Phone : +91-2692-261302 E mail : deanfpt@aau.in Web Site : www.aau.in

COLLEGE OF FOOD PROCESSING TECHNOLOGY & BIO ENERGY (AAU)
Anand – 388110, Gujarat, India

DR. SAMIT DUTTA
PRINCIPAL & DEAN

AAU/FPTBE/PG Acad/ 411 /24
Dated: 30 / 05 /2024

Endorsement for the Programme Specific Outcomes, Programme Outcomes, and Course Outcomes Mapping of M. Tech. and Ph. D.- Food Technology curriculum

ICAR appointed National Core Group and BSMA Committees for revision and restructuring of Post-graduate and Doctoral syllabi in **M. Tech. and Ph. D.- Food Technology** has undertaken the task of formulating and advocating uniform courses, along with meticulously curated syllabi, across all esteemed colleges of food technology within our nation. The courses and syllabi have been structured with integral importance placed on precision and alignment with academic standards. They serve as a beacon of academic integrity and rigor, aimed at fostering a harmonized educational landscape within the realm of Food Technology. The recommendations set forth by the ICAR Fifth Deans' Committee have been duly endorsed and ratified, reflecting the discerning evaluation and unwavering commitment to educational excellence. This initiative has been executed with careful consideration of meticulous deliberations and diligent efforts by deans from various agricultural universities.

M. Tech. and Ph. D – Food Technology curriculumas per the BSMA recommendations is herewith delineates and articulates for the Programme Specific Outcomes, Programme Outcomes, and Course Outcomes, meticulously and mapped to ensure a comprehensive and coherent educational framework. The undersigned hereby affix our official seal and endorsement, thereby granting unequivocal approval.

PRINCIPAL & DEAN

Syllabus of M. Tech. / Ph. D program of Food Technology

Objectives of Programme

- To facilitate the environment for consolidation of the knowledge acquired at undergraduate level and to motivate and inspire the students to create deep interest in the different field of food technology.
- To provide students with theoretical knowledge and practical abilities required to work in the food industry, research centres, and food related national and international organizations.
- To impart the skills in the area specialised filed of food processing, food safety and quality, food process engineering for creating potential entrepreneurs.

Program Outcome (PO)

1. Develop a systematic, extensive and coherent knowledge and understanding of the academic field of study as a whole and its applications, and links to related disciplinary areas/subjects of study; including a critical understanding of the established processes, technologies, their applications and of a number of advanced and emerging issues in the field of Food Technology.
2. Develop procedural knowledge that creates different types of professionals related to the subject area of Food Technology, including research and development, teaching and government and public service.
3. Develop skills in areas related to one's specialization area and current developments in the academic field of Food Science and Technology, including a critical understanding of the latest developments in the area of specialization, and an ability to use established techniques of analysis and enquiry within the area of specialization.
4. Develop comprehensive knowledge about materials and methods, including current research, scholarly, and/or professional literature, relating to essential and advanced learning areas pertaining to various subfields in food science and technology, and techniques and skills required for identifying food science and technology problems and issues in their area of specialization.

Program Specific Outcome (PSO)

1. Develop and strengthen the basic knowledge and concepts that are required for food processing sector.
2. Expose students to higher education with research oriented creative tools/techniques for innovations in food technology domain.
3. Raising the capability of students for use of technologies and instruments in the field of food technology.
4. Enable students for utilisation of recent technologies to develop new concepts/intervention demanded by food technology sector through research and practical concepts.
5. Develop skills and current developments in specialized area of food technology.
6. Develop student for continuous learning and research for successful academic and industrial career in the food technology sector.
7. To impart knowledge of professional and ethical responsibilities toward the society.

Mapping between POs and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7

PO1							
PO2							
PO3							
PO4							

PO = **Program outcome** with PSO = **Program Specific outcome**

<table>
<tr><td>Course code</td><td colspan="2">FPT 501</td></tr>
<tr><td>Course title</td><td colspan="2">Emerging Technologies in Food Processing</td></tr>
<tr><td>Corse credit</td><td colspan="2">3 (2+1)</td></tr>
<tr><td>Teaching per Week</td><td colspan="2">4 h</td></tr>
<tr><td>Course Objective (CO)</td><td colspan="2">1. To understand the principle of membrane separation and supercritical extraction
2. To understand the principles of microwave and its application in food processing
3. To understand the principles of high-pressure processing and its application in food
4. To understand the principles of pulse electric field and its application in food
5. To understand the principles of cryogenic grinding and its application in spice processing</td></tr>
<tr><td>Course Content</td><td colspan="2">
<table>
<tr><td>Unit 1</td><td>Membrane technology: Pressure activated membrane processes: MF, UF, NF and RO and their industrial application. Membrane distillation
Supercritical fluid extraction: Concept, property of super critical fluids SCF, extraction methods, application in food processing</td></tr>
<tr><td>Unit 2</td><td>Microwave and radio frequency processing: Advantages, mechanism of heat generation, application in food processing: microwave blanching, sterilization and finish drying
Hurdle technology: Concept and Principle, Preservation techniques as hurdles and their principles, hurdle tech foods.</td></tr>
<tr><td>Unit 3</td><td>High pressure processing: Concept, equipment for HPP treatment, mechanism of microbial and enzyme inactivation and its application in food processing, effect on food constituents.
Ultrasonic processing: Properties of ultrasonic, types of equipment, application of ultrasonic as processing technique.</td></tr>
<tr><td>Unit 4</td><td>Newer techniques in food processing: Principle and application of high intensity light, Pulse electric field, Ohmic heating, IR heating, Inductive heating, Cold plasma, and Pulsed X-rays in food processing and preservation, Cryo-processing of foods.
Nanotechnology: Principles and applications in foods.</td></tr>
</table>
List of Practicals
<table>
<tr><td>1</td><td>To evaluate the characteristics of treated water using RO system</td></tr>
<tr><td></td><td>To study production and characteristics of treated water using, microfiltration, UF, NF and RO system</td></tr>
<tr><td>2</td><td>To study the effect of ultrafiltration process on fruit juices quality</td></tr>
<tr><td>3</td><td>To study suitability and production of fruit juices using ultrafiltration</td></tr>
<tr><td>4</td><td>To study the effect of microfiltration process on milk quality</td></tr>
<tr><td>5</td><td>To study super critical fluid extraction system and to carry out extraction of bioactivecompound from selected samples</td></tr>
<tr><td>6</td><td>To carry out extraction of lycopene from tomato using SCFE system</td></tr>
<tr><td>7</td><td>To study microwave system and to evaluate the effect of different power on drying characteristics of selected vegetable products</td></tr>
<tr><td>8</td><td>To study microwave blanching of vegetable and determination of</td></tr>
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</table>

		blanching efficacy
	9	To study the effect of different drying techniques/ hybrid drying techniques on fruits and vegetables
	10	To study the ultrasonicator and evaluate the effect of ultrasonication on micro-organism in sample
	11	To evaluate the effect of ultrasonication on extracted juice yield from fruit pomace
	12	To evaluate the different pre-treatment on oil yield from oil seed cake
	13	To prepare nano emulsion and study of their characteristics
	14	To study ohmic heating system and to study the processing of fruit pulp using ohmic heating system
	15	To visit food industries utilizing advance food processing techniques

References:

1. Gould G W, 2000. New Methods of Food Preservation, CRC Press.
2. Barbosa-Canovas, 2002. Novel Food Processing Technologies, CRC Press.
3. Dutta AK & Anantheswaran RC. 1999. Hand Book of Microwave Technology for FoodApplications, CRC Press.
4. Sun DW, 2015. Emerging Technologies for Food Processing, Elsevier Ltd.
5. Kudra T and Mujumdar AS, 2009. Advanced Drying Technologies, CRC Press.
6. Nema PK, Kaur BP and Mujumdar AS, 2018. Drying Technologies for Foods: Fundamentals andApplications, CRC Press

Course Outcomes

CO1: Familiarisation with working of ultra-sonicator for food processing
CO2: Expose to the industrially applications of PEF
CO3: Familiarisation with use of HPP equipment's
CO4 Familiarisation with working of super critical fluid extraction system
CO5 Familiarisation with making of nano-emulsion

Mapping between COs with PSOs

Mapping between COs and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1							
CO2							
CO3							
CO4							
CO5							

Course code	**FPT 502**	
Course title	**Emerging Technologies in Food Packaging**	
Corse credit	**3(2+1)**	
Teaching per Week	**4 h**	
Course Objective (CO)	1. To study the active and intelligent packaging system and its application in foods 2. To study about different scavenging techniques used in food packaging 3. To study about antimicrobial food packaging used for food packaging 4. To study non migratory bio active polymers and its food application 5. To study fermenter design 6. To study the downstream processing	
Course Content	**Unit 1**	Active and Intelligent Packaging: Packaging techniques- Definition, Concept, Types, current use of novel packaging techniques. Novel packaging- oxygen, ethylene and other scavengers: Oxygen scavenging technology, selecting right types of oxygen scavenger, ethylene scavenging technology, carbon dioxide and other scavengers. Antimicrobial food packaging: Antimicrobial agents, constructing/ designing antimicrobial packaging systems, factors affecting the effectiveness of antimicrobial packaging.
	Unit 2	Non-migratory bioactive polymers (NMBP): Advantages of NMBP, Inherently bioactive synthetic polymers: types and application, Polymers with immobilized bioactive compounds and their applications. Time temperature indicators (TTIs) and labels: Defining and classifying TTIs, Requirements for TTIs, Development of TTIs, Maximizing the effectiveness of TTIs, Application of TTIs- to monitor shelf-life, and optimization of distribution and stock rotation, leakage indicators, oxygen indicators, micro indicators etc. Freshness indicator in packaging: Compounds indicating the quality of packaged food products, freshness indicators, pathogen indicators, other methods for spoilage detection. Self-heating /rehydrating packages.
	Unit 3	Packaging-flavour interaction: Factors affecting flavor absorption, role of food matrix, role of different packaging materials, flavour modification and sensory quality, Study of packaging materials compatibility with foods. Developments in modified atmosphere packaging (MAP): Permeability properties of polymer packaging, measurement of permeability – water and gases. Selection criteria of packaging films, Novel MAP gas, testing novel MAP applications, applying high oxygen MAP. Recycling packaging materials: Recyclability of packaging plastics, improving the recyclability of plastics packaging, testing safety and quality of recycled materials, uses of recycled plastics in packaging.
	Unit 4	Green plastics for food packaging: Problems of plastic packaging wastes, range of biopolymers, developing novel biodegradable materials. Edible Films and Coatings: Properties, types, sources, applications, advantages, disadvantages, theories of plasticization, challenges and opportunities. PFS machine, seal and closures. Safety and legislative aspects of packaging: Regulatory considerations, plastic, metal, paper and glass packaging.
	List of Practicals	

	1.	Determination of WVTR in different packaging materials
	2.	Determination of GTR in different packaging materials.
	3.	Study of different ethylene scavengers and their analysis
	4.	Study of different oxygen scavengers systems and their analysis
	5.	Application of anti-microbial packaging for moisture sensitive foods
	6.	Evaluation of chemical residue migration from package to food
	7.	Application of MAP packaging in selected foods
	8.	Study of TTI label, leakage indicators etc.
	9.	Determination of oxidative changes in packaged foods
	10.	Comparative evaluation of flexible and rigid packages for fragile foods
	11.	Packaging of foods under inert atmosphere.
	12.	To study textural characteristics of selected fruit/ vegetable under MAP storage
	13.	Shelf life evaluation of packaged food product.
	14.	Determination of oil and grease resistant test for packaging films
	15.	Determination of respiration rate in fresh fruits and vegetables
	16.	Determination of shelf life of fresh fruits and vegetables by using edible coating and films.
	17.	Effect of edible coating and films on respiration behaviour, chemical, physical and sensory characteristics of fresh fruits and vegetables.
	18.	Visit to food packaging material manufacturing industry

References:

1. Ahvenainen R, 2001. Novel Food Packaging Techniques, CRC Press.
2. Robertson GL, 2012. Food Packaging, CRC Press.
3. Hanlon, J F, Kelsey R J & Forcinio H. 1998. Handbook of Package Engineering, CRC Press.
4. Paine FA, 1992. A Handbook of Food Packaging, Blackie.
5. Rooney ML, 1988. Active Food Packaging, Chapman & Hall.
6. Coles R & Kirwan M, 2011. Food and Beverage Packaging Technology, Wiley -Blackwell.
7. Han J and Han J, 2005. Innovations in Food Packaging, Academic Press.
8. Yam K & Lee D, 2012. Emerging Food Packaging Technologies, Woodhead Publishing

Course Outcomes

CO1: Expose to the different novel food packaging techniques
CO2: Application of MAP, Aseptic packaging its application in food.
CO3: Knowledge about antimicrobial food packaging and its application.
CO4: Familiarisation with various properties and testing of food packaging materials
CO5: Familiarisation with time temperature indicators and non-migratory bioactive compounds used in food packaging

Mapping between COs with PSOs

Mapping between COs and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1							
CO2							
CO3							
CO4							
CO5							

