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

DR. SAMIT DUTTA
PRINCIPAL & DEAN

AAU/FPTBE/PG Acad/ 410 /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 Fifth Deans' Committee 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 curriculumis 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>FPT 501</td></tr>
<tr><td>Course title</td><td>Advances in Food Packaging Technology</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 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</td></tr>
<tr><td>Course Content</td><td>
<table>
<tr><th>Unit No.</th><th>Content</th></tr>
<tr><td>1</td><td>Active and intelligent packaging systems, Advances in Active packaging techniques and Intelligent packaging techniques
Current use of novel packaging techniques in different food products, consumers acceptance of novel food packaging</td></tr>
<tr><td>2</td><td>Oxygen and ethylene, scavenging technology, concept and its food applications
Carbon dioxide, odor and flavour absorber and other scavengers, ethanol emitters and preservative releaser, and their food packaging uses
Antimicrobial food packaging: concept and mechanism, Factors affecting the effectiveness of antimicrobial packaging.</td></tr>
<tr><td>3</td><td>Non-migratory bioactive polymers (NMBP) in food packaging, Advantages and limitations
Inherently bioactive synthetic polymers: types and applications,
Polymers with immobilized bioactive compounds.</td></tr>
<tr><td>4</td><td>Time-temperature indicators (TTIs), Definition and classification of TTIs, Requirement, development and current TTI systems, effectiveness of TTIs, Application of TTIs- to monitor shelf-life, and optimization of distribution and stock rotation</td></tr>
<tr><td>5</td><td>Packaging-flavour interactions, Factors affecting flavour absorption, Role of the food matrix and different packaging materials.
Case studies: Packaging and lipid oxidation, Modelling lipid oxidation and absorption Shelf life evaluation of packaged food</td></tr>
<tr><td>6</td><td>Permeability properties of polymer packaging, measurement of permeability –water and gases. Selection criteria of packaging films
Novel MAP gases, Testing novel MAP applications, Novel MAP applications for fresh and prepared food products,</td></tr>
<tr><td>7</td><td>Aseptic packaging technology-advances, systems and its food applications, packaging for high pressure processing</td></tr>
</table>
List of Practicals
<table>
<tr><th>S. No.</th><th>Title of experiment</th></tr>
<tr><td>1</td><td>Determination of WVTR in different packaging materials</td></tr>
<tr><td>2</td><td>Determination of GTR in different packaging materials.</td></tr>
<tr><td>3</td><td>Development of ethylene scavengers for fresh fruits and vegetables</td></tr>
<tr><td>4</td><td>Development of oxygen scavengers systems for food products</td></tr>
<tr><td>5</td><td>Application of anti-microbial packaging for moisture sensitive foods</td></tr>
<tr><td>6</td><td>Evaluation of chemical residue migration from package to food</td></tr>
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</table>

	7	Application of MAP packaging in selected foods
	8	Study of time temperature indicators
	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	Study of aseptic packaging system
	15	Determination of oil and grease resistant test for packaging films
	16	Determination of respiration rate in fresh fruits and vegetables
	17	Visit to food packaging material manufacturing industry

References:

1. Ahvenainen R. 2001. *Novel Food Packaging Techniques*. CRC.
2. Crosby NT. 1981. *Food Packaging Materials*. App. Sci. Publ.
3. Mahadeviah M & Gowramma RV. 1996. *Food Packaging Materials*. Tata McGraw Hill.
4. Painy FA. 1992. *A Handbook of Food Packaging*. Blackie.
5. Palling SJ. 1980. *Developments in Food Packaging*. App. Sci. Publ.
6. Rooney ML. 1988. *Active Food Packaging.* Chapman & Hall.
7. Sacharow S & Griffin RC.1980. *Principles of Food Packaging*. AVI Publ.

Course Outcomes

CO1: Expose to the different novel food packaging techniques
CO2: Application of MAP, Aseptic packaging its application in food.
CO3: Kowledge about antimicrobial food packaging and its applications.
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							

<table>
<tr><td>Course code</td><td>FPT 502</td></tr>
<tr><td>Course title</td><td>Advances in Food Processing Technology</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>Objective of Course</td><td>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 cryogenic grinding and its application in spice processing</td></tr>
<tr><td>Course Content</td><td>
<table>
<tr><th>Unit No.</th><th>Content</th></tr>
<tr><td>1</td><td>Emerging technology in food processing- Active and intelligent packaging, membrane technology, HPP, PEF, Ultra sound.
Supercritical fluid extraction: Concept, property of near critical fluids NCF and extraction methods. Application of SCFE in food processing</td></tr>
<tr><td>2</td><td>Microwave and radio frequency, IR drying: Definition, Advantages, mechanism of heat generation, inductive heating in food processing and preservation.
Application in food processing: microwave blanching, sterilization and finish drying.
Hurdle technology: Types of preservation techniques and their principles, concept of hurdle technology and its application.</td></tr>
<tr><td>3</td><td>High Pressure processing: Types of equipment, mechanism of microbial inactivation
Effect of HPP on -fruit juices, meat products, jam
Ultrasonic processing: Properties of ultrasonic, types of equipment, effect of ultrasonic treatment on microbial inactivation, oil yield etc.</td></tr>
<tr><td>4</td><td>High intensity light generation system, Application of high intensity light in food processing,
Pulse electric field-mechanism of inactivation, PEF generation system, PEF treatment chambers,
Mechanism of ohmic heating and its application in liquid food processing, Principle of cold plasma technology and its generation systems and its application
Nanotechnology: Principles and its applications in foods.</td></tr>
<tr><td>5</td><td>Cryogenic grinding- Properties of cryogens, systems, and their different applications</td></tr>
</table>
List of Practicals
<table>
<tr><th>S. No.</th><th>Title of Experiment</th></tr>
<tr><td>1</td><td>To evaluate the characteristics of treated water using RO system</td></tr>
<tr><td>2</td><td>To carry out ultrafiltration study on fruit juices</td></tr>
<tr><td>3</td><td>To carry out nanofiltration study on liquid foods</td></tr>
<tr><td>4</td><td>To study super critical fluid extraction system and to carry out extraction of eugenol from Basil leaves</td></tr>
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	5 To carry out extraction of lycopene from tomato using SCFE system **6** To study microwave system and to evaluate the effect of different power on drying characteristics of selected vegetable product **7** To study microwave blanching of fruits and vegetable and determination of blanching efficacy **8** To study the ultrasonicator and to evaluate the effect of amplitude and time of ultrasonication on microbial inactivation in idli batter **9** To study the ultrasonicator and to evaluate the effect of amplitude and time of ultrasonication on extracted juice yield from fruit pomace **10** To evaluate the different pre-treatment on oil yield from oil seed cake **11** To study cryogenic grinding of selected spices **12** To compare the yield and quality of bioactive compounds obtained from cryogenically ground spice **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. Barbosa-Canovas 2002. *Novel Food Processing Technologies*. CRC. 2. Dutta AK & Anantheswaran RC.1999. *Hand Book of Microwave Technology for Food Applications*. 3. Frame ND. (Ed.). 1994. *The Technology of Extrusion Cooking*. Blackie. 4. Gould GW. 2000. *New Methods of Food Preservation*. CRC.
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 pulse electric field processing in food processing CO4: Understand ohmic heating and able to apply its principles in food processing CO5: Understand cryogrinding and able to develop cryo-grind spices
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 510</td></tr>
<tr><td>Course title</td><td>Lipid 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. Familiarize the students with lipids and its sources
2. Learn structure and functional relationship of fats and foods
3. Study various steps of oil and fat processing and structured fats
4. Learn applications of fat in salad dressing, chocolates, fat spread, culinary fats etc.
5. Understand Quality aspects of fats and oils</td></tr>
<tr><td>Course Content</td><td>
<table>
<tr><th>Unit No.</th><th>Content</th></tr>
<tr><td>1</td><td>Sources of Lipid: Plant, Animal, Microbial, Marine</td></tr>
<tr><td>2</td><td>Structure function relation to food, polymorphism of fats;
plasticity of edible oil and fat,
lipid- protein and lipid-saccharide interactions</td></tr>
<tr><td>3</td><td>Oil and fat processing- Extraction/ rendering, refining, degumming, Bleaching, filtration, hydrogenation, inter-esterification, winterization, Dewaxing, fractionation, blending, deodorization, packaging and handling finished fat</td></tr>
<tr><td>4</td><td>Bakery Fat- functions of fat in cake, pastry and biscuit;
Quality parameters for shortening; Liquid shortening and powdered fat</td></tr>
<tr><td>5</td><td>Salad dressing- types and categories- pourable, spoonable etc.,
Ingredients and manufacturing process of mayonnaise, salad cream, French dressing</td></tr>
<tr><td>6</td><td>Fat for chocolate and sugar confectionery- Properties and processing of cocoa butter;
Fat bloom in confectionery- causes and control</td></tr>
<tr><td>7</td><td>Spreadable fats- types- margarine, sweet and svaoury spreads;
Ingredients and process technology</td></tr>
<tr><td>8</td><td>Culinary fats and speciality oils- selection criteria of a frying fat
Process Technology for powdered or beaded fat; Fat flakes;</td></tr>
<tr><td>9</td><td>Quality analysis of fats and oils
Food reformulation to reduce saturated fats- biscuits, savoury snacks, pastry and confectionery</td></tr>
<tr><td>10</td><td>Structured lipids and fats</td></tr>
</table>
</td></tr>
<tr><td>References:</td><td>
1. Food Chemistry, O.R. Fennema, Ed., 2008. Marcel and Dekker, Inc., New York, NY.
2. Bailey's Industrial Oil & Fats Products, Ed. by Y.H. Hui, John Wiley & Sons, Inc
3. Akoh, C. C. and Min, D. B. 2002. Food Lipids: Chemistry, Nutrition, and Biotechnology. Marcel Dekker, Inc. Newyork.
4. Gunstone, F. D. 2006. Modifying lipids for use in food. Woodhead Publishing Limited
5. Gunstone, F. D. 2008. Oils and fats in the food industry. Wiley-Blackwell
6. Talbot, G. 2011. Reducing saturated fats in foods. Woodhead Publishing Limited
7. Rajah, K.K. 2002. Fats in Food Technology. Sheffield Academic Press Ltd
</td></tr>
<tr><td>Course Outcomes</td><td>CO1: Understanding the concept of lipids and its sources
CO2: Recognize the importance of lipids for structure formation of various food products
CO3: Understanding the important steps for lipid/ oil extraction and its purification as well as modification
CO4: Interpret the applications of fats and oils for various value added fat rich products like fat spreads, margarine, fat flakes, fat powder etc..
CO5: Recognize analysis protocol and standards for fats and lipids</td></tr>
</table>

