, Florida, USA: CRC Press.
3. Ronald, S., Rodrick, H., & Gary, E. (2003). Food safety handbook. Hoboken, USA: John Wiley and Sons Publication.
4. Hester, R. E., & Harrison, R. M. (2001). Food safety and food quality. Cambridge, UK: The Royal Society of Chemistry.
5. Jouve, J. L., Stringer, M.F., & Baird Parker, A. C. (1998). Food safety management tools. Brussels, Europe: International Life Science Institute.
6. Sara Mortimore and Carol Wallace. 2013. HACCP - A practical approach. Third edition. Chapman and Hall, London.

25RFT303 Advanced Techniques in Food Processing 4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0 **Marks External: 100** **Total: 100**
End Semester Exam: 3 Hours

UNIT-I TEMPERATURE AND PRESSURE PROCESSING TECHNIQUES

Low temperature- refrigeration, chilling, freezing, methods of freezing, effect of low temperature on food. Preservation of food by high temperature- basic concepts in thermal destruction of microorganisms D, Z, F, values. Microorganism associated with high temperature and low temperature foods. Blanching, pasteurization and sterilization of foods. Canning and aseptic processing of food. High Pressure processing- concept, equipment for HPP treatment, mechanism of microbial inactivation and its application in food processing. Aseptic Processing- methods of sterilization, aseptic packaging systems.

UNIT-II RADIATION AND MEMBRANE TECHNOLOGY

Microwave and radio frequency Processing- mechanism of heat generation, applications in food processing, blanching, sterilization and drying. Heating of foods via electrical resistance. Membrane technology- micro-filtration, ultra-filtration, nano-filtration and reverse osmosis and their application. Supercritical fluid extraction and its application. principles and applications of hurdle technology.

UNIT-III ULTRASOUND AND OHMIC PROCESSING TECHNOLOGY

Ultrasonic processing- properties of ultrasonic, application of ultrasonic in food processing. High voltage pulse techniques in food processing. Biodegradable food films and coatings and its applications. Basics of ohmic heating- electrical conductivity, generic configurations, treatment of products, mechanism of microbial and enzyme inactivation.

UNIT-IV PULSED ELECTRIC FIELD PROCESSING TECHNIQUE

PEF- principles, mechanism of action, PEF treatment systems, main processing parameters, mechanism of microbial and enzyme inactivation, safety aspects, processing of liquid foods using PEF, process models. Comparison of high-pressure processing and PEF- enzymatic inactivation by PEF e.g., microbiological and chemical safety of PEF foods.

UNIT–V FOOD NANOTECHNOLOGY AND BIOSENSORS

Nano-fluids for thermal processing of foods**.** Nanotechnology- principles and applications in foods. Biosensors, nano-biosensors- design, and applications. Bio-based composites- design, testing and applications, biomimicing in food technology; 3-D printing in foods.

SUGGESTED READINGS:

1. Da-wen Sun: Emerging Technologies for Food Processing, Elsevier Academic Press and Marcel Dekker Inc, 2014.
2. Gustavo V. Barbosa- Canovas, Maria S. Tapia, M. Soledad Tapia, M. Pilar Cano, Novel Food Processing Technologies (Food Science and Technology Series), CRC Press,2004.
3. Cullen, P.J., Tiwari, B.K. and Valdramidis V.P. Novel thermal and non-thermal technologies for fluid foods. Academic press, 32 Jamestown Road, London NW17BY, UK. 2012.
4. Sivasankar, B. 2011. Food processing and preservation, Eastern Economy Edition, BHI Publishers, New Delhi.
5. M. Shafiur Rahman, 2007. Handbook of Food Preservation, Second Edition. CRC Press, Muscat, Sultanate of Oman.
6. Neelam Khetarpaul. 2005. Food Processing and Preservation, Daya Publishing House, New Delhi

25RFT304 **Advances in Food Chemistry** **4H- 4C**

Instruction Hours / Week: L: 4 T: 0 P: 0 **Marks External: 100** **Total: 100**
End Semester Exam: 3 Hours

UNIT I PHYSICOCHEMICAL PROPERTIES OF FOOD COMPONENTS

Food chemistry- Fundamentals Water activity and its relevance to deteriorative processes in foods (chemical, physical andmicrobial changes). Methods for stabilization of foods by control of water activity. Glass transition and molecular mobility in foods, their relevance to quality and stability of food products.