Course code	**FPT 503**
Course title	**Industrial Manufacturing of Food and Beverages**
Corse credit	**3(2+1)**
Teaching per Week	**4 h**
Course Objective (CO)	1. To get exposure towards grain-based food products development 2. Familiarization with extrusion technology for food product development 3. To study fruits and vegetable product manufacturing 4. Familiarization with food chocolate and cocoa based food products 5. To acquire knowledge of carbonated and non-carbonated beverage making

Course Content

Unit 1	Grain products: Industrial manufacturing of grain-based products: formulation, processes, machinery andmaterial balance of baked, rolled, shredded, puffed, flaked, roasted products. Extrusion technology: Importance and applications of extrusion in food processing; Pre and post extrusion treatments; Manufacturing process of extruded products; Changes in functional properties of food components during extrusion. Breakfast cereals, RTE/RTC foods, instant premixes, functional foods.
Unit 2	Fruit and vegetable products: Industrial manufacturing of fruit and vegetable-based products: formulation, processes, machinery and material balance of minimally processed, Retorted products, Intermediate Moisture Food (IMF), high moisture stable foods, IQF: Machines and equipment for batch and continuous processing offruit and vegetable products.
Unit 3	Chocolates and candies: Coating or enrobing of chocolate (including pan-coating); Maintenance, safety and hygiene of bakery plants. Fats and oils processing: Technology of refined oil, winterized oil, hydrogenated fat, texturized fat, by- products of fat/oil processing industries – oil seed protein isolates; Quality standards of fats and fatty foods; Antioxidants and its mechanism of application.
Unit 4	Beverages: Production technology of beer and wine Non – alcoholic beverages: Carbonated beverages: carbonation equipment, ingredients, preparation of syrups, Filling system-packaging containers and closures. Non-carbonated beverage: Coffee bean preparation, processing, brewing, decaffeination, instant coffee ; Tea types-black, green, Fruit juices and beverages, Flash pasteurization, Aseptic packaging of beverages, Tea/coffee and cocoa beverages, Grain based and malted beverages. Packaged drinking water: types, manufacturing processes, quality evaluation of raw and processed water, methods of water treatment, BIS quality standards of bottled water; mineral water, natural spring water, flavoured water, carbonated water.

List of Practicals

1	Preparation of cereals based fried snack foods
2	Preparation of cereal, pulses based ready-to-eat snack food by extrusion cooking their quality evaluation
3	Preparation of cereal grain based puffed products
4	Development of instant food premixes
5	Preparation of cereal and legume based roasted snack

	6	Preparation of flaked rice product
	7	To study the effect of roasting time and temperature on quality of pop-corn
	8	Determination of shelf-life and packaging requirements of snack food products
	9	Preparation of fruits/vegetable based ready to serve beverages and quality evaluation
	11.	Heat classification of milk powders
	12.	Determination of degree of browning-chemical/physical methods
	13.	Determination of quality of packaged drinking water
	14.	Preparation of wine and beer
	15.	Preparation of soy milk
	16.	Determination of quality of canned food

References:

1. Edmund WL, 2001. Snack Foods Processing, CRC Press.
2. Gordon BR, 1990. Snack Food, Springer US.
3. Frame ND, 1994. Technology of Extrusion Cooking, Springer US
4. O'Brien RD, 2008. Fats and Oils: Formulating and Processing for Application, CRC Press.
5. Davis B, Lockwood A, Alcott P & Pantelidis L, 2012. Food and Beverage Management, CRC Press.
6. Kunze W, 2010. Technology: Brewing and Malting, VLB.
7. Dhillon PS and Verma S, 2012. Food and Beverage: Production Management for Hospitality Industry, Abhijeet Publications.
8. Bamforth CW, 2006. Brewing: New Technologies, Woodhead Pub.

Course Outcomes

CO1: Able to develop grain-based food products
CO2: Knowledge about development of fruits and vegetable-based products
CO3: Familiarisation with chocolate and candies related product and their production
CO4: Familiarisation with carbonated and non-carbonated beverages
CO5: Familiarisation with package drinking water and their processing

Mapping between COs with PSOs

Mapping between COs and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1							
CO2							
CO3							
CO4							
CO5							

<table>
<tr><td>Course code</td><td>FPT 504</td></tr>
<tr><td>Course title</td><td>Food Material and Product Properties</td></tr>
<tr><td>Corse credit</td><td>3(2+1)</td></tr>
<tr><td>Teaching per Week</td><td>4 h</td></tr>
<tr><td>Course Objective (CO)</td><td>1. To get exposure towards properties of biomaterial and food products
2. Familiarization with mechanical and rheological properties of food products
3. To acquire knowledge of thermal, electrical and optical properties of food
4. Familiarization with instruments used for measurement of properties of food and food products
5. To acquire knowledge about sensory properties of food products</td></tr>
<tr><td>Course Content</td><td>
<table>
<tr><td>Unit 1</td><td>Introduction: Biomaterials and their properties in relation to processing and product development.
Physico-chemical characteristics: Shape, sphericity, size, volume, microstructure, density, porosity, surface area, coefficients of friction and angle of repose and influence of constituents on processing.</td></tr>
<tr><td>Unit 2</td><td>Mechanical & rheological properties: Flow behaviour of granular and powdered food materials, rheological models, creep phenomenon, stress–strain - time effects & relationships, and techniques of model fitting, Elastic vs. textural characteristics and textural profile analysis of food products.</td></tr>
<tr><td>Unit 3</td><td>Thermal, electrical and optical properties: Specific heat, thermal conductivity, phase transition, Thermodynamics-basic principles and laws, Thermodynamic properties of moist air, kinetics of water absorption, heat capacity, thermal diffusivity, electrical resistance and conductance, dielectric constant, reflectivity, transmittivity and absorptivity of incident rays.
Food microstructure: Methods and systems for food microstructure, determination of food quality by light microscopy, transmission electron microscopy, scanning electron microscopy, other instrumentation and techniques, Image analysis: image acquisition, image processing, measurement analysis.</td></tr>
<tr><td>Unit 4</td><td>Functional properties: Dextrinization, gelatinisation, crystallisation, gelation, foaming, coagulation, denaturation and syneresis, emulsification.
Sensory attributes: Sensory properties and correlation with objective indices, microstructure and its relation to texture from their mechanical models and its examination.
Sorption behaviour of food: sorption isotherm, modelling.</td></tr>
</table>
List of Practicals
</td></tr>
</table>

	1	To determine physical dimension and shape for suitability of processing and packaging of food materials
	2	To determine bulk, true density and porosity of samples
	3	To determine the angle of repose using rough and smooth surface
	4	Analysis of powder characteristics using powder flow analyser
	5	To determine the mixing and strength characteristics of wheat flour using faringograph/mixograph / mixolab/ doughlab/ texture analyser
	6	Organoleptic evaluation of food materials
	7	TEM and SEM, image analysis and image processing techniques
	8	To determine water activity of food
	9	To determine colour value of food viz. Lab, whiteness index, yellowness index, browning index
	10	To determine the amylolytic activity using falling number of wheat flour
	11	Development of stress and strain curve and to study viscosity of Newtonian and non-Newtonian fluid
	12	Effect of temperature on viscosity profile of a food sample
	13	Texture profile analysis of foods samples
	14	Effect of temperature on textural profile of food
	15	Determination of thermal properties of foods using DSC
	16	To estimate dielectric constant of foods

References:	1. Rao M A and Rizvi S S H, 1986. Engineering Properties of Foods, Marcel Dekker. 2. Aguilera J M & Stanley D W, 1999. Microstructural principles of food processing and Engineering,Springer. 3. Mohsenin N N, 1986. Physical properties of Plant and Animal Materials, Gordon & Breach Science. 4. Bourne M C, 1981. Food Texture and Viscosity; Concept and Measurement, Academic Press. 5. Steffe J F, 1992. Rheological Methods in Food Process Engineering, Freeman Press. 6. Aguilera J M, 1999. Micro Structure: Principles of Food Processing Engineering, Springer. 7. Rahman M S, 2009. Food Properties Handbook, CRC Press. 8. Serpil S & Sumnu S G, 2006. Physical Properties of Foods, Springer-Verlag. 9. Pomeranz Y, 1991. Functional Properties of Food Components, Academic Press
Course Outcomes	CO1: Exposure to different properties of biomaterial CO2: Able to determine different mechanical, thermal and optical properties of food. CO3: Able to carry out sensory and textural studies of food products. CO4: Familiarisation with change in various properties with processing CO5: To correlate the sorption characteristics of food with its storage

Mapping between COs with PSOs	**Mapping between COs and PSOs**

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1							
CO2							
CO3							
CO4							
CO5							

Course code	**FPT 511**	
Course title	**Traditional Foods**	
Corse credit	**3 (2+1)**	
Teaching per Week	**4 h**	
Course Objective (CO)	1. Familiarize the students with various categories of Indian traditional food products, their present status and their prospects 2. Learn the formulation, processing, packaging, and storage of traditional food products 3. Understand the innovative technologies and mechanized processing of traditional products	
Course Content	**Unit 1**	Present status of traditional food products, Globalization of traditional food products; Plans andpoliciesof the Government and developmental agencies Overview of heat-desiccated, coagulated, fried, fermented traditional food Products Process technology for Indian bread (chapatti), paratha, stuffed paratha, panipoori. Process technology for Indian fried foods-poori, samosa, sev, fafda, chorafali, jalebi Process technology for fermented traditional food and its improvement- pickle, idli, khaman, nan, dahi,dhokla, spiced buttermilk etc). Process improvement in production of Indian sweets (Halwasan, kajukatli, carrothalwa, Rabdi,chocolateburfi, Chikki etc). Process improvement in production of puffed cereals and grains by microwave technique
	Unit 2	New products based on fruits, vegetables and cereals Application of membrane technology, microwave heating, steaming, extrusion for industrial production oftraditional food products (Shrikhand, Dhokla, Wadi, Murukku/Chakri, Patra, Khandvi) Utilization and scope of legumes and grains in India for novel food products development like- flour, readyto eat products, flour mixes etc. (Puranpoli, Idlimix, Wada mix, Gotamix) Process technology for convenience traditional food products (ready to eat and serve - Curried vegetables,pulses and legumes), chutneys, paste Use of natural and permitted synthetic preservatives and new packaging systems for traditional foodproducts
	Unit 3	Techno-economic aspects for establishing commercial units for traditional products Introduction to traditional foods of India, composition and nutritive values, microbial and biochemical diversity, quality and food safety challenges Processing & Preservation methods of Sweets & Desserts**:** kulfi, falooda, kheer, khurchan, khoa/mawa, rabri, jalebi, imarti, Gulab jamun, peda, petha, rewdi, gajak, milk cake, balushahi, bal mithai, singori, rasmalayi, gulqand, ghevar, rasgolla, chamcham, son halwa, son papri, several varieties of halwa, laddu, barfi & rasgolla.
	Unit 4	Traditional fermented foods: Dosa, Vada, Dahi (Curd), Srikhand. Processing and preservation methods of snacks**:** Gujiya, kachauri, samosa, mirchibada, kofta, potato chips, banana-chips, mathri, bhujiya, fried dhals, bhujia, shakarpara, pakora,

	vada. Processing and preservation methods of baked and fried products: Biscuits, Toast, Candies, Cookies, Breads, Roti, Naan, Tandoori Roti, Parantha, Kulcha, Puri, Bhatura. Processing and preservation methods of preserves and beverages: Murabba, Sharbat, Panna, Aampapad, Coconut water, Milk (khas, rose), Alcoholic Beverages Industrialization, Socioeconomic conditions and sustainability of traditional foods

List of Practicals

1	To study the effect of different combination of salt and oil in quality of traditional fermented food product (pickle)
2	To study the effect of different starter culture on taste and texture of idli
3	To evaluate the shelf life of stuffed paratha under different storage conditions
4	To study the effect of time and temperature on quality of fried food products (poori/ pani poori) etc.
5	To study effect of sugar and Artificial sweetners in the preparation of kaju katli
6	To study the microwave heating in drying of khaman/ dhokla
7	To study the effect of cold extrusion on mixing of vermicilli
8	To prepare instant carrot halwa mix
9	To study the effect of different packaging material on shelf life of traditional Indian food products
10	To study the effect of different natural food preservatives in traditional sweets
11	Preparation of spiced buttermilk
12	Preparation of puffed cereals and grains
13	Preparation and quality evaluation of Instant Premixes (Puranmix)
14	Preparation of quality evaluation of dried malted moth bean powder
15	Preparation of Indian traditional confections (chikki)
16	Visit to ethnic food industry (Instant mixes/Pickle making)

References:

1 Steinkrus KH, 1995. Handbook of Indigenous Fermented Foods. CRC Press
2 Wickramasinghe P, 2007. The Food of India, OM Book Service
3 Aneja RP, Mathur, BN, Chandan, RC and Banerjee AK, 2002. Technology of Indian Milk Products,India Year Book Publications
4 Mangal R, 2013. Fundamentals of Indian Cooking: Theory and Practice