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 513**
Course title	**Protein Technology**
Corse credit	**3(3+0)**
Teaching per Week	**3 h**
Course Objective (CO)	1. To learn about importance of protein in human diet 2. To learn about various properties of proteins 3. To learn about milk proteins and their applications 4. To learn about cereal proteins and their applications 5. To learn about textured vegetable proteins, proteins gels and other advancements

Course Content

Unit No.	Content
1	Survey of protein availability and world's protein need. Present status of proteins in food industry Classification of proteins by structure or function; Chemical and functional properties of proteins in food systems, Modification of chemical and functional properties of food proteins, Protein interactions with other food constituents
2	Rheological properties of protein- solubility, viscosity, gelling, surfactants Proteins functionality test- Model foods for testing- foam, gelation, emulsification (Whipped topping, Angel cake)
3	Milk proteins- casein: Structure and properties, manufacture of casein-based ingredients, Use and application of casein-based ingredients, interaction with other ingredients
4	Cereal protein- Gluten: formation, properties and modification and food applications (bread, biscuit, pasta), Gluten manufacturing process, use and application of gluten
5	Soy protein- structures and functional properties of β-conglycinin and glycinin, production technology for soy protein isolate; Application of soy proteins as food ingredients, improving soy protein functionality
6	Gelatin: Introduction, manufacturing process, regulations and standard quality test methods, chemical composition and physical properties, Gelatin derivatives, application of gelatin
7	Textured vegetable proteins and spun fiber technology, types of textured vegetable proteins, Processing of raw materials for texturization, Application of textured vegetable proteins
8	Protein gels – types (egg protein, myosin, surimi etc.), mechanism of formation Protein based film and coating manufacturing techniques Application of protein-based films for fried foods, nut and nut containing product, minimally processed vegetables
9	Potato proteins: Introduction, physico-chemical properties, functionality, potato protein isolation, application and uses

		10	Single cell protein- significance, historical evolution in production, harvesting and commercialization, functional properties, utilization
		11	Protein as antifreeze agent- evolution and structures, mechanism of action, application Taste modifying proteins- types, methods of extraction and purification

References:

1. Yada, R. Y. 2004. Proteins in food processing. Woodhead Publishing Limited and CRC Press LLC
2. Gennadios, A. 2002. Protein-Based Films and Coatings. CRC Press LLC
3. Mine, Y. and Shahidi, F. 2006. Nutraceutical Proteins and Peptides in Health and Disease, CRC Press Taylor & Francis Group
4. Phillips. G.O and Williams.P.A. 2011. Handbook of food proteins, Woodhead Publishing Limited, New Delhi.
5. Encyclopedia of Food Science, Food Technology and Nutrition. 1993. Vols. I-VII, Academic Press.
6. Fennema OR. 1985. Food Chemistry. Marcer Dekker.
7. Fox PF. 1983. Development in Dairy Chemistry. Vol. II. Applied Science Publ.
8. Fox PF. 1992. Advanced Dairy Chemistry. Vol I. Proteins. Elsevier.
9. Macrac R, Robinson RK & Sadler MJ. 1993. IDF Special Issue 9303.
10. Walstra P & Jenness R. 1984. Dairy Chemistry and Physics. John Wiley & Sons.
11. Thompson**.** Abby, Boland, Mike and Harjinder Singh. 2009. Milk Proteins:from Expression to Food. Academic Press is an imprint of Elsevier.

Course Outcomes

CO1: Apply protein knowledge in R&D of various food formulations
CO2: Can solve the functionality problems in food systems
CO3: Can innovate new protein-based products
CO4: Can solve problems of allergy by replacing allergic proteins with hypoallergenic foods
CO5: Can help to solve the problem of malnutrition in developing countries

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 515**
Course title	**Technology for RTE/RTC Food Products**
Corse credit	**3 (2+1)**
Teaching per Week	**4 h**
Course Objective (CO)	**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

Course Content

Unit	Content
1	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.
2	Technology for fruit and vegetable-based snacks: chips, wafers, papads etc. Technology for coated nuts – salted, spiced and sweetened products- *chikkis,Sing bhujia* Technology of ready to eat fruits and vegetable-based food products like, sauces, fruit bars, glazed candy etc. Technology of ready-to-eat canned value added fruits/vegetables and mixes and ready to serve beverages etc.
3	Technology of ready- to- eat baked food products, drying, toasting roasting and flaking, coating, chipping Extruded snack foods: Formulation and processing technology, colouring, flavouring and packaging
4	Technology for ready-to-cook food products- different puddings and curried vegetables etc. Technology for ready-to-cook and ready to eat meat and meat food products
5	Technology for preparation of instant cooked rice, carrot and other cereals-based food products Technology of ready to eat instant premixes based on cereals, pulses etc.
6	Technology for RTE puffed snack- sand puffing, hot air puffing, explosion puffing, gun puffing etc. Technology for preparation of traditional Indian dairy products

List of Practicals

1	Preparation of cereals based fried snack foods
2	Preparation of legume based fried snack foods
3	Preparation of cereal, pulses based ready-to-eat snack food by extrusion cooking their quality evaluation
4	Preparation of cereal grain based puffed products
5	To study the effect of frying time and temperature on potato chips
6	Development of instant food premixes
7	Preparation of cereal and legume based roasted snack
8	Preparation of flaked rice product

	9 To study the effect of roasting time and temperature on quality of pop-corn **10** Determination of shelf-life and packaging requirements of snack food products **11** Preparation of fruits/vegetable based ready to serve beverages and quality evaluation **12** Preparation of canned fruits and vegetables products and quality evaluation **13** Preparation of pumpkin powder added cookies and quality evaluation **14** Preparation of pumpkin Tutti-frutti/petha **15** Preparation of pickle using natural preservatives **16** Visit to industries manufacturing snack foods
References:	1 Edmund WL. *Snack Foods Processing*. AVI Publ. 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 Kamaliya M.K and Kamaliya K.B. 2001.*Baking science and Industries* , Vol.1 and 2, M. K. Kamaliya Publisher, Anand. 6 Lal Girdhari, Siddappaa. G.S, and Tandon, G.L. 1998. *Preservation of fruits and vegetables*. Indian Council of Agricultural Research, New Delhi. 7 Chavan U.D. and Patil J.V. 2013. *Industrial Processing of Fruits and Vegetables***.** Daya Publishing House New Delhi. 8 Duncan Manley**.**2000**.** *Technology of Biscuits, Crackers And Cookies*. CRC Press. Woodhead Publishing Limited, Cambridge, England.
Course Outcomes	**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** Skill for development 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 ■ ■ ■ ■

Course code	**FPT 518**
Course title	**Traditional and Value Added Food Products**
Corse credit	**3 (2+1)**
Teaching per Week	**4 h**
Course Objective (CO)	1. Familiarize the students with various categories of Indian traditional and value added food products and their prospects 2. Learn the formulation, processing, packaging, and storage of traditional and value added food products

	3. Understand the innovative technologies and mechanized processing of traditional products

Course Content

Unit No.	Content
1	Present status of traditional food products Globalization of traditional food products; Plans and policies of the Government and developmental agencies.
2	Overview of heat-desiccated, coagulated, fried, fermented traditional food products Process technology for Indian bread (chapatti), paratha, stuffed paratha, pani poori 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, Handvo, Spiced buttermilk etc. Process improvement in production of Indian sweets (Halwasan, kaju katli, carrot halwa, Rabdi, chocolate burfi,Chikki etc). Process improvement in production of puffed cereals and grains by microwave technique
3	New products based on fruits, vegetables and cereals Application of membrane technology; microwave heating, steaming, extrusion for industrial production of traditional 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, ready to eat products, flour mixes etc (puranpoli, Idlimix, Wadamix, Gotamix).
4	Process technology for convenience traditional food products (ready to eat and serve Curried vegetables, pulses and legumes and Undhiyu etc.), chutneys, paste Use of natural and permitted synthetic preservatives and new packaging systems for traditional food products
5	Techno-economic aspects for establishing commercial units for traditional products.