UNIT II CARBOHYDRATES

Modification of carbohydrates especially starches and celluloses, manufacture of maltodextrins and corn syrups. Food applications (nutraceutical and functional properties) of carbohydrates. Interactions of carbohydrates with other food constituents and their implications. Changes in food carbohydrates during processing. Dietary fiber- sources, types, functional ingredients. Resistant oligosaccharides and its modifications.

UNIT III LIPIDS

Introduction and definition of lipids and their classification, structural aspects, nutritional aspects of food lipids and their sources- omega-3 and omega-6 fatty acids and their significance. Physical and chemical characteristics of various fats and oils. Measurement of lipid degradation parameters during deep-fat frying and storage of foods. Hydrogenation of vegetable oils. Characteristics tests for various oils. Trans-fatty acids- formation during processing and nutritional aspects.

UNIT IV PROTEINS

Protein structure and chemistry, physico-chemical properties of protein and their structure. Protein-protein interactions, methods of evaluation of protein quality and amount, conventional and novel sources of protein. Protein concentrates/isolates. functional properties of proteins and their applications. High protein food formulations, modification of proteins by enzymes, chemical and physical methods. Interactions of proteins with flavours, polysaccharides, lipids and their technological effects. Enzymes- classification, properties, kinetics.

UNIT V MICRONUTRIENTS

Vitamins, structure, stability in foods, degradation of vitamins during processing, analysis of vitamins, bioavailability of vitamins. Pigments- structure and types of various pigments viz carotenoids, flavonoids, chlorophylls, quinoids, betalins. Physical and chemical properties, stability during processing

SUGGESTED READINGS:

1. Fontana. M.G., Corrosion Engineering, Tata McGraw Hill, 3rd Edition, 2005.
2. Fennema, O. R. (2008). Fennema's food chemistry. S. Damodaran, & K. L. Parkin (Eds.). Boca Raton: CRC press.
3. Jones.D.A. Principles and Prevention of Corrosion, 2nd Edition, Prentice Hall, 1996.
4. Amir Eliezer, Corrosion, Processes and Advanced Materials in Industry, Trans Tech Publications Ltd, 2010.
5. Lloyd H. Hihara, Environmental Degradation of Advanced and Traditional Engineering Materials,

25RFT305 Waste Utilization and By-product Development 4H-4C

Instruction Hours / Week: L: 4 T: 0 P: 0 **Marks External: 100** **Total: 100**
End Semester Exam: 3 Hours

UNIT I FRUIT AND VEGETABLE INDUSTRIES

Different sources- composition of different fruit wastes- possible by products from fruit and vegetable waste- utilization of different wastes - extraction of fat, essential oil, starch, pectin, animal feed, natural colours, organic acid, leaf protein

UNIT II CEREAL AND PULSES MILLNG INDUSTRIES

Waste from rice milling industry- rice husk and rice bran- utilization of rice husk- cement preparation, ceramic materials. Utilization of rice bran- problems in processing of rice bran- stabilization - methods of utilization- rice bran stabilizers- extraction of rice bran- refining- uses of bran, bran oil and defatted bran. Waste utilization from wheat milling and pulse milling industry.

UNIT III TUBER AND PLANTATION CROPS

Waste utilization from sugarcane industries, press mud and bagasse and molasses. Coconut processing industries- coir pith, shell, charcoal.

UNIT IV MEAT FISH AND POULTRY WASTE UTILIZATION

Fish industry by products- methods and production of fish meal, fish protein concentrate- fish and body oils. Poultry waste - recycling.

UNIT V BIO GAS PRODUCTION

Biogas- definition, composition, history of biogas, production of biogas – factors affecting the efficiency, types of biogas plant (floating drum type and fixed dome type) and their components, selection and design of biogas plant.

SUGGESTED READNGS:

1. L.R. Verma and V. K Joshi. General concepts and principles.2000. Postharvest Technology of Fruits and Vegetables: Handling, Processing, Fermentation and waste management. M.L. Gidwani, Indus Publishing Company, New Delhi.
2. P. N. Chereminoff & A.C Morresi, 1976, "Energy from Solid Wastes" New York, Marcel Dekker, Inc. (Pollution Engineering and Technology. Volume 1), 1976. 513 p.
3. Vasso Oreopoulou, Winfried Russ "Utilization of By-Products and Treatment of Waste in the Food Industry" ISBN: 1441941374, 9781441941343, Springer 2011.
4. Oreopoulou, V., & Russ, W. (Eds.). (2007). Utilization of by-products and treatment of waste in the food industry.
5. Joshi, V. K. (Ed.). (2011). *Food processing waste management: Treatment and utilization technology*. New India Publishing Agency.