Course Outcomes

CO1: Recognize the importance and opportunities of industrial manufacturing of Indian traditional food products in domestic and global market
CO2: Interpret the classification of Indian traditional food products and the science and technology involved in their preparation
CO3: Understanding the importance of recipe standardization, mechanized processing, value addition and packaging of traditional products
CO4: Recognize the scope of innovation in traditional and value-added food products manufacturing
CO5: Understanding the techno-economics of traditional food products

Mapping between COs with PSOs

Mapping between COs and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1							
CO2							

	CO3							
	CO4							
	CO5							

<table>
<tr><td>Course code</td><td>FPT 512</td></tr>
<tr><td>Course title</td><td>Technologies of Convenience Foods</td></tr>
<tr><td>Corse credit</td><td>3 (2+1)</td></tr>
<tr><td>Teaching per Week</td><td>4 h</td></tr>
<tr><td>Course Objective (CO)</td><td>CO1 Understand different grain-based snacks
CO2 Gain knowledge about fruits and vegetable-based snacks
CO3 To understand different type of instant mixes
CO4 To study various technicalities in development of different extruded food products
CO5 To understand different aspects in development of traditional Indian food products</td></tr>
<tr><td>Course Content</td><td>
<table>
<tr><td>Unit 1</td><td>Overview of grain-based snacks: whole grains – roasted, toasted, puffed, popped and flakes Coated grains- salted, spiced and sweetened
Flour based snack– batter and dough-based products; savoury and farsans; formulated chips and wafers, papads
Fruit and vegetable-based snacks: chips, wafers, papads etc.
Coated nuts – salted, spiced and sweetened products- chikkis, fried groundnut pakora</td></tr>
<tr><td>Unit 2</td><td>Technology of ready- to- eat baked food products, drying, toasting, roasting and flaking, coating, chippingExtruded snack foods: Formulation and processing technology, flavouring and packaging</td></tr>
<tr><td>Unit 3</td><td>Ready-to-cook food products- different puddings and curried, Vegetables, meat and meat food productsetc.
Technology of instant cooked rice, carrot and other cereals-based food products, Technology of ready to eat instant premixes based on cereals, pulses etc.
Technology for RTE puffed snack- sand puffing, hot air puffing, explosion puffing, gun puffing etc.</td></tr>
<tr><td>Unit 4</td><td>Equipment for frying, baking and drying, toasting, roasting and flaking, popping, blending, coating, chipping</td></tr>
</table>
List of Practicals
<table>
<tr><td>1</td><td>Preparation of cereals based fried snack foods</td></tr>
<tr><td>2</td><td>Preparation of legume based fried snack foods</td></tr>
<tr><td>3</td><td>Preparation of cereal, pulses based ready-to-eat snack food by extrusion cooking their quality evaluation</td></tr>
<tr><td>4</td><td>Preparation of cereal grain based puffed products</td></tr>
<tr><td>5</td><td>To study the effect of frying time and temperature on potato chips</td></tr>
<tr><td>6</td><td>Development of instant food premixes</td></tr>
<tr><td>7</td><td>Preparation of cereal and legume based roasted snack</td></tr>
<tr><td>8</td><td>Preparation of flaked rice product</td></tr>
<tr><td>9</td><td>To study the effect of roasting time and temperature on quality of pop-corn</td></tr>
<tr><td>10</td><td>Determination of shelf-life and packaging requirements of snack food products</td></tr>
<tr><td>11</td><td>Determination of shelf-life and packaging requirements of snack food products</td></tr>
<tr><td>12</td><td>Preparation of cereal and legume based roasted snack foods by vacuum frying</td></tr>
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<tr><td>13</td><td>Visit to industries manufacturing snack foods.</td></tr>
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<tr><td>References:</td><td>
1. Edmund WL 2001 Snack Foods Processing. CRC Press
2. Frame ND 1994 Technology of Extrusion Cooking, Blackie Academic.
3. Gordon BR 1997 Snack Food AVI Publ.
4. Samuel AM. 1976 Snack Food Technology. AVI Publ.
5. Duncan Manley 2000 Technology of Biscuits, Crackers and Cookies CRC Press
6. Deny AV and Dobraszczyk BJ 2001 Cereals and Cereal Products, Aspen Publishers
7. Ram S and Mishra B. 2010 Cereals: Processing and nutritional quality, New India Publishers
</td></tr>
<tr><td>Course Outcomes</td><td>
CO1 Able to apply basic concepts or ready to eat food products
CO2 To develop different type of cereal based snack foods
CO3 To develop different type of fruits and vegetable based snack food products
CO4 Able to produce vacuum fried food products
</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
Mapping between COs and PSOs
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<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td><td>PSo7</td></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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Course code	**FPT 520**
Course title	**Special Problem**
Corse credit	**2 (0+2)**
Teaching per Week	**4 h**
Course Objective (CO)	1. Familiarize the students with research problems 2. To learn analytical techniques as per the research 3. To develop statistical skills 4. To develop writing skills report

Course Content

S. No.	Title
1	To identify the research problem
2	To conduct literature survey related to selected problem
3	To design the experiment as per the appropriate statistical designs
4	To perform the experiment as per the design
5	To conduct various physico-chemical analysis as per the study
6	To perform various microbial analysis as per the study
7	To conduct various sensory/ textural studies as per the study
8	To perform storage and shelf-life studies as per the study
9	To write report on the basis of conducted studies

References:

1. Watts CM, Ylimaki CL, Jaffery LE & Elias LG. 1989. *Basic Sensory Methods for Food Evaluation*. Int. Dev. Res. Centre, Canada.
2. Chatfield C. 1983. *Statistics for Technology*. 3rd Ed. Chapman & Hall.
3. Belitz, H-D., Grosch, W. & Schieberle, P. (2004) *Food Chemistry* 3rd Ed. Springer

Course Outcomes

CO1: Identification of research problems
CO2: Recognize the importance of experimental design
CO3: Ability to conduct experiment independently
CO4: Interpretation and analysis of experimental data
CO5: Ability to write the research report

Mapping between COs with PSOs

Mapping between COs and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1							
CO2							
CO3							
CO4							
CO5							

Course code	**FPT 601**
Course title	**Novel Technologies for Food Processing and Shelf Life Extension**
Corse credit	**3(3+0)**
Teaching per Week	**3 h**
Course Objective (CO)	1. To understand the basic concept of emerging technologies 2. To understand the principles of microwave and its application in food processing 3. To understand the principles of high-pressure processing and its application in food 4. To understand the principles of pulse electric field and its application in food 5. To understand the principles of shelf life prediction
Course Content	Recent advances in novel food processing technology; Membrane processing, Supercritical fluid extraction, Microwave and radio frequency processing, High Pressure processing, Ultrasonic processing, Ozonation, Plasma Technique, Novel drying techniques. Various techniques to increase shelf life and shelf life prediction.
References:	1. Gould G W, 2000. New Methods of Food Preservation, CRC Press 2. Barbosa-Canovas, 2002. Novel Food Processing Technologies, CRC Press 3. Dutta AK and Anantheswaran RC, 1999. Hand Book of Microwave Technology for FoodApplications, CRC Press 4. Sun DW, 2015. Emerging Technologies for Food Processing, Elsevier Ltd 5. Kudra T and Mujumdar AS, 2009. Advanced Drying Technologies, CRC Press 6. Kilkast D and Subramanium P, 2000.The stability and shelf life of food. CRC Press 7. Doona C J and Feeherry F E, 2007.High pressure processing of foods. Blackwell Publishing Ltd
Course Outcomes	CO1: Understand basic concept of emerging technologies in food processing. CO2: Able to apply principles of high-pressure processing for preservation of food. CO3: Able to apply principles of microwave in processing of food CO4: To understand concept of shelf life and its prediction
Mapping between COs with PSOs	Mapping between COs and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1							
CO2							
CO3							
CO4							

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<tr><td>Course code</td><td>FPT 602</td></tr>
<tr><td>Course title</td><td>Food Packaging</td></tr>
<tr><td>Corse credit</td><td>3(3+0)</td></tr>
<tr><td>Teaching per Week</td><td>3 h</td></tr>
<tr><td>Course Objective (CO)</td><td>1. To study the active and intelligent packaging system and its application in foods
2. To study about different scavenging techniques used in food packaging
3. To study about antimicrobial food packaging used for food packaging
4. To study non migratory bio active polymers and its food application</td></tr>
<tr><td>Course Content</td><td>Recent advances in active and intelligent packaging like antimicrobial food packaging, Non- migratory bioactive polymers, Freshness indicator, Recycling, Biodegradable packaging, Edible films and coatings, Aseptic packaging, Self-heating and hydrate packages.</td></tr>
<tr><td>References:</td><td>1. Ahvenainen R, 2001. Novel Food Packaging Techniques, CRC Press.
2. Rooney ML, 1988. Active Food Packaging, Chapman & Hall.
3. Coles R and Kirwan M, 2011. Food and Beverage Packaging Technology, Wiley -Blackwell.
4. Han J and Han J, 2005. Innovations in Food Packaging, Academic Press.
5. Yam K and Lee D, 2012. Emerging Food Packaging Technologies, Woodhead Publishing.
6. Mihindukulasuriya SDF and Lim LT, 2014. Nanotechnology development in food packaging-a review.Trends in Food Science and Technology, 149-167.
7. Souza VGL and Fernando L, 2016. Nano-particles in food packaging-biodegradibility and potential migration to food – a review. Food Packaging and Shelf Life, 63-70.</td></tr>
<tr><td>Course Outcomes</td><td>CO1: Expose to the different novel food packaging techniques
CO2: Application of Aseptic packaging its application in food.
CO3: Knowledge about antimicrobial food packaging and its applications.
CO4: Familiarisation with biodegradable food packaging materials
CO5: Familiarisation with time temperature indicators and non-migratory biopolymers used in food packaging</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>Mapping between COs and PSOs
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<tr><td>Course code</td><td>FPT 603</td></tr>
<tr><td>Course title</td><td>Food Manufacturing Technology</td></tr>
<tr><td>Corse credit</td><td>3(3+0)</td></tr>
<tr><td>Teaching per Week</td><td>3 h</td></tr>
<tr><td>Course Objective (CO)</td><td>1. To gain knowledge about planning of resources
2. To understand inventory control
3. To have exposure to production scheduling
4. To understand job scheduling</td></tr>
<tr><td>Course Content</td><td>Manufacturing resource planning, Inventory control, Production planning, Production scheduling, Material requirement planning, Resource planning, Capacity requirement planning. Jobscheduling</td></tr>
<tr><td>References:</td><td>1. Badiru AB, 2015. Global Manufacturing Technology Transfer: Africa-USA Strategies, Adaptations, and Management, CRC Press.
2. Hitomi K, 1996. Manufacturing Systems Engineering: A Unified Approach to Manufacturing Technology, Production Management and Industrial Economics, CRC Press.
3. Yamane Y and Childs T, 2013. Manufacturing Technology Transfer: A Japanese Monozukuri View of Needs and Strategies, CRC Press.</td></tr>
<tr><td>Course Outcomes</td><td>CO1: Basic concepts of different techniques involved in manufacturing
CO2: Able to do resource planning in food industry
CO3: Able to manage inventory in industry
CO4: Familiarisation with production and job scheduling</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>Mapping between COs and PSOs
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<tr><td>Course code</td><td>FPT 606</td></tr>
<tr><td>Course title</td><td>Animal Food Products</td></tr>
<tr><td>Corse credit</td><td>3(3+0)</td></tr>
<tr><td>Teaching per Week</td><td>3 hrs</td></tr>
<tr><td>Course Objective (CO)</td><td>1. To study the research and development activity in meat, fish, and poultry products
2. To study about gross composition of muscle pre and post slaughter operations and handling of meat
3. To study about value added products from eggs, meat and fish
4. To study irradiation of fish and fisheries products
5. To study quality control and quality assurance in meat, fish and poultry products
6. To study the allergens, toxins and infectious diseases from meat, Poultry and fish products</td></tr>
<tr><td>Course Content</td><td>Research and development activities on meat, fish and poultry products. gross and microstructure of muscle, Pre-slaughter care, ante and post mortem, slaughter, handling of offal (edible and inedible). Methods to improve tenderness, Special poultry products, Breaded poultry, packaged precooked chicken, Freeze dried poultry meat. Egg preservation, egg powder production. Meat analogues and restructured meat products, Production of fish paste, fish oils, sauce, fish protein concentrates. Irradiation of fish and fisheries products, packaging of fish products, Quality control and quality assurance. Allergens, toxins and infectious diseases from meat, Poultry and fish products</td></tr>
<tr><td>References:</td><td>1. Nollet ML, 2012. Handbook of Meat, Poultry and Seafood Quality, Wiley-Blackwell.
2. Mountney GJ, 1988. Poultry Meat and Egg Production, Springer.
3. Robert RJ, 2012. Fish Technology, Wiley-Blackwell.
4. Mead G, 2004. Poultry Meat Processing and Quality, Woodhead Publishing.
5. Sahoo J, Sharma DK and Chatli MK, 2016. Practical Handbook on Meat Science and Technology, Daya Pub. House.
6. Pearson, AM and Gillet TA, 1996. Processed Meat, Springer.
7. Kerry JP, Kerry JF and Ledwood D, 2002. Meat Processing, Elsevier.
8. Wheaton FW and Lawson TB, 1985. Processing of Aquatic Food Products, John Wiley & Sons.</td></tr>
<tr><td>Course Outcomes</td><td>CO1: Able to the different pre, ante and post slaughter operations and handling of meat
CO2: Knowledge about value addition of meat, fish and poultry products and recent advances.
CO3: Knowledge about irradiation of fish and fisheries products and other preservation techniques used.
CO4 Familiarisation with quality control and quality assurance of meat fish and poultry products.
CO5 Familiarisation with allergens, toxins and infectious diseases from meat, Poultry and fish products</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>Mapping between COs and PSOs
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<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td><td>PSO7</td></tr>
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	CO4							
	CO5							