List of Practicals

S. No.	Title of Experiment
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 sweeteners 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 vermicelli
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. Traditional Foods: General and Consumer Aspects (2016). Integrating Food Science and Engineering Knowledge Into the Food Chain. Ed. Kristberg Kristbergsson & Jorge Oliveira, by Springer, New York
2. Modernization of Traditional Food Processes and Products (2016). Integrating Food Science and Engineering Knowledge Into the Food Chain. Ed. Anna McElhatton & Mustapha Missbah El Idrissi, by Springer, New York
3. Functional Properties of Traditional Foods (2016). Integrating Food Science and Engineering Knowledge Into the Food Chain. Ed. Kristberg Kristbergsson & Semih Ötles, by Springer, New York
4. Technology of Sweets (Mithai), Namkeen and Snacks Food with Formulae (2012). Engineers India Research Institute, EIRI Board, Delhi

Course Outcomes

CO1: Recognize the importance and opportunities of industrial manufacturing of Indian traditional and value-added 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	■			■	■		■

Course code	**FPT 597**
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 of experiments
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							

<table>
<tr><td>Course code</td><td>FPE 501</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>1. To impart the parametric fundamentals to create and manipulate geometric models using curves, surfaces and solids.
2. To prepare them for taking up CAD knowledge in design and analysis of food machineries.
3. To make them use of CAD knowledge to simulate different food processes.
4. 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>
</table>
</td></tr>
<tr><td>References:</td><td>1. Higgins L & Morrow LC. 1977. Maintenance Engineering Hand-Book. McGraw Hill.</td></tr>
</table>

<table>
<tr><td></td><td>
2. Keating FH. 1959. *Chromium-Nickel Austentic Steel*. Butterworths Scientific Publ.
3. Newcomer JL. 1981. *Preventive Maintenance Manual for Dairy Industry*. Venus Trading Co., Anand.
4. Stanier W. 1959. *Plant Engineering Hand-Book*. McGraw Hill.
</td></tr>
<tr><td>Course Outcomes</td><td>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.</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>
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<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>FPE 502</td></tr>
<tr><td>Course title</td><td>Advances in Food Process Engineering</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 introduce students the various engineering properties and their significance.
2. To educate students on fluid flow operations
3. To familiarize the students with the mechanical processing of food for their processing.
4. To get acquainted with the heat & mass transfer, thermal processing, drying and process analysis of the food material.</td></tr>
<tr><td>Course Content</td><td>
<table>
<tr><td>Unit 1</td><td>Engineering properties of biological materials and their significance in equipment design; processing and handling of products.</td></tr>
<tr><td>Unit 2</td><td>Fluid flow operations: food rheology, mechanical energy balance, piping system, flow measurement and pumping equipment</td></tr>
<tr><td>Unit 3</td><td>Mechanical processing: Size reduction, size enlargement, mixing and forming, conveying of solids and separations.</td></tr>
<tr><td>Unit 4</td><td>Heat transfer: coefficients, heat exchangers, electrical/radiation heating and applications</td></tr>
<tr><td>Unit 5</td><td>Mass transfer: vapour/liquid equilibria, distillations, solvent extraction, gas/liquid absorption, adsorption and ion exchange, crystallization and osmo concentration of food</td></tr>
<tr><td>Unit 6</td><td>Thermal processing: kinetics of thermal inactivation, heat transfer considerations, equipment, in-container sterilization, continuous-flow sterilization, pasteurization, baking, roasting and frying.</td></tr>
<tr><td>Unit 7</td><td>Drying: Psychrometrics, drying kinetics, dryer design, drying equipment, energy efficiency in drying</td></tr>
<tr><td>Unit 8</td><td>Process analysis: spreadsheet applications, heat exchanger problem formulation & solution, psychrometric calculation, fitting curves and statistical quality control</td></tr>
</table>
PRACTICALS
<table>
<tr><td>1</td><td>Determination of particle density / true density, bulk density and specific gravity of solid grains / fruits and vegetable</td></tr>
<tr><td>2</td><td>Determination of coefficient of friction, angle of internal friction and aerodynamic property (Terminal Velocity) of grain sample</td></tr>
<tr><td>3</td><td>Determination of viscosity of food materials</td></tr>
<tr><td>4</td><td>Study of various types of heat exchangers</td></tr>
<tr><td>5</td><td>Mixing – determining mixing parameters</td></tr>
<tr><td>6</td><td>Chemical kinetics in food processing
a) Determining rate constants of zero, first order reactions and half-life of reactions</td></tr>
</table>
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	7	Microbial destruction in thermal processing of foods a) Determining decimal reduction time from microbial survival data b) Thermal resistance factor, z-value, in thermal processing of foods c) Determining process lethality for conduction heating food with a microorganism with a z-value d) Determining center and mass-averaging sterilizing value for a thermal process
	8	Mechanical transport of liquid foods a) Measuring viscosity of liquid foods using a capillary tube viscometer b) Rheological properties of power law fluids
	9	Steady state heat transfer in food processing a) Reducing heat transfer through a wall using insulation b) Selecting insulation to reduce heat loss from cylindrical pipes c) Convective heat transfer coefficient in laminar flow conditions d) Convective heat transfer coefficient in turbulent flow conditions
	10	Transient heat transfer in food processing a) Predicting temperature in a liquid food heated in a steam jacketed kettle b) Transient heat transfer in spherical shaped foods c) Transient heat transfer in a cube
	11	Solving simultaneous equations in designing multiple-effect evaporators

References:	Saravacos G.D. & Maroulis Z.B. 2011. *Food Process Engineering Operations*. CRC Press. Chandra P.K. & Singh R.P. *Applied Numerical Methods for Food and Agricultural Engineers*. CRC Press. Singh R.P. *Computer Applications in Food Technology.* Elsevier Science & Technology
Course Outcomes	CO1: Students will acquire understanding of various engineering properties and their significance CO2: Students will be able to understand the basics of fluid flow operations CO3: Students will gain the knowledge about the mechanical processing of the food material CO4: To be able to understand the heat & mass transfer, thermal processing, drying and process analysis of the food material.
Mapping between COs with PSOs	**Mapping between COs and PSOs**

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1							
CO2							
CO3							
CO4							

Course code	**FPE -503**	
Course title	Advances in Instrumentation and 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 system. Multiplexing systems. Modern Digital Data Acquisition system.

	Unit 4	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 in Food Industry Image Processing Methodology: Images and Image Processing, Shape Analysis, Feature Detection and Object Location, Three-Dimensional Processing Application to Food Industry: Inspection and Inspection Procedures, X-Ray Inspection,Computer Vision Systems,Electronic Nose and Electronic Tongue
	Unit 6	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 for measurement of pressure ,temperature, flow, level
2	Study of PLC and to program a PLC using Ladder programming & PLC based control of Multi process system
3	To make Ladder Logicdiagrams 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
6	Study of SCADA Application Software/ Computerized Control of PC-PLC Based Multi-Process Control System

References:

1. Process Control: Principles and Applications by Surekha Bhanot; Oxford University Press.
2. Singh .S.K., 2005. Industrial Instrumentation and Control. Second Edition. Tata McGraw-Hill Publishing Company Limited, New Delhi
3. K. Krishnaswamy and S. Vijayachitra, Industrial Instrumentation. New Age International (P) Limited, New Delhi.
4. Instrument Engineers' Handbook (Vol. – II) by B. G. Liptak; Pub: CRC Press
5. Mechanical & Industrial Measurements by R. K. Jain, Khanna Publications
6. Industrial Instrumentation by Rangan, Sharma, Mani
7. Principles of Industrial Instrumentation, D Patranabis, 3rd edition, Mc Graw hill

Course Outcomes

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.