25RFT306 **Food Nanotechnology** **4H- 4C**

Instruction Hours / Week: L: 4 T: 0 P: 0 **Marks External: 100** **Total: 100**
End Semester Exam: 3 Hours

UNIT I BIOACTIVE NUTRACEUTICALS

Nutraceuticals– definition, concept, history and market. Evolution of nutraceuticals and functional foods market. Classification of nutraceuticals and functional foods. Significance and relevance of nutraceuticals and functional foods in the management of diseases and disorders

UNIT II EXTRACTION

Source of bioactive compounds- extraction methods- supercritical fluid extraction, subcritical fluid extraction, ultrasound-assisted extraction, microwave-assisted extraction, pulsed electric field extraction.

UNIT III ENCAPSULATION VIA LIQUID SYSTEM

Emulsion, nano-emulsion, liposomes, nano-crystallization, oleogel, hydrogel, organogels, nano dispersion, solid-liquid nanoparticles.

UNIT IV ENCAPSULATION VIA SOLID SYSTEM

Encapsulation for bioactive compounds – ultrasound, spray drying, spray chilling, fluidized bed coating, freeze drying.

UNIT V FOOD FORTIFICATION

Food fortification – introduction, development of functional foods, use of encapsulated bioactive compounds in appropriate food system, physicochemical and sensory attributes, digestibility studies via *in-vitro* and *in-vivo*.

SUGGESTED READINGS:

1. Anandharamakrishnan, C., & Parthasarathi, S. (Eds.). (2019). Food nanotechnology: principles and applications. CRC Press.
2. Jafari, S. M. (Ed.). (2020). Handbook of food nanotechnology: applications and approaches. Academic Press.
3. Molina, G., Pelissari, F. M., & Asiri, A. M. (Eds.). (2019). Food applications of nanotechnology. CRC Press.
4. Echiegu, E. A. (2017). Nanotechnology applications in the food industry. Nanotechnology: Food and Environmental Paradigm, 153-171.
5. Assadpour, E., Dima, C., & Jafari, S. M. (2020). Fundamentals of food nanotechnology. In Handbook of food nanotechnology (pp. 1-35). Academic Press.

25RFT307 **Advanced Drying Technology** **4H- 4C**

Instruction Hours / Week: L: 4 T: 0 P: 0 **Marks External: 100** **Total: 100**
End Semester Exam: 3 Hours

UNIT I PRINCIPLES OF DRYING

Principles of drying- fundamentals of air-water mixtures, theories of drying. Psychometric chart- problems based on psychometry. Drying curves- constant and falling rate period. Heat and mass transfer in dryers- with and without recirculation. Dryers in food processing industry- issues in food drying technology, water content in foods and its determination

UNIT II ADVANCED DRYING TECHNOLOGIES

Drum driers- types of drum dryers, foam mat drying, factors affecting foam mat drying. Rotary dryer and osmotic dehydration- principles, osmotic agents. Spray drying- interaction of droplets with air, drying of droplets with soluble and insoluble solids, factors affecting spray drying. Foam spray drying, applications in the food industry.

UNIT III FLUIDIZED BED, PNEUMATIC AND FREEZE DRYING

Fluidized bed drying- effects of processing parameters in fluidized bed dryer. Freeze dryer- fundamentals of freeze drying. Pneumatic /Flash dryers- basic operation principle and applications of flash dryers, design of flash dryers, materials dried in flash dryers.

Unit IV NOVEL DRYING TECHNOLOGIES

Refractive window dehydration, superheated steam drying, high electric field drying, infrared drying, spray-freeze drying and heat pump drying.

UNIT IV SPECIAL DRYING TECHNIQUES

Special drying techniques- contact-sorption drying, drying on inert particles, pulse combustion drying, drying with induction heating. Novel dryers- airless drying, drying in mobilized beds, vacuum jet drying.