Course code	**FPE 501**
Course title	Emerging Food Engineering Operations
Corse credit	**3 (2+1)**
Teaching per Week	**4 Hours**
Course Objective (CO)	1. To study the different emerging processing techniques and its commercial application in food processing 2. To study working principles of process 3. To study the basic mechanisms and its application 4. To study in detail about the mechanism involved and equipment/machine requirement.
Course Content	**UNIT I** Ionizing and non-ionizing radiation processing system & operations: types of radiations, generation, microwave assisted processing systems, IR assisted processing systems, radio frequency systems, O_3, UV and X-ray assisted processing systems, gamma irradiations systems, e-beam radiation systems and applications. **UNIT II** Pulse electric field (PEF) generation system and applications, cold plasma generation systems and applications, high pressure processing systems and applications, ultrasonic processing systems and applications. **UNIT III** Extrusion systems, batch and continuous ohmic heating systems and applications,inductive heating systems and applications, applications of nanotechnology **UNIT IV** Drying systems: superheated steam drying, refractance window drying, heat pump drying, freeze drying, spray drying, foam bed drying, microwave drying, instant pressure drop (DIC) drying and hybrid drying systems. **UNIT V** Membrane processing systems: UF, MF, NF, reverse osmosis and vapour permeation, pervaporation, membrane distillation. Supercritical fluid extraction: concept, property of near critical fluids (NCF), extraction methods. Cryoprocessing-cryogens properties, systems and their different applications. **Practicals** **S. No.** | **Title**

	1	To evaluate the characteristics of treated water and selected liquid foods using membranesystems (NF, UF, RO etc)
	2	To study super critical fluid extraction system and application
	3	To study microwave system and microwave assisted food processing
	4	To study efficacy of hot water, steam, microwave, ultrasound blanching of selected fruits andvegetables
	5	To study the ultrasonicator and applications
	6	To study cryogenic processing system and applications
	7	To prepare Nano emulsion and study of their characteristics
	8	To study ohmic/inductive heating systems andapplications
	9	To study cold plasma system and applications
	10	To study gamma irradiation system and applications
	11	To study drying kinetics using different drying systems
	12	To study operations in 3 D printing
	13	Solving problems in food processing and case studies
	14	Visits of food industries utilizing advance food processing systems.

References:

1. Datta, A. K. (2001). Handbook of microwave technology for food application. CRC Press.
2. Purkait, M. K., Singh, R. (2018). Membrane technology in separation science. CRC Press Taylor& Francis Group.
3. Frame, N. D. (1994). The technology of extrusion cooking. Blackie.
4. Gould, G. W. (2012). New methods of food preservation. Springer Science & Business Media.
5. Berk, Z. (2018). Food process engineering and technology. Academic press.
6. Nema, P. K., Kaur, B. P. & Mujumdar, A. S. (2019). Drying technologies for foods: Fundamentalsand applications. CRC Press
7. Meredith, R. J. (1998). Engineers' handbook of industrial microwave heating (No. 25). Iet.
8. Arvanitoyannis, I. S. (2010). Irradiation of food commodities: techniques, applications, detection, legislation, safety and consumer opinion. Academic Press.
9. Yanniotis, S. (2008). Solving problems in food processing and case studies. Springer
10. Hui, Y.H., Clary, C., Farid, M.M., Fasina, O.O., Noomhorm, A. & J. Welti-Chanes (2008). Food drying science and technology. DEStech Publications
11. Fellows P.J. (2017). Food processing technology, 4ed. Elsevier

<table>
<tr><td>Course Outcomes</td><td>CO1: Identify the emerging processes involved in processing and study of the process
CO2: To get the understanding of solving problems involved
CO3: Application of emerging techniques in food processing
CO4: Familiarisation with various methods of food engineering operations
CO5: Students will apply emerging engineering concepts in engineering operations.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>Mapping between COs and PSOs
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<tr><td>CO5</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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CO = Course outcome with PSO = Program Specific outcome PO1</td></tr>
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Course code	**FPE 502**	
Course title	**Engineering Properties of Food Materials**	
Corse credit	**3 (2+1)**	
Teaching per Week	**4 hours**	
Course Objective (CO)	1. To familiarize the students with engineering properties of food materials 2. To understand the concepts of magnetic properties, food rheology and food texture 3. To depict rheological properties of foods and measuring methods. 4. To illustrate various aspects of examining food microstructures and food structuring	
Course Content	**Unit 1**	Physical characteristics of different food grains, fruits and vegetables; shape and size, volume and density, porosity, surface area, water activity. Thermal properties: Specific heat, thermal conductivity, thermal diffusivity, phase transition, methods of determination, steady state, transient heat flow. Electrical properties; Dielectric loss factor, loss tangent, temperature dependent electrical conductivity and dielectric constant, method of determination, energy absorption from high-frequency electric field.
	Unit 2	Magnetic properties: paramagnetism, ferromagnetism, diamagnetism, magnetization, applications for magnetic field forces, magnetic resonance; Electromagnetic properties: electric polarization, temperature dependency, frequency dependency, microwave, conversion of microwaves into heat, penetration depth of microwaves, applications; Optical properties: refraction, colorimetry, near infrared, ultraviolet, applications; Acoustical properties: sound, ultrasonic sound and applications; Radioactivity: types of radiation, radioactive decay, measurement of ionizing radiation, natural radioactivity, applications.
	Unit 3	Contact stresses between bodies, hertz problems, firmness and hardness, mechanical damage, dead load and impact damage, vibration damage, friction, effect of load, sliding velocity and surface roughness. Friction in agricultural materials, rolling resistance, angle of internal friction, angle of repose, flow of bulk granular materials, aero dynamics of agricultural products, drag coefficients, terminal velocity.
	Unit 4	Rheological properties and classification of fluid foods: measurement methods and techniques; Mechanisms and relevant models; Effect of temperature; Compositional factors affecting flow behavior; Viscosity of food dispersions – dilute and semi-dilute systems, concentration effects.
	Unit 5	Rheology of semi-solid and solid food; Rheological characterization of foods in terms of stress- strain relationship; Viscoelasticity; Transient tests - Creep Compliance and Stress Relaxation; Mechanical models for viscoelastic foods: Maxwell, Kelvin, Burgers and generalized models and their application; Dynamic measurement of viscoelasticity.
	Unit 6	Large deformations and failure in foods: fracture, rupture and other related phenomena; Relationship between instrumental and sensory

	data; Texture Profile Analysis; Instrumental measurements – Empirical and Fundamental methods; Rheometers and Texture Analyzers; Measurement of Extensional viscosity; Acoustic measurements on crunchy foods.
Unit 7	Food structuring: traditional food structuring and texture improvement, approaches to food structuring, extrusion and spinning, structuring fat products, structure and stability, gels, gelation mechanisms, mixed gels, the microstructure of gels, structure-property relationships.
Unit 8	Examining food microstructures: light microscopy transmission electron microscopy, scanning electron microscopy, other instrumentation and techniques, image analysis: image acquisition, image processing and analysis.

PRACTICALS

S. No.	Title
1.	Viscosity measurements of fruit juices and semisolid food products
2.	Comparative analysis of Newtonian and non-Newtonian fluids
3.	Development of stress and strain curve and to study viscosity of Newtonian and non- Newtonian fluids
4.	Temperature dependent and shear dependent rheology
5.	Pasting analysis of food; Determination of thermal conductivity, specific heat and glass transition temperature using differential scanning colorimetry (DSC)
6.	Texture analysis of fruits and vegetable-based products
7.	Texture analysis of baked foods products (bread/ biscuit)
8.	Starch characterization using starch master
9.	Dough rheology using doughlab or farinograph
10.	Determination of microstructures in selected foods using light microscopy
11.	TEM and SEM, image analysis and image processing techniques
12.	Evaluation of phase transition in colloidal systems, evaluation of structure texture function relations
13.	Case studies on food properties and applications.

References:

1. Rao, M. A., Rizvi, S.S., Datta, A. K. & Ahmed, J. (2014). Engineering properties of foods. CRC press.
2. Figura O.L. & Teixeira A.A. (2007). Food physics: physical properties - measurement and applications. Springer Science & Business Media.
3. Sahin, S. & Sumnu, S.G. (2006). Physical properties of foods. Springer Science & Business Media.
4. Mohsenin, N.N. (1980). Thermal properties of foods and agricultural materials. New York. USA.
5. Mohsenin, N.N. (1986). Physical properties of plant and animal materials. Gordon and Breach Science Publishers.
6. Peleg, M., & Bagley, E. B. (1983). Physical properties of foods. In IFT basic symposium series (USA). AVI Pub. Co..
7. Ronal, J., Felix E., Bengt, H., Hans, F., Meffert, Th., Walter, E. C., & Gilbert V. (1983). Physical Properties of Foods. Applied Science Publishers.
8. Bourne, M. (2002). Food texture and viscosity: concept and measurement. Elsevier.

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<tr><td></td><td>9. Norton, I. T., Spyropoulos, F. & Cox, P. (2010). Practical food rheology: an interpretive approach. John Wiley & Sons.</td></tr>
<tr><td>Course Outcomes</td><td>CO1: Students will gain an understanding of various properties of the food material which can be used to design and develop the equipments for its necessary processing.
CO2: Comprehend various magnetic, rheological and textural properties of solid and liquid foods
CO3: Apprehend different models and tests related to food rheology and grasp knowledge regarding various instruments used in determination of food rheology.
CO4: Understanding about the examining food microstructures and food structuring</td></tr>
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<tr><td>Course code</td><td>FPE 503</td></tr>
<tr><td>Course title</td><td>Transport Phenomenon</td></tr>
<tr><td>Corse credit</td><td>3 (2+1)</td></tr>
<tr><td>Teaching per Week</td><td>4 hours</td></tr>
<tr><td>Course Objective (CO)</td><td>5. To study the basic mechanisms of the transport of each of the three properties i.e. momentum, energy and mass
6. To deal with flow problems involving Newtonian and Non-newtonian fluids, solid-state heat conduction, forced & free convection.
7. To study in detail about the (i) Fluid dynamics: involves transport of momentum, (ii) Heat transfer: deals with transport of energy, and (iii) Mass transfer: concerned with transport of mass.</td></tr>
<tr><td>Course Content</td><td>
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<tr><td>Unit 1</td><td>Introduction to transport phenomena – Molecular transport mechanism, transport properties and their proportionality constants in momentum, energy and mass transfer.</td></tr>
<tr><td>Unit 2</td><td>Principles of Steady and unsteady state heat transfer and governing equations; transient heat transfer; Lumped system analysis; Estimation of Conductivity and other thermal properties of foods; overall heat transfer coefficient.</td></tr>
<tr><td>Unit 3</td><td>Steady-state equations - Momentum transport equations for Newtonian and non-Newtonian fluids, continuity equation in different co-ordinates.</td></tr>
<tr><td>Unit 4</td><td>Equations of motion - Navier–Stokes equations and their application in viscous fluid flow between parallel plates and through pipes.</td></tr>
<tr><td>Unit 5</td><td>Turbulent transport mechanism - Mathematical analysis; eddy viscosity and eddy diffusivity; velocity, temperature and concentration distribution; time smoothing equations. Inter-phase transport in isothermal system - friction factors for various geometries.</td></tr>
<tr><td>Unit 6</td><td>Mass transfer - Fick’s law of diffusion, diffusion of gases and liquids through solids, equimolal diffusion, isothermal evaporation of water into air, mass transfer coefficients.</td></tr>
<tr><td>Unit 7</td><td>Dimensional analysis – Buckingham Pi-theorem and matrix method, application to transport phenomena, analysis among mass, heat and momentum transfer, Reynolds’ and relevant analogies.</td></tr>
<tr><td>Unit 8</td><td>Boundary layer concept - Theoretical and exact solutions for heat, mass and momentum transfer.</td></tr>
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PRACTICALS
<table>
<tr><th>S. No.</th><th>Title</th></tr>
<tr><td>1</td><td>Effects of water concentration and water vapor pressure on the water vapor permeability and diffusionof chitosan films</td></tr>
<tr><td>2</td><td>Mass transfer description of the osmo dehydration</td></tr>
<tr><td>3</td><td>Pretreatment efficiency in osmotic dehydration</td></tr>
<tr><td>4</td><td>Structural effects of blanching and osmotic dehydration pretreatments on air drying kinetics of fruittissues</td></tr>
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	5	Thermal processing of particulate foods by steam injection (1. Heating rate index for dicedvegetables 2. Convective surface heat transfer coefficient for steam)
	6	Relating food frying to daily oil abuse (1. Determination of surface heat transfer coefficients withmetal balls 2. A practical approach for evaluating product moisture loss, oil uptake, and heat transfer)
	7	Heat and mass transfer during the frying process; Influence of liquid water transport on heat and masstransfer during deep-fat frying
	8	Numerical simulation of transient two-dimensional profiles of temperature, concentration, and flow ofliquid food in a can during sterilization
	9	Case studies on transport phenomenon and its applications.