<table>
<tr><td></td><td>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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<table>
<tr><td>Course code</td><td>FPE 504</td></tr>
<tr><td>Course title</td><td>Thermal process engineering</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 get familiarize with thermal processing operations carried out in food processing
2. To get the knowledge of thermal process calculations and kinetics of thermal processing
3. To study the equipment used for batch and continuous thermal processing of foods and thermal process controls
4. To get an idea of thermal processing plant operation and its maintenance</td></tr>
<tr><td>Course Content</td><td>
<table>
<tr><td>Unit 1</td><td>Overview of thermal operations carried out in food processing</td></tr>
<tr><td>Unit 2</td><td>Measurement and prediction of thermos-physical properties of foods, mass and energy balances and heat transfer considerations for thermal processing of foods</td></tr>
<tr><td>Unit 3</td><td>Blanching, sterilization, pasteurization and cooking criteria, concentration and evaporation, crystallization and freezing</td></tr>
<tr><td>Unit 4</td><td>Heat penetration in packaged foods, kinetics of thermal processing and loss of nutrients</td></tr>
<tr><td>Unit 5</td><td>Equipment used for batch and continuous thermal processing of foods,</td></tr>
<tr><td>Unit 6</td><td>Measurements for thermal process controls</td></tr>
<tr><td>Unit 7</td><td>Process evaluation techniques, optimization and validation of thermal processes</td></tr>
<tr><td>Unit 8</td><td>Thermal processing plant operation and maintenance</td></tr>
</table>
PRACTICALS
<table>
<tr><th>S. No.</th><th>Title</th></tr>
<tr><td>1</td><td>Measurement of thermal conductivity, thermal diffusivity, emissivity and absorptivity of solid and liquid foods.</td></tr>
<tr><td>2</td><td>Study of various thermal processing systems i.e. radio frequency heating, microwave heating, infrared heating, instant and high-heat infusion, ohmic heating, dryers, canning line and retorts.</td></tr>
<tr><td>3</td><td>Use of data loggers to study thermal process.</td></tr>
<tr><td>4</td><td>Use of different model to optimise thermal processes.</td></tr>
<tr><td>5</td><td>Using computational fluid dynamics to optimise thermal processes.</td></tr>
<tr><td>6</td><td>Study of various packaging formats for different thermal processing.</td></tr>
<tr><td>7</td><td>Visit to thermal processing plants.</td></tr>
</table>
</td></tr>
<tr><td>References:</td><td>1. Sun Da-Wen 2006. Thermal food processing. CRC Press
2. Richardson P. 2004. Improving the thermal processing of foods. CRC Press
3. Richardson P. 2001. Thermal technologies in food processing. Woodhead Publishing Ltd
4. Sandeep K.P. 2011. Thermal Processing of Foods: Control and Automation. Blackwell Publishing
5. Holdsworth S.D. & Simpson R. 2007. Thermal Processing of Packaged Foods. Springer</td></tr>
<tr><td>Course Outcomes</td><td>CO1: Able to use modern engineering tools and techniques to analyse and interpret the data in fluid flow and thermal engineering problems.
CO2: Will be able to solve thermal process calculations for any thermal process</td></tr>
</table>

<table>
<tr><td></td><td>CO3: Able to apply advanced thermal engineering concepts in the design of engineering equipment/ systems.
CO4: Would be able to operate any thermal processing plant and its maintenance</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	**FPE 505**		
Course title	Advances in dairy engineering		
Corse credit	3(2+1)		
Teaching per Week	**4 hours**		
Course Objective (CO)	1. To get familiarize with different engineering properties of milk and milk products 2. To learn about advancements in operations and processing of milk and milk products 3. To learn about application of various pumps, agitators in dairy industry 4. To learn about dairy plant cleaning and maintenance		
Course Content	Unit 1	Engineering properties of dairy and food materials and their significance in equipment design; processing and handling of dairy and food products.	2
	Unit 2	Homogenization of milk: Principle of homogenization, Effect of homogenization, Technical execution, valves and pumps, single and double stage homogenizers, care and maintenance of homogenizers, Efficiency of homogenization, design principles of homogenizers, operation and maintenance, application of homogenization in dairy industry. Recent advances in homogenization.	4
	Unit 3	Thermal processing of milk and milk products: Pasteurization; batch, flash and continuous pasteurizer, HTST pasteurizer and design principle and thermal death kinetics, care and maintenance, UHT processing of milk, quality changes during processing of milk and milk products	3
	Unit 4	Tanks, pumps, stirrer mixtures and centrifugation: Designs and equipment of tank, types of tanks, pumps in dairy industry, Agitation and mixing, construction of agitators and patterns of flow. Factors in mixing, types, operation, mixing gas, liquid and solid, heat transfer in mixers, power requirement, transmission, scale-up of models. Separation by gravity and centrifugal force, clarifiers and separators, centrifugal separator and efficiency of separation, flow rate and power consumption.	5
	Unit 5	Evaporation: Classification, design of multiple-effect evaporator, temperature distribution, boiling point elevation, operation, feeding methods, condensate and air removal, scale formation and removal, heat and mass balance, vapor recompression, design of recovery system, selection and design of auxiliary equipment.	6

	Unit 6	Spray and drum drying: Theory of drying, estimation of drying rates and drying time, drying equipments, particle size calculation, design of spray and drum dryer, skim milk and whole milk powders manufacturing methods. Fluidized bed drying, Principle s of fluidized bed method, Types of fluidized bed drier, Drying and cooling times in fluidized bed; Freeze drying; Agglomeration, Problems of reconstitution, Methods of Agglomeration, The effect of drying on milk products. Recent advances in drying. Design data, performance and selection and design of dryer.	6
	Unit 7	Material handling: System and devices, design of screw, belt, flight, apron conveyors, bucket elevators, power requirements, and applications, feeders and feeding mechanism.	4
	Unit 8	Dairy plant production planning, operation and maintenances	2

List of Practicals

1	Studying complete set of milk receiving & storage equipments for their constructional, operational and maintenance details.
2	Studying complete set of milk pasteurizing / sterilizing and related equipments.
3	Studying complete set of fat handling equipments.
4	Studying complete set of condensing / drying equipments.
5	Studying complete set of ice-cream and frozen products equipments.
6	Studying complete set of cheese and casein equipments.
7	Detailed study of steam generating systems, their construction, operation & maintenance.
8	Detailed study of steam supply & distribution systems.
9	Detailed study of water treatment equipment, water supply & distribution.
10	Detailed study of electricity supply & distribution.
11	Detailed study of refrigeration plants, chilled water supply & distribution.
12	Detailed study of compressed air generation, supply & distribution.
13	Demonstration of various heat transfer models & equipment.
14	Studying instrumentations of milk processing plants.
15	Design calculations for selected process equipments.
16	Studying material handling equipment, building details & plant layout.

References:

Das H. 2005. *Food Processing Operations and Analysis*. Asian Books.

Fellows PJ. 1988. *Food Processing Technology, Principle & Practices*. Ellis Horwood.

Toledo RT. 2007. *Fundamentals of Food Process Engineering*. Springer.

Ahmed T. 1997. *Dairy Plant Engineering and Management*. 4th Ed. Kitab Mahal.

Gary Krutz, Lester Thompson & Paul Clear. 1984. *Design of Agricultural Machinery*. John Wiley & Sons.

<table>
<tr><td></td><td>Hall CW & Davis DC. 1979. Processing Equipment for Agricultural Products. AVI Publ.
Higgins L & Morrow LC. 1977. Maintenance Engineering Hand-Book. McGraw Hill.
Stanier W. 1959. Plant Engineering Hand-Book. McGraw Hill.</td></tr>
<tr><td>Course Outcomes</td><td>CO1: Acquainted to dairy equipments and plants
CO2: Apply knowledge of latest advancements in dairy machinery in designing and development of equipment
CO3: Can handle a sophisticated advanced plant confidently
CO4: Can maintain the plant in smooth running conditions
CO5: Useful in R&D in dairy</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>
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CO = Course outcome with PSO = Program Specific outcome PO1</td></tr>
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Course code	**FPE 506**	
Course title	**Engineering, textural & rheological characteristics 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 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, description of shape and size, volume and density, porosity, surface area. Thermal properties: Specific heat, thermal conductivity, thermal diffusivity, methods of determination, steady state and transient heat flow. Electrical properties; Dielectric loss factor, loss tangent, A.C. conductivity and dielectric constant, method of determination, energy absorption from high-frequency electric field.
	Unit 2	Contact stresses between bodies, Hertz problems, firmness and hardness, mechanical damage, dead load and impact damage, vibration damage, friction, effect of load, sliding velocity, temperature, water film 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 3	Rheological classification of Fluid Foods : Shear-rate dependence and time dependence of the flow-curve; Non-Newtonian fluids; thixotropy; Mechanisms and relevant models for non-Newtonian flow; Effect of temperature; Compositional factors affecting flow behaviour; Viscosity of food dispersions – dilute and semi-dilute systems, concentration effects.
	Unit 4	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 5	Large Deformations and failure in foods: Definitions of fracture, rupture and other related phenomena; Texture Profile Analysis; Instrumental measurements – Empirical and Fundamental methods; Rheometers and Texture Analyzers; Measurement of Extensional viscosity; Acoustic measurements on crunchy foods.
	Unit 6	Rheological and textural properties of selected food products: Measurement modes and techniques; Effect of processing and additives (stabilizers and emulsifiers) on food product rheology; Relationship between instrumental and sensory data.
	Unit 7	Examining food microstructures: history of food microstructure studies, light microscopy, transmission electron microscopy, scanning electron microscopy, other instrumentation and techniques, image analysis: image acquisition, image processing, measurement analysis.
	Unit 8	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 relations in gels.