SUGGESTED READINGS:

1. Mujumdar, A. S. (2001). Drying technology in agriculture and food science. Drying Technology, 19(6), 1217-1218.
2. Anandharamakrishnan, C. (Ed.). (2017). Handbook of drying for dairy products. John Wiley & Sons.
3. Loasecke H.W.V., Drying and dehydration of Foods, Agrobios, Jodhpur, 2001.
4. Kudra, T and Majumdar, A.S., Advanced Drying Technologies, Marcel Dekker Inc., NewYork, 2002.
5. Loeseck ,H. W. V, "Drying & Dehydration of Foods", Published by Agrobios, 2005.

25RFT308 **Advances in Plant-based Foods** **4H- 4C**

Instruction Hours / Week: L: 4 T: 0 P: 0 **Marks External: 100** **Total: 100**
End Semester Exam: 3 Hours

UNIT I INTRODUCTION TO PLANT-BASED FOODS

Processing and preservation: Fruits and nuts, spices and herbs, cereal grains, legumes, foods from leaves, stem and roots, Beverages: both alcoholic and non-alcoholic, vegetable oils and fats, gums, gels and resins.

UNIT II NUTRITIONAL AND SENSORY CHARACTERISTICS OF PLANT-BASED FOODS

Nutritional value of plant foods, processing impact on nutritional quality, sensory attributes, level of antioxidants and other functional ingredients of plant foods. Quality evaluation of plant foods by chromatography, spectrometry, scanning electron microscopy and various non-destructive techniques.

UNIT III QUALITY IMPROVEMENT AND PLANT SUBSTITUTES FOR ANIMAL PRODUCTS IN FOODS

Organic farming, fortification of plant-based ingredients in foods: nutritional value and economic aspects. Animal protein substitutes, milk fat substitutes.

UNIT IV APPLICATION OF NOVEL PROCESSING TECHNIQUES IN PLANT-BASED FOODS

Application of pulsed electric field (PEF) assisted extraction from food plants, application of PEF to liquid foods and juices, use of high pressure to processing and preservation of plant foods, use of ultra-violet light, ultra sound, microwave and ohmic-heating technology for processing of plant foods, extraction of essential oils by super-critical fluid extraction, application of novel thermal and non-thermal techniques for plant food processing.

UNIT V UTILIZING BIOTECHNOLOGY IN PLANT-BASED FOOD PRODUCTION

Transgenic plants, biotechnology advancements to improve the nutritional quality of plant-based foods, genetic modification of plant seed – chemistry and biosynthesis, engineering of starches and other carbohydrates for food application, chemistry and engineering of vegetable oils and fats, plant

cell and tissue culture for production of food ingredients, plant pigments - characteristics, biosynthesis, gene regulation and application as food additives, regulation and risk of genetically modified foods and transgenic plants.

SUGGESTED READINGS:

1. Sundaram Gunasekaran, Nondestructive Food Evaluation: Techniques to Analyze Properties and Quality, CRC Press, 2000 7.
2. M. Shafiur Rahman, Handbook of Food Preservation, CRC Press, 2007 8.
3. Pieternel A. Luning, F. Devlieghere and Roland Verhé, Safety in the Agri-food Chain, Wageningen Academic Publishers, 2006
4. Shi, J., Nawaz, H., Pohorly, J., Mittal, G., Kakuda, Y., & Jiang, Y. (2005). Extraction of polyphenolics from plant material for functional foods—Engineering and technology. Food reviews international, 21(1), 139-166.
5. Altman, A., & Hasegawa, P. M. (Eds.). (2012). Plant biotechnology and agriculture: prospects for the 21st century. Academic press.

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25RFT309 **Advances in Animal Products Technology** **4H- 4C**

Instruction Hours / Week: L: 4 T: 0 P: 0 **Marks External: 100** **Total: 100**
End Semester Exam: 3 Hours

UNIT I ADVANCEMENT IN MEAT PROCESSING

Processing- meat quality and its nutritional properties, automation technologies for the modern slaughterhouse, high pressure processing of meat, modified atmosphere packaging, perspectives for the active packaging, hot-boning of meat, new spectroscopic techniques analyzing meat quality, developments in chilling, freezing of meat products.

UNIT II ADVANCEMENT IN POULTRY PROCESSING

Quality of poultry – improvements in stunning and slaughter, processing and packaging, new techniques of preservation of poultry products, processing and production of products from turkeys, geese, ducks and game birds, microbial hazards in poultry production and processing, treatment and disposal of poultry processing waste and utilization of poultry processing waste for byproduct development.