References:

1. Bird, R. B., Stewart, W. E., & Lightfoot, E. N. (2007). Transport phenomena. John Wiley & Sons.
2. Treybal, R. E. (1980). Mass transfer operations. New York.
3. Yuan, S. W. (1969). Foundations of Fluid Mechanics. Prentice Hall of India.
4. Welti -Chanes, J., & Velez -Ruiz, J. F. (Eds.). (2016). Transport phenomena in food processing. CRC press.
5. Geankoplis, C. J., Hersel, A.A., & Lepek, D.H. (2018). Transport processes and separation process principles:(includes unit operations). Prentice Hall Professional Technical Reference.

Course Outcomes

CO1: Identify the transport processes involved in some simple situations and Write down the equations of change for mass, momentum and energy for the system

CO2: To get the understanding of solving flow problems involving Newtonian and Non-newtonian fluids, solid-state heat conduction, forced & free convection.

CO3: Apply the shell balance approach to derive differential mass and heat balance equations in Cartesian, cylindrical, and spherical coordinates; apply the generalized differential mass and heat balance equations and the Navier-Stokes equations to analyze transport problems; analyze transport problems in simple geometries and derive analytically the concentration, temperature or velocity distribution

Mapping between COs with PSOs

Mapping between COs and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1							
CO2							
CO3							

<table>
<tr><td>Course code</td><td>FPT 504</td></tr>
<tr><td>Course title</td><td>Food Material and Product Properties</td></tr>
<tr><td>Corse credit</td><td>3 (2+1)</td></tr>
<tr><td>Teaching per Week</td><td>4 hours</td></tr>
<tr><td>Course Objective (CO)</td><td>1. To familiarize the students with the properties of the biomaterials in relation to processing and product development
2. To get acquainted with the Mechanical & Rheological properties of the food material
3. To gain knowledge of Thermal, electrical and optical properties & Food microstructure
4. To get the understanding of Functional properties and Sensory attributes</td></tr>
<tr><td>Course Content</td><td>
<table>
<tr><td>Unit 1</td><td>Introduction: Biomaterials and their properties in relation to processing and product development. Physico-chemical characteristics: Shape, sphericity, size, volume, microstructure, density, porosity, surface area, coefficients of friction and angle of repose and influence of constituents on processing.</td></tr>
<tr><td>Unit 2</td><td>Mechanical & rheological properties: Flow behaviour of granular and powdered food materials, rheological models, creep phenomenon, stress–strain - time effects & relationships, and techniques of model fitting, Elastic vs. textural characteristics and textural profile analysis of food products.</td></tr>
<tr><td>Unit 3</td><td>Thermal, electrical and optical properties: Specific heat, thermal conductivity, phase transition, Thermodynamics-basic principles and laws, Thermodynamic properties of moist air, kinetics of water absorption, heat capacity, thermal diffusivity, electrical resistance and conductance, dielectric constant, reflectivity, transmittivity and absorptivity of incident rays.
Food microstructure: Methods and systems for food microstructure, determination of food quality by light microscopy, transmission electron microscopy, scanning electron microscopy, other instrumentation and techniques, Image analysis: image acquisition, image processing, measurement analysis.</td></tr>
<tr><td>Unit 4</td><td>Functional properties: Dextrinization, gelatinisation, crystallisation, gelation, foaming, coagulation, denaturation and syneresis, emulsification.
Sensory attributes: Sensory properties and correlation with objective indices, microstructure and its relation to texture from their mechanical models and its examination.
Sorption behaviour of food: sorption isotherm, modelling.</td></tr>
</table>
PRACTICALS
<table>
<tr><th>S. No.</th><th>Title</th></tr>
<tr><td>1.</td><td>To determine physical dimension and shape for suitability of processing and packaging of foodmaterials</td></tr>
<tr><td>2.</td><td>To determine bulk, true density and porosity of samples</td></tr>
<tr><td>3.</td><td>To determine the angle of repose using rough and smooth surface</td></tr>
<tr><td>4.</td><td>Analysis of powder characteristics using powder flow analyser</td></tr>
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	5.	To determine the mixing and strength characteristics of wheat flour using faringograph/mixograph /mixolab/ doughlab/ texture analyser
	6.	To determine the amylolytic activity using falling number of wheat flour
	7.	Development of stress and strain curve and to study viscosity of Newtonian and non-Newtonian fluid
	8.	Effect of temperature on viscosity profile of a food sample
	9.	Texture profile analysis of foods samples
	10.	Effect of temperature on textural profile of food
	11.	Determination of thermal properties of foods using DSC
	12.	To estimate dielectric constant of foods
	13.	Organoleptic evaluation of food materials
	14.	TEM and SEM, image analysis and image processing techniques
	15.	To determine water activity of food
	16.	To determine colour value of food viz. Lab, whiteness index, yellowness index, browning index

References:

1. Rao M A and Rizvi S S H, 1986. Engineering Properties of Foods, Marcel Dekker.
2. Aguilera J M & Stanley D W, 1999. Microstructural principles of food processing and Engineering,Springer.
3. Mohsenin N N, 1986. Physical properties of Plant and Animal Materials, Gordon & BreachScience.
4. Bourne M C, 1981. Food Texture and Viscosity; Concept and Measurement, Academic Press.
5. Steffe J F, 1992. Rheological Methods in Food Process Engineering, Freeman Press.
6. Aguilera J M, 1999. Micro Structure: Principles of Food Processing Engineering, Springer.
7. Rahman M S, 2009. Food Properties Handbook, CRC Press.
8. Serpil S & Sumnu S G, 2006. Physical Properties of Foods, Springer-Verlag.
9. Pomeranz Y, 1991. Functional Properties of Food Components, Academic Press

Course Outcomes

CO1: Students will gain an understanding of various properties of the food material which can be used to design and develop the equipments for its necessary processing.
CO2: The students will learn about the flow behaviour of granular and powdered food materials and different rheological models.
CO3: The students will get acquainted with the thermal, electrical and optical properties in relation to food material, their applications & food microstructure
CO4: Will have the knowledge of functional properties of the food material and about the sensory attributes.

Mapping between COs with PSOs

Mapping between COs and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1							
CO2							
CO3							
CO4							

<table>
<tr><td>Course code</td><td colspan="2">FPE 506</td></tr>
<tr><td>Course title</td><td colspan="2">Numerical Techniques and Simulation</td></tr>
<tr><td>Corse credit</td><td colspan="2">2 (1+1)</td></tr>
<tr><td>Teaching per Week</td><td colspan="2">3 hours</td></tr>
<tr><td>Course Objective (CO)</td><td colspan="2">5. To impart fundamental knowledge to students in the latest technological topics on numerical techniques, modelling and simulation.
6. To enable students to develop mathematical models that represent food processes, such as heat transfer, mass transfer, kinetics of reactions, and flow behavior, facilitating the prediction and analysis of these processes.
7. To prepare them for use of advance numerical techniques viz FEM and CFD in optimization of food process parameters
8. To familiarize students with simulation techniques and software used in food technology, enabling them to simulate and analyze various scenarios and phenomena, optimizing processes, and predicting outcomes.
9. To teach students methodologies for validating and verifying models and simulations against experimental data, ensuring the accuracy and reliability of the computational predictions in the context of food technology.</td></tr>
<tr><td>Course Content</td><td colspan="2">
<table>
<tr><td>Unit 1</td><td>Modelling and Simulation: Fundamentals of modeling and simulation; Different steps for modeling and simulation, Types of models; Advantages of modeling and simulation, Application areas of simulation.</td></tr>
<tr><td>Unit 2</td><td>Solution of partial differential equations models: Differential Laplace, Poisson, parabolic and hyperbolic equations, Bender – Schmidt method, finite difference method, finite volume method.</td></tr>
<tr><td>Unit 3</td><td>Optimization: Optimization theory and methods, Graphical and numerical methods of optimization; experimental optimization; linear and nonlinear un-constrain and constrain optimization, multivariate optimization, genetic algorithm, goal driven optimization.</td></tr>
<tr><td>Unit 4</td><td>Modelling and simulation applications of some food engineering operations: Thermal processing, convection & osmotic dehydration, spray & freeze drying, deep fat frying; extrusion process; filtration processes; distillation and Extraction processes.</td></tr>
<tr><td>Unit 5</td><td>Computational fluid dynamics (CFD) applications in food processing.</td></tr>
</table>
PRACTICALS
<table>
<tr><th>Practical</th><th>Title</th></tr>
<tr><td>17.</td><td>Introduction to various features in different spreadsheet softwares</td></tr>
<tr><td>18.</td><td>Solving problems using functions and/or add-Ins and/or Analysis Tool pack in spreadsheets</td></tr>
<tr><td>19.</td><td>Use of software packages for summarization and tabulation of data, obtaining descriptive statistics, graphical representation of data</td></tr>
<tr><td>20.</td><td>Practice on data visualization and analytics softwares i.e. Power Bi, Tableu, etc.</td></tr>
<tr><td>21.</td><td>Testing linearity and normality assumption, Testing the goodness of fit of different models</td></tr>
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	22.	Testing the hypothesis for one sample t-test, two sample t-test, paired t-test, test for large samples - Chi-squares test, F test, Analysis of variance etc.
	23.	Practice on modelling and simulation softwares i.e. MATLAB, FLUENT, GAMBIT, EDEM, Solid works, ANSYS, Python, etc.
	24.	Practice on process optimization softwares i.e. SAS, SPSS, Origin Pro, Design Expert (DX), Minitab, Matlab etc.
	25.	Practice on design analysis and optimization softwares i.e. Solid works, ANSYS etc.

References:

1. Das, H. (2005). Food processing operations analysis. Asian Books Private Limited
2. Denn, M. M. (1986). Process modeling. Longman
3. Holland, C. D. (1975). Fundamentals and modeling of separation processes. Prentice Hall.
4. Luyben, W. L. (1990). Process modeling simulation and control for chemical engineers 2ed. McGraw Hill.
5. Najim, K. (1990). Process modeling and control in chemical engineering. CRC
6. Aris, R. (1999). Mathematical modeling, Vol. 1: A chemical engineering perspective (Process System Engineering). Academic Press.
7. Kreyszig, E. (2005). Advanced engineering mathematics. John Wiley & Sons publication
8. Granato, D. & Ares, G. (2014). Mathematical and statistical methods in food science and technology. IFT Press, Wiley Blackwell
9. Standard software for modelling, analysis and simulations

Course Outcomes

CO1: Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise obstinate mathematical problems.
CO2: Students would be able to assess the approximation techniques to formulate and apply appropriate strategy to solve real world problems.
CO3: They can use the basics of simulation modeling for replicating the practical situations in food industries.
CO4: Students will be capable of developing mathematical models that describe food processes, allowing them to analyse and predict behaviour under different conditions, aiding in process optimization and innovation in food technology.
CO5: Students will be adept at using simulation software to replicate and analyse real-world food processes, enabling them to assess and optimize various factors affecting food quality, safety, and shelf-life.