PRACTICALS

S. No.	Title
1.	Viscosity measurements of fruit juices using ostwald visometer
2.	Viscosity measurements of liquid food products using Brookefield viscometer
3.	Development of stress and strain curve and to study viscosity of Newtonian and non Newtonian fluid
4.	Determination of thermal conductivity and specific heat using differential scanning colorimetry (DSC)
5.	Texture analysis of foods fruits and vegetables
6.	Texture analysis of foods baked products (bread/ biscuit)
7.	Starch characterization using starch master
8.	Dough rehology using doughlab
9.	Determination of microstructures in selected foods using light microscopy
10.	TEM and SEM, image analysis and image processing techniques
11.	Evaluation of phase transition in colloidal systems, evaluation of structure texture function relations

References:

1. Barbosa-Canovas GV, Kokini JL, Ma L & Ibarz A. 1997. *Rheology of Semi-liquid foods*. *Adv. Food & Nutr. Res*., 39:1-69.
2. DeMann JM, Voisey PW, Rasper VF & Stanley DW. 1976. *Rheology and Texture in Food Quality*. AVI Publ.
3. Aguilera JM. 2001. *Micro Structure: Principles of Food ProcessingEngineering.*
4. Bechtel DB. 1983. *New Frontiers in Food Microstructure*. American Association of Cereal Chemists.
5. Moskowitz 1999. *Food Texture.* AVI Publ.

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: Comprehend various 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

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>FPE 508</td></tr>
<tr><td>Course title</td><td>Food industry energy management and auditing</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 students with various aspects of energy conservation, management and auditing.
2. Identifying the quality and cost of various energy inputs.
3. Relating energy inputs and production output.
4. Highlighting wastage's in major areas of food industries and identifying potential areas of thermal and electrical energy economy.</td></tr>
<tr><td>Course Content</td><td>
<table>
<tr><td>Unit 1</td><td>General Aspects of Energy Management & Energy Audit: Energy scenario, basics of energy and its various forma, material and energy balance, monitoring and targeting and financial management</td></tr>
<tr><td>Unit 2</td><td>Energy Auditing Basics: ASHRAE Definitions of Energy Audits, The Audit Process, Pre-Site and Post-Site Work, Audit report</td></tr>
<tr><td>Unit 3</td><td>Energy Accounting and Analysis: Energy Accounting and Analysis, The Energy Use Index, Conditioned Area, Electricity Costs, Thermal energy costs, Energy-Using Systems, Commercial Energy Use Profiles, Identifying Potential Measures, Industrial Audit Opportunities, Industrial Energy Use Profiles.</td></tr>
<tr><td>Unit 4</td><td>Energy economics: Simple payback, Time value of money, Job simulation experience, Making decisions for alternate investments, Depreciation, taxes and the tax credit, Impact of fuel inflation on life cycle costing</td></tr>
<tr><td>Unit 5</td><td>Measurements, Survey Instrumentation, and Data Collection: General audit instrumentation; CO2, Temperature, Pressure, Fluid and Fuel flow, Combustion gas composition, Electrical and Light measurement, measuring building losses, Application of IR thermograph, Infrared radiation and its measurement, Measuring electrical system performance</td></tr>
<tr><td>Unit 6</td><td>Energy Conservation Technologies Applied to Food Processing Facilities: Energy Conservation in Steam Generation and Consumption System, Energy Conservation in Heat Exchangers, Energy Conservation in Compressed Air System, Energy Conservation in Power and Electrical Systems, Waste-Heat Recovery and Thermal Energy Storage in Food Processing Facilities, Building Envelop Audit, Energy Consumption and Saving Opportunities</td></tr>
</table>
PRACTICALS
<table>
<tr><th>Practical</th><th>Title</th></tr>
<tr><td>1.</td><td>Study and practice with energy assessment and auditing instruments</td></tr>
<tr><td>2.</td><td>Performance assessment of motors and variable speed drives</td></tr>
<tr><td>3.</td><td>Performance assessment of pump, fans and blowers</td></tr>
<tr><td>4.</td><td>Performance assessment of refrigeration system</td></tr>
<tr><td>5.</td><td>Performance assessment of heat exchangers</td></tr>
<tr><td>6.</td><td>Performance assessment of furnace</td></tr>
<tr><td>7.</td><td>Performance assessment of boilers</td></tr>
</table>
</td></tr>
</table>

	8.	Energy conservation in dairy processing facilities
	9.	Energy conservation in grains and oilseeds milling facilities
	10.	Energy conservation in sugar and confectionary processing facilities
	11.	Energy conservation in fruit and vegetable processing facilities
	12.	Energy conservation in bakery processing facilities
	13.	Energy efficiency and conservation in food irradiation
	14.	Energy conservation in meat processing facilities

References:

1. Wang L. 2009. *Energy Efficiency and Management in Food Processing Facilities*. CRC Press
2. Thumann A., Niehus T. & Younger W.J. 2013. *Handbook of Energy Audits* 9ed. Fairmont Press
3. BEE-NPC Cases studies

Course Outcomes

CO1: Demonstrate understanding of common energy conservation methods, basics of auditing and energy management and how they are used to obtain food process related solutions.
CO2: Students would be able to apply energy conservation knowledge to minimize energy loss and energy economics.
CO3: They can use the basics of energy management by collecting data for financial analysis related to energy and apply energy conservation techniques in food industries for reducing energy loss.
CO4: Students will develop problem-solving skills related to auditing tool operation and maintenance, enabling them to troubleshoot minor issues and ensure the continuous functioning of machinery used in food processing.

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>FPE 512</td></tr>
<tr><td>Course title</td><td>Post-harvest management and storage engineering</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 establish the knowledge about the basics of postharvest physiology of fruits and vegetables
6. To familiarize about the packaging materials for different perishable and non-perishable foods.
7. To familiarize with the grain management, storage of perishables and design of storage structures.</td></tr>
<tr><td>Course Content</td><td>
<table>
<tr><td>Unit 1</td><td>Postharvest physiology of fruits and vegetables; Advances in fruits and vegetable selection, grading, sorting, blanching and other pre processing steps in automation of processing line; kinetics of quality changes: physical, chemical, sensory and nutritional changes during handling for processing</td></tr>
<tr><td>Unit 2</td><td>Packaging materials & its advancement, Mass transfer in packing material, Innovation in food packing(active, passive, intelligent), Package testing. Factors affecting shelf life of agriculture produce as well as products; storage of agricultural produce</td></tr>
<tr><td>Unit 3</td><td>Storage of grains, biochemical changes during storage, production, distribution and storage capacity estimate models, storage capacity models, ecology, storage factors affecting losses, storage requirements.</td></tr>
<tr><td>Unit 4</td><td>Bag and bulk storage, godowns, bins and silos, rat proof godowns and rodent control, method of stacking, preventive method, bio-engineering properties of stored products, function, structural and thermal design of structures, aeration system.</td></tr>
<tr><td>Unit 5</td><td>Grain markets, cold storage, controlled and modified atmosphere storage, effects of nitrogen, oxygen, and carbon dioxide on storage of durable and perishable commodities, irradiation, storage of dehydrated products, food spoilage and preservation, storage pests and control, BIS/FSSAI standards.</td></tr>
<tr><td>Unit 6</td><td>Physical factors influencing flow characteristics, mechanics of bulk solids, flow through hoppers, openings and ducts; recent advances in handling of food materials</td></tr>
</table>
PRACTICALS
<table>
<tr><th>S. No.</th><th>Title of Experiment</th></tr>
<tr><td>1</td><td>Determination of quality and maturity indices of selected foods</td></tr>
<tr><td>2</td><td>Measurement of respiration of fruits/grains in the laboratory and determination of shelf life</td></tr>
<tr><td>3</td><td>Determination of effects after different postharvest treatments</td></tr>
<tr><td>4</td><td>Study of evaporative cooling and cold storage systems for selected fruits and vegetables</td></tr>
<tr><td>5</td><td>Determination of WVTR & GTR in different packaging materials</td></tr>
<tr><td>6</td><td>Visits to traditional storage structures, CA storage , cold storage</td></tr>
</table>
</td></tr>
</table>