UNIT III ADVANCEMENT IN FISH AND SEAFOOD

Fresh fish handling and chill storage, modified atmospheric packaging of seafoods, fish odours and flavours, assessment of freshness of fish and seafoods, traditional dried and salted fish products, proteolyzed fish products, minced fish technology, retort pouch processing technology, irradiation and microwave in fish handling and processing, advanced freezing technology for fish storage, high pressure processing of seafoods, value addition of freshwater and farmed fish products.

UNIT IV ADVANCEMENT IN DAIRY TECHNOLOGY

Physical, chemical and nutritional properties of milk components, improvements in the pasteurization and sterilization of milk. Flavour generation in dairy products, controlling texture of fermented dairy products, functional dairy products, novel separation technologies to produce dairy ingredients, new technologies to increase shelf-life of dairy products, genetic engineering of milk proteins, production and utilization of functional milk proteins.

UNIT V REGULATORY STANDARDS

Marketing and regulatory issues for animal-based products: CODEX Guidelines, EU guidelines and FSSAI guidelines

SUGGESTED READINGS:

1. Advanced Technologies for Meat Processing, By Leo M. L. Nollet, Fidel Toldnl, Published by CRC Press, 2006 2.
2. Meat Processing: Improving Quality, By Joseph Kerry, D.A. Ledward, Published by Woodhead Publishing, 2002.
3. Walstra, P., Walstra, P., Wouters, J. T., & Geurts, T. J. (2005). Dairy science and technology. CRC press.
4. Boziaris, I. S. (Ed.). (2014). Seafood processing: Technology, quality and safety. John Wiley & Sons.
5. Hui, Y. H. (2010). Handbook of Poultry Science and Technology, Primary Processing (Vol. 1). John Wiley & Sons.

25RFT310	**Functional Foods**	**4H- 4C**

Instruction Hours / Week: L: 4 T: 0 P: 0 **Marks External: 100** **Total: 100**

End Semester Exam: 3 Hours

UNIT I INTRODUCTION

Overview; definition, classification; functional food, functional food science, food technology and its impact on functional food development; markers for development of functional foods; key issues in Indian functional food industry and nutraceutical. Relation of functional foods and nutraceutical (FFN) to foods and drugs.

UNIT II BIOACTIVE COMPOUNDS

Historical perspective; definition, nature, nutraceutical compounds and their classification based on chemical/biochemical nature with suitable and relevant descriptions; scope and future prospects. Applied aspects of the nutraceutical science, relation of nutraceutical science with other sciences: medicine, human physiology, genetics, food technology, chemistry and nutrition

UNIT III ANTIOXIDANTS

Concept of free radicals and antioxidants; antioxidants role as nutraceuticals and functional foods. Phytochemicals: sources, properties and application in foods, role of isoprenoids, isoflavones, flavonoids, carotenoids, tocotrienols, chlorophyll, terpenoids, proanthocyanidin.

UNIT IV FOOD SOURCES

Different foods as functional food: cereal products (oats, wheat bran, rice bran, etc.), fruits and vegetables, milk and milk products, legumes, nuts, oil seeds and sea foods, herbs, spices and medicinal plants. Coffee, tea and other beverages as functional foods/drinks and their protective effects. Protein, complex carbohydrates like dietary fibers as functional food ingredients; probiotic, prebiotics and symbiotic foods, and their functional role.

UNIT V ANTI-NUTRITIONAL FACTORS PRESENT IN FOODS

Types of inhibitors present in various foods and their inactivation. Assessment of nutritional status and recommended daily allowances. Effects of processing, storage and interactions of various environmental factors on the potentials of such foods. Marketing and regulatory issues for functional foods and nutraceuticals. Recent development and advances in the areas of nutraceutical and functional foods.

SUGGESTED READINGS:

1. Mitsuoka, T. (2014). Development of functional foods. Bioscience of microbiota, food and health, 33(3), 117-128.
2. Smith, J., & Charter, E. (Eds.). (2011). Functional food product development.
3. Mine, Y., Li-Chan, E., & Jiang, B. (Eds.). (2010). Bioactive proteins and peptides as functional foods and nutraceuticals (Vol. 29). John Wiley & Sons.
4. Egbuna, C., & Dable-Tupas, G. (2020). Functional foods and nutraceuticals. Springer Nature Switzerland AG, 1, 1-632.
5. Aluko, R. E. (2012). Functional foods and nutraceuticals (pp. 37-61). New York, NY, USA: Springer.