Mapping between COs with PSOs

Mapping between COs and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1							
CO2							
CO3							
CO4							
CO5							

<table>
<tr><td>Course code</td><td>FPE 507</td></tr>
<tr><td>Course title</td><td>Computer Aided Design of Food Plant Machinery and Equipment</td></tr>
<tr><td>Corse credit</td><td>3 (1+2)</td></tr>
<tr><td>Teaching per Week</td><td>5 hours</td></tr>
<tr><td>Course Objective (CO)</td><td>8. To impart the parametric fundamentals to create and manipulate geometric models using curves, surfaces and solids.
9. To prepare them for taking up CAD knowledge in design and analysis of food machineries.
10. To make them use of CAD knowledge to simulate different food processes.
11. To impart knowledge of latest food manufacturing processes viz, 3D food printing.</td></tr>
<tr><td>Course Content</td><td>
<table>
<tr><td>Unit 1</td><td>Introduction - Definition of CAD/CAM, product cycle.</td></tr>
<tr><td>Unit 2</td><td>Automation, CPU, types of memory, input/output devices, data presentation, data and file structures, data base design, design work station.</td></tr>
<tr><td>Unit 3</td><td>Graphics terminal, operating devices, plotters and other output devices, CPU secondary storage, Turnkey CAD system, selection criteria, evaluation of alternative systems.</td></tr>
<tr><td>Unit 4</td><td>Geometric Modeling Techniques - wireframe, surface and solid modeling, Geometric transformations, Graphics standards.</td></tr>
<tr><td>Unit 5</td><td>CAM - Introduction to Numerical Control (NC) technology, current status of NC, Influence of NC in design & manufacturing.</td></tr>
<tr><td>Unit 6</td><td>Computer aided NC programming in APT language, elements of APT language, APT vocabulary, symbols, numbers and scalars, punctuation, definition, statement labels, notations for APT statement format, statements defining point, line, circle, vector, planes and curves, point to point motion.</td></tr>
</table>
PRACTICALS
<table>
<tr><th>Practical</th><th>Title</th></tr>
<tr><td>1.</td><td>Preparation of manual drawings with dimensions from Models and Isometric drawings of objects and machine components</td></tr>
<tr><td>2.</td><td>Preparation of sectional drawings of selected machine parts</td></tr>
<tr><td>3.</td><td>Drawing of riveted joints and thread fasteners</td></tr>
<tr><td>4.</td><td>Demonstration and practice on computer graphics and computer aided drafting using standard softwares such as AutoCAD and/or Inventor and/or Solidworks and/or Creo and/or Catia</td></tr>
<tr><td>5.</td><td>Computer graphics for food engineering applications</td></tr>
<tr><td>6.</td><td>Practice and use of basic and drawing commands on AutoCAD and Solid works</td></tr>
<tr><td>7.</td><td>Generating simple 2-D drawings with dimensioning using AutoCAD and Solidworks</td></tr>
<tr><td>8.</td><td>Small projects using CAD/CAM</td></tr>
<tr><td>9.</td><td>Practice on assembly using Solidwork assembly tool</td></tr>
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	10.	Analysis of machine/equipment component for structural parameters using FEM
	11	Design optimisation of food machine/equipment using goal driven optimization technique
	12	Kinematic and dynamic analysis of mechanism and machines using Solidworks motion study tool
	13	To study design standards of general food processing equipment and systems
	14	Case studies or reports on hygienic design of food plant machinery, equipment and plants
	15	Preparation of manual drawings with dimensions from Models and Isometric drawings of objects and machine components
	16	Food process analysis using computational fluid dynamics.

References:

1. Farin, G., Hoschek, J. & Kim, M. S. (2002). Handbook of computer added geometric design. Elsevier Science
2. Goetsch, D.L. (1988). MicroCADD: Computer aided design and drafting on microcomputers. Prentice Hall
3. Holah, J.T. & Lelieveld, H. L. M. (2011). Hygienic design of food factories. Woodhead publishing house
4. Higgins, L.& Morrow, L. C. (1977). Maintenance engineering hand-book. McGraw Hill. Keating, F.
5. H. (1959). Chromium-Nickel Austentic Steel. Butterworths Scientific Publ.
6. Newcomer, J. L.(1981). Preventive maintenance manual for dairy industry. Venus Trading Co., Anand.
7. Stanier, W. (1959). Plant engineering hand-book. McGraw Hill.

Course Outcomes

CO1: Students can apply/develop solutions or to do research in the areas of Design and simulation in food engineering.
CO2: Have abilities and capabilities in developing and applying CAD software and hardware to food engineering design.
CO3: Have abilities and capabilities in simulating and analysing CAD software and hardware to food engineering design and process related problems.
CO4: Have able to formulate research problems for innovative food manufacturing techniques.

Mapping between COs with PSOs

Mapping between COs and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1							
CO2							
CO3							
CO4							

Course code	**FPE -511**	
Course title	Process Control in Food Industries	
Corse credit	**3 (2+1)**	
Teaching per Week	**4 Hours**	
Course Objective (CO)	1. Interpret techniques to measure the industrial Process Control parameters. 2. Obtain the mathematical model of system components based on operational principles and/or experimental results and therefrom model the overall digital feedback 3. Evaluate computer based automation system used in industries ranging from discrete, continuous process to hybrid processes. 4. To formulate PLC programs. 5. To utilize software tools in industrial instrumentation.	
Course Content	**Unit 1**	Process Control: Dynamic behavior of first/second order systems, Response of first order systems/first order system in series. Block diagrams and transfer functions, Feedback control, P, PI, PID controllers.
	Unit 2	Measurement of Electrical and Non Electrical Quantities. Motion and displacement measurement: Strain gages, Hall effect devices and Proximity sensors, Large displacement measurement using synchros and resolvers, Shaft encoders. Pressure Measurement: Mechanical devices like Diaphragm, Bellows, and Bourdon tube, Variable inductance and capacitance transducers, Piezo electric transducers, Low pressure and vacuum pressure measurement using Pirani gauge, McLeod gauge, Ionization gauge. Force and Torque Measurement: Load cells and their applications, various methods for torque measurement. Flow measurement differential pressure meter like, Rotameter, Turbine flow meter Electromagnetic flow meter, hot wire anemometer, Ultrasonic flow meter. Temperature Measurement: Resistance type temperature sensors – RTD & Thermistor Thermocouples & thermopiles, Different types of pyrometers. Humidity measurement and Moisture measurement techniques. Liquid level measurement: Resistive, inductive and capacitive techniques for level measurement, Ultrasonic and radiation methods, Air purge system (Bubbler method).
	Unit 3	Digital Data Acquisition Systems & Control: Use of signal conditioners, scanners, signal converters, recorders, display devices, A/D & D/A circuits in digital data acquisition. Instrumentation systems. Types of Instrumentation systems. Data–acquisition systems. Multiplexing systems. Modern digital data acquisition system. Control systems for processing plants.

Unit 4	Industrial Automation. PLC, DCS and SCADA System: Introduction, Basic parts of a PLC, Operation of a PLC, Basic symbols used in PLC realization, Difference between PLC and Hardwired systems, Difference between PLC and computer, Relay logic to ladder logic, Ladder commands, Examples of PLC ladder diagram realization, PLC timers, PLC counters and examples, Classification of PLCs, History of DCS,DCS concepts, DCS hardware & software, DCS structure, Advantages and disadvantages of DCS, Representative DCS, SCADA, SCADA hardware & software.
Unit 5	Image Processing Applications: Methodology, Shape analysis, Object identification and feature/s detection, Three-dimensional processing. Application to food industry: Inspection and inspection Procedures, X-Ray, Computer vision systems, Electronic nose and Electronic tongue.
Unit 6	Virtual Instrumentation: Introduction to LABVIEW: Virtual instruments, Parts of VI, Project explorer, Front panel and block diagram window, Creating simple VI.

Practicals

S. No.	Title of Experiment
1	Study of various online / offline industrial instrumentations for measurement of pressure , temperature, flow, level etc.
2	Study of PLC and to program a PLC using Ladder programming & PLC based control of Multi process system
3	To make ladder logic diagrams and flow sheet diagrams for control logic
4	Study of data loggers- computerized data acquisition and data processing
5	Programming and making GUI in LABVIEW and other relevant softwares
6	Study of image acquisition system and analysis using suitable softwares
7	Study of SCADA application software/ computerized control of PC-PLC based multi- process control system.
8	Study on applications of electronic nose and electronic tongue.
9	Case studies and reports on instrumentation and process control for food manufacturing.

References:

1. McFarlane I. (1995). Automatic control of food manufacturing processes, 2e. Springer Science and Business Media
2. Bhanot, S. (2008). Process control: principles and application. Oxford University Press.
3. Singh, S. K. (2005). Industrial instrumentation & control, 2e. Tata McGraw-Hill Education.

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<tr><td></td><td>
4. Krishnaswamy, K. (2003). Industrial Instrumentation (Vol. 1) . New Age International.
5. 5.Liptak, B. G. (2018). Instrument engineers' handbook, volume two: process control and optimization. CRC press.
6. Jain, R. K. (1988). Mechanical and industrial measurements. Khanna Publishers.
7. Rangan, C. S., Sarma, G. R., & Mani, V. S. V. (1983). Instrumentation: devices and systems. Tata McGraw-Hill.
8. Patranabis, D. (1976). Principles of industrial instrumentation. Tata McGraw-Hill Publishing.
9. Mittal G.S. (1997). Computerized control systems in the food industry. CRC Press
</td></tr>
<tr><td>Course Outcomes</td><td>On completion of the course, the students will be able to
CO1. Analyze the working of typical real-life digital feedback control system in terms of its constituent parts.
CO2. Given the mathematical model of a digital control system, determine performance specifications, and gauge the gap between required and actual performance.
CO3 .Illustrate current trends, technology, and practices used in automation in food industries.
CO4. Interpret communication modes/protocols used in automation in food industries.
CO5. Develop algorithm to achieve desired objective using software.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>Mapping between COs and PSOs

CO = Course outcome with PSO = Program Specific outcome PO1
<table>
<tr><th></th><th>PSO 1</th><th>PSO 2</th><th>PSO 3</th><th>PSO 4</th><th>PSO 5</th><th>PSO 6</th><th>PSO 7</th></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO5</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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Course code	**FSQ 501**
Course title	**Techniques in food quality analysis**
Corse credit	**4 (2+2)**
Teaching per Week	**6 hrs**
Course Objective (CO)	1. To understand use of spectroscopy in food analysis 2. To obtain knowledge of different separation techniques for isolation and separation of compounds 3. To obtain knowledge of chromatographic techniques used in food quality analysis 4. To obtain knowledge of thermal techniques used in analysis of food 5. To obtain knowledge of sampling and microbial analysis in food
Course Content	**Theory** **UNIT I** Sampling Procedures, Calibration and Standardization: Sub- sampling and its procedures, LOD, LOQ, Internal standards, Reference standards and certified reference materials. Spectroscopy techniques: Operation, calibration and standardization procedures as applicable to particular technique. Principles and applications of pH Meter, Digital analyzer, Auto-analyzer, Ultraviolet- visible spectroscopy (UV-VIS), Infra-Red, Fourier-Transform Infrared Spectroscopy (FTIR), Near Infra-Red (NIR), Atomic Absorption spectroscopy (AAS). **UNIT II** Chromatography Techniques: Principles, Components and applications of (i) Paper Chromatography- Ascending and Descending-One dimensional & Two-dimensional (ii) Thin layer chromatography (iii) Ion Exchange (iv) GC (v) GLC (vi) HPLC (vii) HPTLC (viii) GCMS (ix) LCMS (x) Amino acid Analyzer **UNIT III** Separation Techniques: Dialysis, Gel filtration, Electrophoresis: Principles, components and applications of (i) Paper (ii) Starch (iii) Gel (iv) Agar-gel (v) Polyacrylamide gel (vi) Moving boundary (vii) Immuno electrophoresis. Centrifugation: Types of centrifuge – Ordinary and Ultracentrifuge- Principle and applications. **UNIT IV** Principle, Components and Applications of (i) Differential scanning calorimetry (DSC) (ii) Thermogravimetric analysis (TGA) (iii) Isothermal microcalorimetry (IMC) (iv) Thermomechanical analysis (TMA) (v) Isothermal titration caloritmetry (ITC) (vi) Dynamic elemental thermal analysis (DETA) (vii) Nuclear magnetic resonance (NMR) (viii) Scanning electron microscopy (SEM) (ix) Transmission electron microscopy (TEM) (x) X-ray diffraction technique (XRD) (xi) Rapid visco-analyzer (xii) Texture analyzer and (xiii) Micro-dough lab. **UNIT V** Sampling for microbial analysis, Quantitative methods for enumeration of microorganisms in foods, Methods for isolation of microorganisms in foods, Rapid detection of microorganisms using molecular biological tools, immunoassays and biosensors. **List of practical:** • Analysis and characterization of pigment in fruits by UV-VIS.

<table>
<tr><td></td><td>
• Characterization of starches by FTIR spectroscopy.
• Assessment of microstructure of food components by SEM/Reviewing a micrograph obtained through SEM
• Study of thermal denaturation of proteins and food enzymes by DSC.
• Quantization of allergenic proteins by LCMS.
• Separate and identification of pesticides in food samples by HPLC.
• Identification and molecular characterization of proteins by SDS-PAGE.
• Quantization of lipids and fatty acids using TLC.
• Assessment of pasting properties of starches and flours/flour-blends using RVA.
• Analysis of textural properties of food products with texture analyzer.
• Comparative rheological study of wheat flour samples of different varieties.
• Differential thermal analysis (DTA) and Thermogravimatric Analysis of a food samples
• A rapid, visual demonstration of protein separation by gel filtration chromatography.
• Amino acid profiling of food samples
• Detection of food borne pathogens using RT-PCR
• Rapid detection of microorganisms using ELISA
</td></tr>
<tr><td>References:</td><td>

1. Ongkowijoyo P, Luna-Vital DA, de Mejia EG (2018) Extraction techniques and analysis of anthocyanins from food sources by mass spectrometry: An update Food chemistry.
2. Trimigno A, Marincola FC, Dellarosa N, Picone G, Laghi L (2015) Definition of food quality by NMR-based foodomics, Current Opinion in Food Science 4:99-104.
3. Pare, J. R. J. and Bélanger, J. M. R. (2015). Instrumental Methods of Food Analysis: Elsevier.
4. Alejandro Cifuentes (2012) Food Analysis: Present, Future, and Foodomics, ISRN Analytical Chemistry.
5. Skoog, D. A., Holler, F. J. and Nieman, T. A. (1998). Principles of Instrumental Analysis (5 Ed.): Harcourt, Singapore.