	7 | Shelf life evaluation of packaged food products 8 | Storage study in the MAP
References:	**Suggested Readings** Ramaswamy H.S. 2015. *Post harvest technologies for fruits and vegetables*. DEStech Publications, Inc Chakraverty A. & Singh R.P. 2014. *Postharvest technology and food process engineering*. CRC Press Chakraverty A., Mujumdar A.S. & Ramaswamy H.S. 2002. *Handbook of Postharvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices*. CRC Press Wills R. & Golding J. 2016. *Postharvest: An Introduction to the Physiology and Handling of Fruit and Vegetables*. CABI FAO. 1984. *Design and Operation of Cold Stores in Developing Countries*. FAO. Hall CW 1970. *Handling and Storage of Food Grains in Tropical and Sub-tropical Areas*. FAO Publ. Oxford & IBH. Henderson S & Perry SM. 1976. *Agricultural Process Engineering*. 5th Ed. AVI Publ. McFarlane Ian. 1983. *Automatic Control of Food Manufacturing Processes*. Applied Science Publ. Multon JL (Ed). 1989. *Preservation and Storage of Grains, Seeds and their By-products*. CBS. Ripp BE 1984.*Controlled Atmosphere and Fumigation in Grain Storage*. Elsevier. Shefelt RL & Prussi SE. 1992. *Post Harvest Handling – A System Approach*. Academic Press. Shejbal J (Ed). 1980. *Controlled Atmosphere Storage of Grains*. Elsevier. Vijayaraghavan S. 1993. *Grain Storage Engineering and Technology*. Batra Book Service
Course Outcomes	CO1: Have an idea of the physiology of different perishable and non-perishable foods. CO2: Gain an understanding of various packaging materials & its advancement. CO3: To be able to select and utilize the suitable grain management, storage of perishables and design of storage structures best suited to agricultural commodity.
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>BE 501</td></tr>
<tr><td>Course title</td><td>Non-conventional Sources of Energy</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 Objectives (CO)</td><td>8. To study the energy sources and their importance in environmental protection
9. To learn about solar energy, its various gadgets and applications of solar thermal energy in food processing
10. To know about solar photovoltaic system and its applications
11. To study biomass; its availability, characterization and applications in food industry
12. To understand the importance of biogas technology and uses of food waste for biogas generation and its applications
13. To briefly understand wind energy, geothermal energy, hydroelectric energy, and ocean energy</td></tr>
<tr><td>Course Content</td><td>
<table>
<tr><td>Unit 1</td><td>Classification of energy sources; Introduction to renewable energy sources and technologies, their importance for sustainable development and environmental protection, production and potential.</td></tr>
<tr><td>Unit 2</td><td>Solar radiation, measurement of solar radiation. Types of solar collectors, their construction, working principle. Familiarization with solar energy gadgets: solar cooker, solar concentrator, solar dryer, solar steam generator; utilization of solar thermal energy in food processing.</td></tr>
<tr><td>Unit 3</td><td>Solar photovoltaic cells, types, construction, working principle and uses. Advantages and disadvantages of solar PV systems, power generation through solar PV system. Modules, arrays, conversion process of solar energy into electricity, applications in food industry.</td></tr>
<tr><td>Unit 4</td><td>Introduction to biomass, its availability and characterization. Briquetting of biomass. Biomass combustion, pyrolysis, gasification. Gasifier’s types, construction, working principle and utilization of producer gas in various applications. Power production through gasifiers and its uses in food industry. Liquid biofuels preparation and utilization, bioethanol production and uses.</td></tr>
<tr><td>Unit 5</td><td>Importance of biogas technology, production mechanism, types of biogas plants, construction, working principle, selection and installation of biogas plants, uses of biogas, handling & utilization of digested slurry. Use of food waste for biogas generation and its applications.</td></tr>
<tr><td>Unit 6</td><td>Brief introduction to wind energy, power generation through wind energy, various types of wind energy conversion systems, geothermal energy, hydroelectric energy, ocean energy.</td></tr>
</table>
PRACTICALS
<table>
<tr><td>Practical</td><td>Title</td></tr>
</table>
</td></tr>
</table>

9.	Study of solar radiation measuring instruments.
10.	Study of solar cooker.
11.	Study of solar water heater.
12.	Study of solar dryer.
13.	Study of solar PV system.
14.	Estimation of calorific value of biomass.
15.	Estimation of moisture content of biomass.
16.	Estimation of ash content of biomass.
17.	Estimation of fixed carbon and volatile matter of biomass.
18.	Study of briquetting machine.
11	Demonstration of up draft gasifier.
12	Demonstration of down draft gasifier.
13	Demonstration of working of a fixed dome type biogas plants.
14	Demonstration of working of a floating drum type biogas plants.
15	Demonstration of biodiesel preparation.
16	Demonstration of wind measuring instruments.

References

1. Rai, G.D. 2013. Non-Conventional Energy Sources, Khanna Publishers, Delhi.
2. Rai, G.D., Solar Energy Utilization, Khanna Publishers, Delhi.
3. Khandelwal, K.C. & S. S. Mahdi. 1990. Biogas Technology- A Practical Handbook.
4. Rathore N. S., Kurchania A. K., Panwar N. L. 2007. Non-Conventional Energy Sources, Himanshu Publications.
5. Tiwari, G.N. and Ghoshal, M.K. 2005. Renewable Energy Resources: Basic Principles and Applications. Narosa Pub. House. Delhi.
6. Rathore N. S., Kurchania A. K., Panwar N. L. 2007. Renewable Energy, Theory and Practice, Himanshu Publications.

Course Outcomes

CO1: Expose to various energy sources, renewable energy and its utilization in food processing
CO2: Applications of solar thermal systems in food processing
CO3: Familiarisation with solar photovoltaic systems uses in food processing
CO3: Expose to various types of biomass and its applications as energy source
CO4 Familiarisation with biogas generation from food waste and its utilization in food processing plants
CO6 Understand wind energy, hydro electric energy and ocean energy

Mapping between COs with PSOs

Mapping between COs and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1							
CO2							
CO3							

	CO4							
	CO5							
	CO6							

<table>
<tr><td>Course code</td><td>FQA 501</td></tr>
<tr><td>Course title</td><td>Instrumental techniques in food analysis</td></tr>
<tr><td>Corse credit</td><td>3(1+2)</td></tr>
<tr><td>Teaching per Week</td><td>5 hrs</td></tr>
<tr><td>Course Objective (CO)</td><td>1. To study the general criteria for food analysis
2. To understand the advanced instruments used and its application to food analysis
3. To understand the different chromatographic separation and analysis of food
4. To familiarize about rapid microbial analysis of food
5. To obtain knowledge of thermal techniques and microscopic techniques used in food analysis
6. To obtain theoretical and practical knowledge on modern analytical instruments used for Food analysis</td></tr>
<tr><td>Course Content</td><td>
<table>
<tr><td>Unit 1</td><td>Introduction to Food Analysis: Introduction to food and its components, Sampling, Sample preservation, Extraction, Proximate analysis</td></tr>
<tr><td>Unit 2</td><td>Spectroscopic Techniques: Introduction & theory of spectroscopic techniques, - Principle, Instrumentation, application of each technique. UV-Visible, IR, Raman, & Mass spectroscopy – Principle, Instrumentation, application of each technique. Fluorescence, Turbidoimetric techniques – Principle, Instrumentation, application of each technique. AAS – Principle, Instrumentation, applications. NMR/ESR spectroscopy – Principle, Instrumentation, application.</td></tr>
<tr><td>Unit 3</td><td>Chromatographic Techniques: Introduction, HPLC, GC, Paper chromatography, TLC/HPTLC, Ion chromatography, Flash chromatography – Principle, Instrumentation, applications of each technique.</td></tr>
<tr><td>Unit 4</td><td>Biological Techniques: Electrophoresis, PCR/RTPCR, Immunoassays - Principle, Instrumentation, applications of each technique</td></tr>
<tr><td>Unit 5</td><td>Recent Techniques: Rheology, DSC/DTA/TGA/TMA, XRD/XRF, Electron microscopy, Refractivity, Polarimetry - Principle, Instrumentation, applications of each technique</td></tr>
</table>
PRACTICALS
<table>
<tr><th>Practical</th><th>Title</th></tr>
<tr><td>1.</td><td>Determination of moisture by Karl Fischer method</td></tr>
<tr><td>2.</td><td>Determination of carotenes (spectrophotometric)</td></tr>
<tr><td>3.</td><td>Determination of Vitamin C (spectrophotometric)</td></tr>
<tr><td>4.</td><td>Determination of gingerol by HPLC</td></tr>
<tr><td>5.</td><td>Determination of minerals by AAS</td></tr>
<tr><td>6.</td><td>Fatty acid profile in lipids by GC</td></tr>
<tr><td>7.</td><td>Determination of Chloride content by Ion Chromatography</td></tr>
<tr><td>8.</td><td>Determination of thermal properties using DSC</td></tr>
<tr><td>9.</td><td>Determination of rancidity using Rancimat</td></tr>
<tr><td>10.</td><td>Determination of sugar concentration and solids using Refractometer</td></tr>
<tr><td>11</td><td>Separation of amino acids using TLC/HPTLC</td></tr>
<tr><td>12</td><td>Separation of food colors using TLC/HPTLC</td></tr>
</table>
</td></tr>
</table>

	13	Demonstration of PCR for Gene amplification
	14	Agarose Gel Electrophoresis
	15	Demonstration of ELISA test

References:

1. Food Analysis: Theory and Practice, 1994. Y. Pomeranz and C.E. Meloan. 3rd edn., Conn. (USA): AVI Publ. Co.
2. Stewart, K.K. and Whitaker, J.R. (1984). Modern Methods of Food Analysis. Conn: AVI Publ. Co.
3. James, CS. (1995). Analytical Chemistry of Foods. Blackie Academic and Professional, UK
4. Methods of analysis of food components and additives by Semih Otle, Published in 2005 by CRC Press.