</td></tr>
<tr><td>Course Outcomes</td><td>
On completion of the course students will be able to
CO1. Use spectroscopic techniques in analysis of food
CO2. Use different separation techniques for isolation and separation of compounds
CO3. Use chromatographic techniques for food quality analysis
CO4. Use thermal techniques in analysis of food
CO5. Carry out microbial analysis of food
</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
Mapping between COs and PSOs
<table>
<tr><th></th><th>PSO1</th><th>PSO2</th><th>PSO3</th><th>PSO4</th><th>PSO5</th><th>PSO6</th><th>PSO7</th></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO5</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<table>
<tr><td>Course code</td><td>FSQ 502</td></tr>
<tr><td>Course title</td><td>Microbiology of food spoilage and pathogens</td></tr>
<tr><td>Corse credit</td><td>3(2+1)</td></tr>
<tr><td>Teaching per Week</td><td>4 hrs</td></tr>
<tr><td>Course Objective (CO)</td><td>1. To learn about the microorganisms associated with food spoilage and food borne outbreak.
2. To learn the sources of microorganism, their growth characteristics, factors affecting growth of microorganisms in food and food products and metabolism of microorganisms.
3. To understand the different types of food spoilages caused by the microorganisms and processing for the control of food spoilage.
4. To understand about the food borne pathogens and their role in food borne outbreak.
5. To gain knowledge on the methods of isolating and characterizing and enumerations of spoilage causing microbes and food pathogens.</td></tr>
<tr><td>COURSE CONTENT</td><td>
<table>
<tr><td>UNIT 1</td><td>Food Borne Pathogens, Host Invasion, Pathogenesis, Significance to public health Food hazards and risk factors, Pathogenic foodborne microorganisms – Salmonella, Pathogenic Escherichia coli and other Enterobacteriaceae, Staphylococcus aureus, Listeria monocytogenes, Clostridium botulinum, Clostridium perfringens and Bacillus cereus Other Gram-positive pathogens, Campylobacter, Brucella, Aeromonas, Vibrio cholerae, Mycobacterium, Shigella.</td></tr>
<tr><td>UNIT 2</td><td>Fungal and viral food-borne disorders, Food-borne important animal parasites, Mycotoxins, Incidence and behavior of microorganisms in meat, poultry, milk and milk products, fresh agro produce, sea foods.</td></tr>
<tr><td>UNIT 3</td><td>Controlling pathogens and microbial toxin via food processing, Microbial growth and shelf life, Modeling of microbial growth, Safety concerns of food processed through non thermal processing, management of microbial risk and toxin in foods through HACCP, Risk in antimicrobial nano materials, Risk assessment and predictive modeling</td></tr>
<tr><td>UNIT 4</td><td>Molecular approaches for detection and identification of food borne pathogens, Enzyme Immunoassay (EIA), Enzyme-linked immunosorbent assay (ELISA), Radioimmunoassay (RIA) - instrumentation and applications of each immunoassay technique. DNA: DNA purification, DNA Fingerprinting. PCR/RTPCR (Real time) based analysis and sequencing, Biosensors, Recombinant DNA technology; Microchip based techniques, cDNA and genomic libraries, immunochemical techniques.</td></tr>
<tr><td>UNIT 5</td><td>Important factors in microbial food spoilage, Spoilage of specific food groups, New food spoilage bacteria in refrigerated foods, Indicators of microbial food spoilage.</td></tr>
</table>
<table>
<tr><td colspan="2">List of Practical:</td></tr>
<tr><td>1</td><td>Preparation of common laboratory media and special media for cultivation of bacteria, yeast & molds.</td></tr>
</table>
</td></tr>
</table>

	2	Isolation and identification of pathogens.
	3	Coliforms analysis of milk and water samples.
	4	Identification tests for bacteria in foods: IMVIC urease, catalase, coagulase, gelatin and fermentation (acid/gas).
	5	Determination of thermal death characteristics of bacteria.
	6	Determination of DNA and RNA of spoilage microorganism using PCR.
	7	Detection of DNA of trace components allergens, like nuts using ELISA.
	8	DNA/RNA based microarray experiment.
	9	DNA/RNA based microarray experiment.
	10	Determination of growth and activity of microorganisms in incubator.
	11	Determination of preservatives and food colours using Biosensor.
	12	Process time calculation for an indicator organism
	13	Microbes responsible recall – case studies.

References:

1.Ray, B., and A. Bhunia. 2007. Fundamental Food Microbiology, 4th Ed. CRC Press, Boca Ratan, FL.

2.Food and Drug Administration. Food-Borne Pathogenic Microorganisms and Natural Toxins Handbook: The Bad Bug Book.

3.Fratamico PM, Bhunia AK & Smith JL. 2005. Food -Borne Pathogens: Microbiology and Molecular Biology. Caister Academic Press.

4.Vijay K. Juneja, Hari P. Dwivedi, John N. Sofos Editors, 2017, Microbial Control and Food Preservation - Theory and Practice, Springer

5.Ronald H. Schmidt and Gary E. Rodrick 2013 Food Safety Handbook Wiley

Course Outcomes

On completion of course students will be able to:

CO1. Understand about roles played by microorganisms in food spoilage and food borne outbreaks.

CO2. Understand the sources of microorganism, their growth characteristics, factors that affect growth of microorganisms in food and food products and metabolism of microorganisms.

CO3. Understand the various types of food spoilages caused by the microorganisms and processing of food and food products for the control of food spoilage.

CO4. Understand about the food borne pathogens and their role in food borne outbreak.

CO5. Able to use standard protocols for the enumeration of spoilage causing microorganism as well as the methods of isolating and characterizing microorganisms associated to food spoilage and food borne outbreaks.

Mapping between COs with PSOs

Mapping between COs and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	■				■	■	
CO2	■		■	■	■		
CO3	■				■		
CO4	■				■		
CO5	■	■	■	■	■		■

<table>
<tr><td>Course code</td><td colspan="2">FSQ 503</td></tr>
<tr><td>Course title</td><td colspan="2">Advanced food chemistry</td></tr>
<tr><td>Corse credit</td><td colspan="2">3(2+1)</td></tr>
<tr><td>Teaching per Week</td><td colspan="2">4 hrs</td></tr>
<tr><td>Course Objective (CO)</td><td colspan="2">1. To study composition, nutritional and function value of food
2. To study structure and properties of proteins
3. To learn about food flavours
4. To familiarize about food contaminants</td></tr>
<tr><td>Course Content</td><td colspan="2">
<table>
<tr><td>Unit 1</td><td>Composition, nutritional and functional value of food: Water activity and sorption phenomenon, Engineered foods and influencing water activity and shelf-life; Chemical reactions of carbohydrates– oxidation, reduction, with acid & alkali; Maillard reaction, Caramelization, Ascorbic acid oxidation, Resistant Starch, Soluble and Insoluble fibre, Pigments and approaches to minimize the impact of food processing, Molecular Mobility.</td></tr>
<tr><td>Unit 2</td><td>Structure and Properties of proteins; electrophoresis, sedimentation, amphoterism, denaturation, viscosity, gelation, texturization, emulsification, foaming, protein-protein and other interactions in food matrix; Lipids: melting point, softening point, smoke, flash and fire point, turbidity point, polymorphism and polytypism; polymerization and polymorphism, flavor reversion, auto- oxidation and its prevention, fat in food matrix like fat globule in milk, PUFA, MUFA, CLA, ù - fatty acids, trans fatty acids, phytosterol, etc.</td></tr>
<tr><td>Unit 3</td><td>Description of food flavours; Flavour enhancers, Food acids their tastes and flavours, Principles and techniques of flavour encapsulation, types of encapsulation; Factors affecting stabilization of encapsulated flavour and their applications in food industry.</td></tr>
<tr><td>Unit 4</td><td>Processing and packaging induced chemicals and their control – acrylamide, nitrosamines, carcinogenic and genotoxic chloropropanols such as 3-monochloropropane-1,2 diol (3-MCPD), PAHs (in grilled and smoked products), dioxine, histamine, ethyl carbamate, furan, bisphenol A or phthalates from plastic materials, microplastics, 4-methylbenzophenone and 2-isopropylthioxanthone from inks, mineral oil from recycled fibers or semicarbazide from a foaming agent in the plastic gasket.</td></tr>
</table>
List of practical:
<table>
<tr><td>Sr. No.</td><td>Title</td></tr>
<tr><td>1.</td><td>Estimation of protein content in food samples using spectroscopic methods</td></tr>
<tr><td>2.</td><td>Study of effect of heat on protein denaturation using enzymes</td></tr>
<tr><td>3.</td><td>Study of effect of various salt solutions on solubility of proteins</td></tr>
<tr><td>4.</td><td>Separation of milk proteins by salting out method</td></tr>
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</td></tr>
</table>

	5. Separation of proteins using chromatographic methods 6. Fractionation of proteins 7. Extraction and purification of essential oil/ flavoring compound of a natural source 8. Study the process of starch retrogradation, gelatinization and modification 9. Estimation of crude and dietary fibres in given food sample 10. Analysis of resistant starches 11 Estimation of various antioxidants, polar compounds and free fatty acids in frying oils 12 Extraction and purification of natural plant pigment 13 Functional properties and isoelectric point of proteins 14 Qualitative and quantitative evaluation of processing and packaging induced chemicals 15 Qualitative identification of different flavoring compounds
References:	1. O.R. Fennema, Ed., (2008). Food Chemistry, Marcel and Dekker, Inc., New York, NY. 2. Belitz, H. D., Grosch,W., & Schieberle, P. (2009). Food chemistry. Springer. 3. Peter Varelis, Laurence Melton and Fereidoon Shahidi (2019). Encyclopedia of Food Chemistry. Elsevier. 4. Cheung, Peter C. K., Mehta, Bhavbhuti M. (2015) Handbook of Food Chemistry. Springer.
Course Outcomes	CO1: Gain the knowledge of composition, nutritional and function value of food CO2: Insights about structure and properties of proteins CO3: Gain the knowledge about flavours understanding CO4: Knowledge about food contaminants
Mapping between COs with PSOs	**Mapping between COs and PSOs**

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1							
CO2							
CO3							
CO4							

Course code	**FSQ 504**	
Course title	**Global Food Laws and Regulations**	
Corse credit	**2 (2+0)**	
Teaching per Week	**2 h**	
Course Objective (CO)	1. To acquire knowledge of basic concepts of different organisations involved in development of food laws 2. To get acquainted with European and US Food Laws 3. Familiarize with HACCP and its concept and application in food industry 4. Familiarize with Indian Food Laws	
Course Content	**Unit 1**	International Plant Protection Convention, world organization for animal health (OIE), sanitary and phytosanitary measures (SPS), Codex Alimentarius, FAOLEX, OECD Agriculture and Fisheries, International Trade Centre's Standards Map, FAO Food safety and quality emergency Prevention, JFSCA, Fundamental Principles of food safety governance, Risk Analysis as a Method to Determine the Regulatory Outcome, Increasing Responsibility of Businesses (Private) Risk Assessors, Concept of harmonization ofglobal food laws,
	Unit 2	EU Food Safety Standards - Regulation 178 of 2002, The European food safety authority (EFSA), A critical overview of the EU food safety policy and standards, COMESA Food Safety Standards - An overview, Case Studies in Food Safety Standards in EU-COMESA Trade, Private voluntary standards (PVS) and EU food safety standards, FDA Food safety modernization Act (FSMA), FSPCA Preventive Controls for Human Food, Foreign Supplier Ve rification Programs (FSVP), Food Facility Registration, FDA - Current Good Manufacturing Practices (CGMPs)
	Unit 3	Hazard Analysis & Critical Control Points (HACCP) guidelines, Foreign Food Facility Inspection Program, International and Interagency Coordination, Registration of Food Facilities, Seafood Imports and Exports, Regulation on GM Foods Regulations on Irradiated foods, Global Regulations on Health Foods, International Law on Adequacy of thermal processing, Grain Fumigation for Export, Law of trading horticultural Products, Safety Frame Applied to Food Applications of Nanotechnology.
	Unit 4	Review of Indian Regulatory Scenario in Food and Food

	Products - Food Safety and Standards (FSS) Act, 2006, FSS Rules and Regulations, Agricultural Produce Act, 1937 (Grading and Marketing), Export (Quality Control & Inspection), Act, 1963 and Rules, Bureau of Indian Standards relevant to fod safety, Legal Metrology Act, International Food Control Systems/ Laws.
References:	1. Onsando Osiemo, 2018, Food Safety Standards in International Trade: The Case of the EU and theCOMESA, CRC 2. Andrea Barrios Villarreal, 2018, International Standardization and the Agreement on Technical Barriersto Trade, Cambridge University Press 3. Bernd Meulen, Harry Bremmers, Kai Purnhagen, Nidhi Gupta, Hans Bouwmeester L. and Leon Geyer, 2014, Governing Nano Foods: Principles-Based Responsive Regulation 4. Understanding the Codex Alimentarius, 3rd ed., 2006. 5. JessicaVapnek and Melvin Spreij, 2005, Perspectives and guidelines on food legislation, with a newmodel food law for the Development Law Service FAO Legal Office 6. US FDA Website 7. European Food Safety Authority (EFSA) website
Course Outcomes	CO1: Able to elaborate the organisation involved in development of global food laws CO2: Able to apply HAACP in food industry CO3: Able to do registration for foreign food inspection program of US CO4: Able to use knowledge of Indian food laws in industry
Mapping between COs with PSOs	**Mapping between COs and PSOs**

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1							
CO2							
CO3							
CO4							

<table>
<tr><td>Course code</td><td colspan="2">FSQ 507</td></tr>
<tr><td>Course title</td><td colspan="2">Quality concepts and chain traceability</td></tr>
<tr><td>Corse credit</td><td colspan="2">2(2+0)</td></tr>
<tr><td>Teaching per Week</td><td colspan="2">2 hrs</td></tr>
<tr><td>Course Objective (CO)</td><td colspan="2">1. To understand various quality concepts
2. Familiarization with use of various QC tools</td></tr>
<tr><td>Course Content</td><td>Unit 1</td><td>Quality – Concepts, Quality as winning strategy, Total quality management TQM: Introduction, definitions and principles of operation, Tools and Techniques, such as, quality circles, 5 S Practice, Total quality control (TQC), Total employee involvement (TEI), Problem solving process, Quality function deployment (QFD), Failure mode and effect analysis (FMEA), Fault Tree Analysis (FTA), Kaizen, Poka- Yoke, QC Tools, PDCA Cycle, Quality Improvement Tools, TQM implementation and limitations, JH – Autonomous maintenance</td></tr>
<tr><td></td><td>Unit 2</td><td>Introduction, Content, Methods, Advantages and Limitation of: Just –in –Time and Quality Management KANBAN system, Total productive maintenance (TPM), QS 9000. Basic concept, Principle, methodology of contemporary trends: Lean manufacturing, Agile manufacturing, World class manufacturing, Concurrent engineering, Bench marking, Cost of quality (COQ) system.</td></tr>
<tr><td></td><td>Unit 3</td><td>Reliability engineering fundamentals; Failure data analysis; Failure rate; mortality curve; Concept of burn in period; Useful life and wear out phase of a system; Mean time to failure (MTTF); Mean time between failure, (MTBF) and mean time to repair (MTTR); Reliability in terms of Hazard rate and failure density, Measurement systems analysis for accuracy, Probability for quality.</td></tr>
<tr><td></td><td>Unit 4</td><td>SQC -Statistical quality control– X / R / p and c chart, Shewhart and types of control charts, Process capability analysis, process capability index. Acceptance sampling by variables and attributes, design of sampling plans, single, double, sequential and continuous sampling plans, design of various sampling plans for food industry (Note: SQC tables can be used in the examination), Capability analysis. Statistical process control.</td></tr>
<tr><td></td><td>Unit 5</td><td>Traceability in food safety management, Applications of traceability, Traceability challenges, Traceability requirements and standards: ISO 22005, Traceability implementation & application: Traceability data & process flow, Traceability process participants, Traceable item, Batch/Lot and Traceability links management, Food authenticity tools.</td></tr>
<tr><td>References:</td><td colspan="2">1. Montgomery, Jennings and Pfund, 2010, Managing, Controlling and Improving Quality, Wiley
2. K C Arora, 2016 (4th Edition), Total Quality Management, S K Kataria & Sons Pub
3. Eugene L. Grant and Richard S. Leavenworth,7th Ed 1996, Statistical Quality Control, McGraw- Hill</td></tr>
</table>

<table>
<tr><td>Course Outcomes</td><td>CO1: Good understanding about various quality concepts
CO2: Knowledge about use of various QC tools</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>Mapping between COs and PSOs
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td><td>PSO7</td></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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Course code	**FSQ 512**
Course title	**Advances in food biotechnology**
Corse credit	**4(2+2)**
Teaching per Week	**6 h**
Course Objective (CO)	1 To learn basic aspects of fermentation process 2 To learn application of enzymes and its production 3 To learn production of different products through fermentation 4 To learn different techniques used in food biotechnology 5 To learn biotechnological aspects for the for the production of functional food
Course Content	**Theory** UNIT I History of biotechnology, status of biotechnology in India, primary and secondary screening, introduction to primary and secondary metabolites. Introduction to control of metabolic pathways. Techniques for isolation and screening of microorganisms, Strain improvement, techniques. UNIT II Introduction to enzyme, Characteristics of enzyme, Food applications of enzymes; amylases, proteases, lipase, pectinase, celluloses, glucose oxidase. Microencapsulation of enzyme/probiotics. UNIT III Fermentation processes, fermentation processes of: alcohol and organic acids, Amylases, protease, lipase, bacteriocins, UNIT IV Functional and nutraceuticals, supplementation/fortification of bioactive peptides and other functional ingredients, nutrigenomics. UNIT V Application of molecular tools, PCR, RT-PCR, biosensors etc. for the detection of pathogens. **List of practical:** • Demonstration of fermenter • To carry out fermentation of amylase enzyme • Introduction to enzyme purification techniques • To carry out quantitative estimation of amylase • To carry out enzyme assay of invertase • Demonstration of enzyme immobilization • Determination of stability of enzyme at different temperature, pH • Extraction and clarification of juices using enzymes • Introduction to microbial isolation techniques • Detection of food borne pathogen by conventional microbiological method • Microencapsulation of probiotics and study of their viability • Isolation of genomic DNA • Agarose gel electrophoresis • DNA amplification by using PCR • RT PCR for pathogen detection

<table>
<tr><td></td><td>• Gene cloning</td></tr>
<tr><td>References:</td><td>1. Principles of Fermentation Technology by Stanbury and Whittaker: 2nd Edition
2. Industrial Microbiology: L.E.Casida,Willey Eastern Ltd., 1989.
3. Bioprocess Engineering–Basic concepts by M. L. Schuler & F. Kargi, Entice Hall; 1992.
4. Biotechnology-a hand book of industrial microbiology: W. Crueger and A. Crueger.
5. Basic Biotechnology by Colin Ratledge and Bjorn Kristiansen: 2nd Edition, Cambridge University Press.</td></tr>
<tr><td>Course Outcomes</td><td>1 Understand basic aspects of fermentation process
2 Learn production of enzymes and its application
3 Understand theoretical and practical aspects of production of different products through fermentation
4 Learn various techniques used in food biotechnology
5 Understand biotechnological aspects for the for the production of functional food</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>Mapping between COs and PSOs
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td><td>PSO7</td></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO5</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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Course code	**FSQ 513**
Course title	**Fundamentals of microbial controls in foods**
Corse credit	**4 (2+2)**
Teaching per Week	**6 h**
Course Objective (CO)	• To gain basic and applied knowledge about microorganisms • To understand growth requirement of the microorganisms • To learn theoretical and practical aspects food preservation methods • To study quality attributes of foods after preservation
Course Content	**Theory** UNIT I Introduction Introduction: scope of food microbiology Microorganisms important in food industry Types of microorganisms, their importance in foods, classification of food borne bacteria, their morphology and distinguishing features with examples. UNIT II Growth of microorganisms in foods Intrinsic (pH, moisture content, redox potential, nutrient content, antimicrobial constituents and biological structures) and extrinsic factors (temp., RH, presence and concentration of gases) governing growth of microorganisms in food. UNIT III Food Preservation: Principles of preservation, methods of food preservation – high temperature, low temperature, drying, radiation, chemical preservatives, bio-preservatives, hurdle technology, active packaging, novel processing technologies. UNIT IV Special topics in safety: Microbial attachment and biofilm formation, microbial metabolism of food components, food preservatives of microbial origin, bacteriocins and nanotechnology, food spoilage by microbial enzymes, opportunistic bacterial pathogens, molds and mycotoxins, viruses, parasites, fish and shell fish toxins. **List of practical:** • Methods of sampling. • Concept of shelf life of different foods • To study the concept of asepsis and sterilization • Determination of pH of different foods using pH meter. • Study quality characteristics of foods preserved by drying. • Study quality characteristics of foods preserved by dehydration. • Study quality characteristics of foods preserved by freezing. • To perform pasteurization of fluids using different methods. • To perform blanching of different plant foods. • To study the thermal destruction curve. • Industrial Visits

<table>
<tr><td>References:</td><td>1. Fundamental Food Microbiology, Arun Bhunia Bibek Ray, CRC Press.
2. Modern Food Microbiology, J M JAY, APAC.
3. Microbiology of Safe Food, S J Forsythe, Blackwell Science.
4. Microbiology of foods, J C Ayres, J O Mundt, W E Sandine, W H Freeman Elsevier.</td></tr>
<tr><td>Course Outcomes</td><td>1. Understand microorganisms and its related aspects
2. Understand theoretical and practical aspects of microbial growth
3. Explore theoretical and practical aspects food preservation methods
4. Explore quality attributes of foods after preservation</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>Mapping between COs and PSOs
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td><td>PSO7</td></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<table>
<tr><td>Course code</td><td>FSQ 603</td></tr>
<tr><td>Course title</td><td>Quality assurance in food supply chain</td></tr>
<tr><td>Corse credit</td><td>3 (3+0)</td></tr>
<tr><td>Teaching per Week</td><td>3 hrs</td></tr>
<tr><td>Course Objective (CO)</td><td>• To understand food safety regulations
• To understand risk assessment and management
• To learn quality control methods
• To learn supplier management</td></tr>
<tr><td>Course Content</td><td>Theory
Modern food safety risk analysis and management, food defense plan and food fraud mitigation plan, beyond HACCP: TACCP and VACCP, advanced block chain and IoT technology behind the lifecycle traceability–Indian requirements and simple solutions, enzymes as analytical tools for the assessment of food quality and safety, nanoparticles as biosensors for food quality and safety assessment, advances in food identification and authentication with modern analytical tools, emerging real time quality depicting packaging solutions. Supply chain research gaps pertaining to temperature abuse, transportation pallet tracking, refrigerated container management, automated systems in final distribution, clean labels etc.</td></tr>
<tr><td>References:</td><td>1. Naomi Rees. David Watson. 2000. International standards for food safety, Aspen Publications.
2. Assuring food safety and quality. 2012. FAO Food and Nutrition Manual., FAO publications, Rome.</td></tr>
<tr><td>Course Outcomes</td><td>1. Understand food safety regulations
2. Learn risk identification and its mitigation
3. Understand quality control methods
4. Understand supplier management</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>Mapping between COs and PSOs
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td><td>PSO7</td></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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Course code	**FSQ 605**
Course title	**Food and nutraceutical chemistry**
Corse credit	**3 (3+0)**
Teaching per Week	**3 hrs**
Course Objective (CO)	1. Learn mechanism of action of nutraceuticals compounds 2. Study impacts of nutraceuticals for various diseases 3. Familiarize the students about complications and toxicity potential of nutraceuticals 4. Learn regulatory developments of nutraceuticals in health claims 5. Understand the proprietary claims of various nutraceuticals
Course Content	**Unit 1**: Recent advances in mechanism of action and chemical properties of potential and established nutraceutical compounds and their applications in functional foods -Updates in chemistry of Nutraceuticals with diseases modifying indications modifying potential for Allergy, Alzheimer's disease and nutraceuticals, Cardiovascular diseases, Cancer, Diabetes, Eye disorders, Immune system, Inflammation, Obesity, Parkinson's, Alzhaimar etc. Complications and toxicity potential of nutraceuticals, Modern approaches regulatory clearance and ban of nutraceutical. **Unit 2**: Regulatory developments in health claims. Disease risk reduction claims and proprietary claims – recent protocols for phytosterols, digestible starch, slowly digestible starch, flavanols, grain / millet fibre, glucomannan, guar gum and hydroxyl propyl methyl cellulose and fructose etc.
References:	1. Robert E.C.2006. Handbook of Nutraceuticals and Functional Foods. 2nd Ed. Wildman. 2. Chintale Ashwini et al. 2013. Role of Nutraceuticals in Various Diseases: A Comprehensive Review.ISSN:2231-2781. 3. Barbara Schneeman. 2015. Science-Based Regulatory and Policy Considerations in Nutrition, American Society for Nutrition. Adv. Nutr. 6:361S–367S, 2015; doi:10.3945/an.114.007013.
Course Outcomes	CO1: Recognize the importance and recent advances in mechanism of action nutraceuticals compounds CO2: Understand chemical properties of nutraceuticals CO3: Understanding the importance of nutraceuticals with diseases modifying indications modifying potential for Allergy, Alzheimer's disease, Cardio vascular diseases, Cancer etc CO4: Recognize the regulatory developments of nutraceuticals compound in health claims CO5: Understanding the proprietary claims of various nutraceuticals for disease risk reduction claims and proprietary claims
Mapping between COs with PSOs	**Mapping between COs and PSOs**

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	■	■				■	■
CO2		■			■	■	
CO3			■	■	■	■	■

	CO4								
	CO5								