Course Outcomes

CO1: Expose to the important criteria and SOPs for food analysis
CO2:. Understand the advanced instruments used and its application to food analysis
CO3: Understand the different chromatographic separation and its analysis for food
CO4: Acquire the knowledge about thermal and optical techniques used in food analysis
CO5: Acquire theoretical and practical knowledge on modern analytical instruments used for food analysis

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">FQA 504</td></tr>
<tr><td>Course title</td><td colspan="2">Advances in food chemistry and nutrition</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 about importance and behaviour of water in food
2. To study about importance and behaviour of proteins in food
3. To study about importance and behaviour of lipids in food
4. To study about importance and behaviour of carbohydrates in food
5. To study about importance and behaviour of micronutrients in food</td></tr>
<tr><td>Course Content</td><td>Unit 1</td><td>Physical and chemical properties of water: structure and chemical properties, solute effects on water, state of water in foods, kinetic principles; water activity: principles, measurement, control, effects, related concepts; acid-base chemistry of foods and common additives</td></tr>
<tr><td></td><td>Unit 2</td><td>Proteins: physical properties of proteins in relation to protein structure, analytical methods; basic properties: hydration, ionization, colloidal behaviour; functional properties; effects of food processing: changes occurring in chemical, functional & nutritional properties of proteins; nitrite function, chemistry and nitrosamine formation. Protein as nutrient, protein quality, role in human body.</td></tr>
<tr><td></td><td>Unit 3</td><td>Lipids: Content and role in foods, analytical methods, chemical, nutritional and physical properties, processing of fats and oils, degradation reactions</td></tr>
<tr><td></td><td>Unit 4</td><td>Carbohydrates: simple sugars, sugar derivatives and oligosaccharides, basic chemistry, conformation, anomeric forms, equilibrium, reactivity, sweetness; sugar derivatives: sugar alcohols, glycosides, etc.; browning and related reactions; case studies – acrylamide and furan formation in foods; polysaccharides: basic structures and properties, starches, celluloses, gums, modification techniques; dietary fiber: components, properties, analysis. Nutritional importance.</td></tr>
<tr><td></td><td>Unit 5</td><td>Vitamins: structure and properties of vitamins, distribution and morphology of vitamins in foods, changes of vitamins in food processing and storage, Regulation and control of vitamins in foods, relationship of vitamins and food quality. Deficiency of vitamins and metabolic disorders.</td></tr>
<tr><td></td><td>Unit 6</td><td>Minerals: structure and properties of minerals, distribution and morphology of minerals in foods and processed goods, changes of minerals in food processing and storage, regulation and control of minerals in foods, relationship of minerals and food quality</td></tr>
<tr><td></td><td>Unit 7</td><td>Role of protein, carbohydrate and lipid in nutrition, water, minerals and vitamins in nutrition: Functions, food sources, storage in body, deficiency, bioavailability etc.</td></tr>
</table>

	Unit 8	Effect of cooking and heat processing on nutritive value of food. Processed supplementary foods. Use of food in body: digestion, absorption transportation and utilization. Nutrition and its relation to obesity. Energy calculations form foods and formulation of balanced diet.

PRACTICALS

Practical	Title
1.	Estimation of moisture content in food sample
2.	Estimation of reducing sugars
3.	Estimation of crude fibre content
4.	Estimation of protein by Kjeldahl's method
5.	Estimation of total ash, water soluble and acid soluble ash
6.	Extraction of fat
7.	Estimation of free fatty acids
8.	Estimation of peroxide value
9.	Estimation of iodine value
10.	Estimation of saponification value
11	Refractive index of fats and oils
12	Specific gravity of fats and oils
13	Water activity
14	Calculation of normal diet
15	Calculation of liquid diet
16	Calculation of high and low calorie diet

References:

1. Fennema's Food Chemistry, Fourth Edition (Food Science and Technology) Srinivasan Damodaran, Kirk L. Parkin, Owen R. Fennema.
2. Belitz, H. D. and Grosch, W. Food Chemistry. Second Edition. New Yolk: Springer verlag, Berlin Heidelberg, 1999.
3. Medeiros, D., & Wildman, R. (2011). Advanced Human Nutrition: Jones & Bartlett Learning.

Course Outcomes

CO1: Sound understanding of importance and behaviour of water in food
CO2: Sound understanding of importance and behaviour of proteins in food
CO3: Sound understanding of importance and behaviour of lipids in food
CO4: Sound understanding of importance and behaviour of carbohydrates in food
CO5: Sound understanding of importance and behaviour of micronutrients in food

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>FQA 509</td></tr>
<tr><td>Course title</td><td>Advances in food additives and preservatives</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 study various classes of food additives
2. To familiarise about working principles of food additives</td></tr>
<tr><td>Course Content</td><td>
<table>
<tr><td>Unit 1</td><td>Introduction- what are food additives, role of food additives in food processing , functions, classification, intentional and unintentional food additives, toxicology and safety evaluation of food additives, beneficial effects of food additives/toxic effects, food additives generally recognized as safe (GRAS), tolerance levels and toxic levels in foods-LD 50 values of food additives</td></tr>
<tr><td>Unit 2</td><td>Naturally occurring food additives, classification, role in food processing, health implications, food colors, natural and synthetic food colors, types , their chemical nature and their impact on health</td></tr>
<tr><td>Unit 3</td><td>Preservatives, what are preservatives, natural preservation, chemical preservatives, their chemical action on foods and human system, Antioxidants and chelating agents, their role in foods, types of antioxidants – natural and synthetic, chelating agents, their mode of action in foods with examples</td></tr>
<tr><td>Unit 4</td><td>Surface active agents, their mode of action in foods with examples, stabilizers and thickners with examples and their role in food processing, bleaching and maturing agents, examples of bleaching agents, what is maturing, examples of maturing agents and their role in food processing</td></tr>
<tr><td>Unit 5</td><td>Starch modifiers, chemical nature, their role in food processing, buffers- acids and alkalis, examples, types, their role in food processing, Sweeteners, what are artificial sweeteners and non nutritive sweeteners, their health implications, role in food processing</td></tr>
<tr><td>Unit 6</td><td>Flavoring agents, natural and synthetic flavors, examples and their chemical nature, role of flavoring agents in food processing, Anti-caking agents, their role in food processing, Humectants- definition, their role in food processing</td></tr>
<tr><td>Unit 7</td><td>Clarifying agents- definition, examples, their role in food processing</td></tr>
</table>
PRACTICALS
<table>
<tr><th>Practical</th><th>Title</th></tr>
<tr><td>1.</td><td>Determination of benzoic acid in food samples</td></tr>
<tr><td>2.</td><td>Estimation of sulphur dioxide in food samples</td></tr>
<tr><td>3.</td><td>Estimation of sorbic acid in cheese and yoghurt</td></tr>
<tr><td>4.</td><td>Determination of nitrate and nitrites in foods</td></tr>
<tr><td>5.</td><td>Detection and determination of aspartame by thin layer chromatography</td></tr>
<tr><td>6.</td><td>Liquid chromatographic determination of caffeine, benzoate and saccharin in soda beverage</td></tr>
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</table>

	7.	Identification of natural colours
	8.	Isolation, identification and estimation of synthetic food colours
	9.	TLC detection of antioxidants in fats and oils
	10.	TLC detection of emulsifiers
	11	Detection of alginates in foods (chocolate, ice cream)
	12	GC determination of menthol in mentholated pan masala

References:

1. Baren, A. F. et al (2001). Food additives, 2nd edition,Marcel Dekker.
2. George, A. B. (1991). Encyclopaedia of food and colour additives, Vol III, CRC Press.
3. Nakai, S. and Modler, H. W. (2000). Food proteins: processing applications, Wiley

Course Outcomes

CO1: Knowledge about various classes of food additives
CO2: Understanding about working principles of food additives

Mapping between COs with PSOs

Mapping between COs and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1							
CO2							

<table>
<tr><td>Course code</td><td>FQA 511</td></tr>
<tr><td>Course title</td><td>Advances in fermentation technology</td></tr>
<tr><td>Corse credit</td><td>4(2+2)</td></tr>
<tr><td>Teaching per Week</td><td>6 hrs</td></tr>
<tr><td>Course Objective (CO)</td><td>1. To learn significance of microorganisms in fermentation and fermentation of foods and food products.
2. To learn the sources, growth characteristics, metabolism of microorganisms associated to fermented foods and food products.
3. To understand the role of starter cultures in industrial production of fermented food and food products.
4. To gain knowledge on the methods of isolating and characterizing microbes associated with fermented foods.
5. To understand the processing methods for the production of well-known fermented foods.</td></tr>
<tr><td>COURSE CONTENT</td><td>
<table>
<tr><td>Unit 1</td><td>Introduction: Fermentation- historical development; fermented food products of India; worldwide fermented food products; classification of fermented food products.</td></tr>
<tr><td>Unit 2</td><td>Fermentation- Basic Concepts: Basic principles involved in fermentation; types of fermentation; starter culture; preparation and maintenance of bacterial, yeast and mold cultures for food fermentations.</td></tr>
<tr><td>Unit 3</td><td>Fermented Milk Products: Processing, manufacture, storage and packaging of acidophilus milk, cultured butter-milk and other fermented milk; bio-chemical changes occurring during manufacture of fermented milks; factors affecting these changes and effects of these changes on the quality of finished products.</td></tr>
<tr><td>Unit 4</td><td>Fermented Vegetables Products: Technological aspects of pickled vegetables, sauerkraut, cucumbers; mushrooms-cultivation and preservation</td></tr>
<tr><td>Unit 5</td><td>Fermented cereal and Pulse Products: Fermented soy sauce; microbiology and biochemistry; soy sauce manufacturing methods; miso fermentation- raw materials and microorganism for fermentation; comparison of Indigenous and modern processing; spoilage microbes; tempeh- production and consumption, raw material used, essential steps of fermentation; indigenous fermented product-idli, dosa, dhokla etc.</td></tr>
<tr><td>Unit 6</td><td>Fermented Fish and Meats Product: Fermented fish and fish products-fish sauces, fermented fish pastes; fermented sausages-process for manufacture of fermented sausage biochemical and microbiological changes during sausage ripening.</td></tr>
<tr><td>Unit 7</td><td>Alcoholic Fermentation Products: Technology for processing oh wine, cider, beer etc.; microbiological and biochemical aspects</td></tr>
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Unit 8	Other Fermented Products: Methods of manufacture for acetic acid/vinegar, baker's yeast, microbial protein, lactic acid etc. Traditional fermented Foods of India: Dahi, lassi, Butter Milk, Jalebi, Khaman, Dhokla, Idli, Wada etc. Future of Fermented Foods: Advances in microbiology, role of intestinal bacteria in human health in future, regulation and health claims for fermented foods.	

List of Practical:	
1	Preparation of fermented cereal products
2	Preparation of fermented pickles
3	Preparation of Dahi and Lassi
4	Freeze drying of starter culture
5	Preparation of Cheese and analysis
6	Preparation of yoghurt
7	Study of bacteriophages in starter culture
8	Preparation of Traditional fermented food of India
9	Preparation of Tempeh
10	Preparation of alcoholic products
11	Study of Probiotic bacteria
12	Preparation of symbiotic food
13	Industrial Visits

References:

1. Microbiology of fermented foods by B. J. B. Wood, Springer
2. Microbiology and Technology of Fermented Foods by Robert W. Hutkins, IFT Press
3. Handbook of Indigenous Fermented Foods by K. H. Steinkrauss, CRC Press
4. Outlines of Dairy Technology by Sukumar De, Oxford University Press

Course Outcomes

On completion of course students will be able to:

CO1. Understand about the fermentation and role of microorganism in fermentation and its application and industrial production of fermented foods.

CO2. Gain the knowledge about the starter cultures and microorganism that are responsible for the fermentation of food and food products.

CO3. Learns the selection and use of microorganisms for production of desirable fermented foods and food products.

CO4. Understand about the various types of fermented foods that are popular throughout the world and production and processing of these fermented foods.

CO5. Understand the different tests and procedure for the characterization and application of starter culture and probiotic microorganisms for the fermented foods production suitability.

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>FQA 512</td></tr>
<tr><td>Course title</td><td>Advances in food microbiology</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 advances in microorganisms associated to food and food products.
2. To learn the sources, growth characteristics, metabolism of microorganisms.
3. To understand the recent techniques and role of microbes in spoilage and pathogenesis.
4. To gain knowledge on the methods of isolating and characterizing microbes associated with foods
5. To understand the methods used to detect pathogens in foods.</td></tr>
<tr><td>COURSE CONTENT</td><td>
<table>
<tr><td>UNIT 1</td><td>History, scope and importance of food microbiology</td></tr>
<tr><td>UNIT 2</td><td>Microorganisms and food: Their primary sources of microorganisms in foods: Airborne bacteria and fungi, Microorganisms found in soil, Microorganisms in water, Normal flora of skin, nose, throat, GI tract.</td></tr>
<tr><td>UNIT 3</td><td>Factors affecting the survival and growth of microorganisms in food: Intrinsic factors for growth, Moisture, pH & acidity, Nutrient content, Biological structure, Redox Potential, Naturally occurring and added antimicrobials, Competitive micro flora, Extrinsic factors for growth, Types of packaging/atmospheres, Effect of time/temperature conditions on microbial growth, Storage/holding conditions, Processing steps.</td></tr>
<tr><td>UNIT 4</td><td>Microbiological examination-
Methods of Isolation and detection of microorganisms or their products in food. - Conventional methods - Rapid methods (Newer techniques) –
Immunological methods: Fluorescent, antibody, Radio immunoassay, ELISA etc. - Chemical methods PCR (Polymers chain reactions), RT PCR, Microchip based techniques</td></tr>
<tr><td>UNIT 5</td><td>Microflora of Fresh Food:
Meat, Poultry, Eggs, Fruits and vegetable, Shellfish and Finish, Milk, Microbial Spoilage of Food, Fresh Foods, Fresh Milk, Canned Foods</td></tr>
<tr><td>UNIT 6</td><td>Food Preservation and application to different types of foods: Physical methods –, Drying, freeze drying cold storage, heat treatments(pasteurization), TDT, TDP, Irradiation (UV, microwave, ionization), high pressure processing, Aseptic packaging, modified atmosphere, Chemical preservatives and Natural antimicrobial compounds. Biologically based preservation systems</td></tr>
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UNIT 7	Food borne infections and diseases: Significance to public health Food hazards and risk factors, Bacterial, and viral food-borne disorders, Food-borne important animal parasites, Mycotoxins. - Bacillus, Campylobacter, Brucella, Staphylococcus, Clostridium, *E.coli*, Aeromonas, *Vibrio cholerae*, Listeria, Mycobacterium, Salmonella, Shigella
UNIT 8	Quality Control/Quality Assurance Legislation for food safety – national and international Criteria, sampling schemes, records, risk analysis QC- microbial source, code Indicators of food safety and quality: Microbiological criteria of foods and their significance.
UNIT 9	The HACCP system and food safety used in controlling microbiological hazards.

List of Practical:	
1	Preparation of common laboratory media and special media for cultivation of bacteria, yeast & molds.
2	Staining of Bacteria: Gram's staining, acid-fast, spore, capsule, Motility of bacteria, Staining of yeast and molds.
3	Isolation of microorganisms: Different methods and maintenance of cultures of microorganisms.
4	Bacteriological analysis of Foods using conventional methods.
5	Coli forms analysis of milk and water samples.
6	To perform various biochemical tests used in identification of commonly found bacteria in foods: IMVIC urease, H_2S, Catalase, coagulase, gelatin and fermentation (Acid/gas).
7	Determination of thermal death characteristics of bacteria.
8	Demonstration of available rapid methods and diagnostic kits used in identification of microorganisms or their products.
9	Visits (at least two) to food processing unit or any other organization dealing with advanced methods in food microbiology.

References:

1. Pelzer, M.I. and Reid, R.D. (1993) Microbiology McGraw Hill Book Company, New York, 5 th Edition.
2. Atlas, M. Ronald (1995) Principles of Microbiology, 1 st Edition, Mosby-Year Book, Inc, Missouri, U.S.A.
3. Topley and Wilson's (1983) Principles of Bacteriology, Virology and Immunity, Edited by S.G. Wilson, A. Miles and M.T. Parkar, Vol. I: General Microbiology and Immunity, II: Systematic Bacteriology. 7 th Edition. Edward Arnold Publisher.
4. Frazier, W.C. (1988) Food Microbiology, McGraw Hill Inc. 4 th Edition,
5. Jay, James, M. (2000) Modern Food Microbiology, 6 th Edition. Aspen publishers, Inc., Maryland.
6. Banwart, G. (1989) Basic Food Microbiology, 2 nd Edition. CBS Publisher.
7. Doyle, P. Benehat, L.R. and Mantville, T.J. (1997): Food Microbiology, Fundamentals and Frontiers, ASM Press, Washington DC.
8. Adams, M.R and M.G. Moss (1995): Food Microbiology, 1st Edition, New Age International (P) Ltd.

Course On completion of course students will be able to:

<table>
<tr><td>Outcomes</td><td>CO1. Understand the role of microorganisms in food spoilage and foodborne out breaks and preservation of food and foods products.
CO2. Understand about the various types of microbes, their characteristics, metabolisms and growth behaviour in food and foods products.
CO3. Understand the various techniques for isolation and characterization of microorganisms associated to food and foods products.
CO4. Apply the learnt techniques to detect the pathogens associated with the foods using standard protocols.
CO5. Understand the recent cutting edge technologies in understanding the role of microbes in food safety and quality.</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>FQA516</td></tr>
<tr><td>Course title</td><td>Advances in food biotechnology</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 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 production of functional food</td></tr>
<tr><td>Course Content</td><td>
<table>
<tr><td>Unit 1</td><td>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.</td></tr>
<tr><td>Unit 2</td><td>Strain improvement, fermentation process of enzyme, fermentation processes of alcohol and organic acids, fermentation processes of antibiotics.</td></tr>
<tr><td>Unit 3</td><td>Food applications of enzymes; amylases, proteases, lipase, pectinase, celluloses, glucose oxidase. Microencapsulation of enzyme/probiotics.</td></tr>
<tr><td>Unit 4</td><td>Genetic improvement of starter cultures to improve technological features of starter cultures such as acid, flavor, EPS production etc.</td></tr>
<tr><td>Unit 5</td><td>Recombinant DNA technology for production of protease, lipase, chimosin, immunoglobulins etc.</td></tr>
<tr><td>Unit 6</td><td>Functional and nutraceuticals, supplementation/fortification of bioactive peptides and other functional ingredients, nutrigenomics.</td></tr>
<tr><td>Unit 7</td><td>Application of molecular tools, biosensors etc. for the detection of pathogens.</td></tr>
<tr><td>Unit 8</td><td>Molecular tools for study of biodiversity. Regulatory standards for GMO and GM foods.</td></tr>
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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
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<tr><td></td><td>
• Agarose gel electrophoresis
• DNA amplification by using PCR
• RT PCR for pathogen detection
• 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,WilleyEasternLtd.,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>
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