Revised BSMA Syllabus
of
M. Tech. (Food Technology)
in
Food Processing Technology,

As per Recommendation of VthDeans
Committee ICAR, New Delhi

for

State Agricultural Universities of Maharashtra
Implemented From
Academic Year 2022-23

- **Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani**
- **Mahatma Phule Krishi Vidyapeeth, Rahuri**
- **Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola**
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BSMA Degree and Discipline Coordinators

Broad Subject Coordinator and Chairman

	Name	Designation
	Dr. R. B. Kshirsagar	Professor &Head Dept. of Food Engineering, College of Food Technology, Vasantrao Naik Marathwada Krishi Vidyappeth, Parbhani

Discipline Coordinators

	Name	Designation	Discipline
	Dr. U. D. Chavan	Head, Dept. Food Science and Technology Mahtma Phule Krishi Vidyappeth Rahuri	Food Processing Technology
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	Dr. S. P. Sonawane	Professor & Head, Agriculture Engineering Section, College of Agriculture, MPKV, Dhule	Food Process Engineering
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Foreword

The processing of agro commodities has immense potential to mitigate the shortage in food and nutritional requirements of the ever increasing population of our country. Furthermore, for food security of our populace, appropriate processing technologies, value addition, enhanced economic returns and employment generation are essential. The main causes of the expansion of the processed food industry include changes in lifestyle, eating habits, organised food retail, and urbanisation. However, the food processing sector in our nation is still in its infancy and is severely fragmented, despite having enormous potential to become the highest-yielding industry and become the world's foremost food supplier. In addition, emerging and advance food processing technologies can reduce postharvest losses, promote food safety practices, induce demand-driven production, enable value addition and facilitate exports. Food processing sector is considered a "Sun Rise Industry" as far as India is concerned.

Further, as per the ICAR Vth Dean Committee, the new syllabus of PG and Ph.D. has been revised and restructured by constituted Broad Subject Matter Area (BSMA) committee with assigned Broad Subject Coordinator and Discipline Coordinator for M.Tech and Ph.D (Food Technology) degree programme in Food Processing Technology, in Food Safety and Quality and in Food Process Engineering based on ICAR BSMA norms under the new education policy.

I avail this opportunity to acknowledge my sincere, humble and whole hearted sense of gratitude to **Dr. Arvind Kumar,** Chairman of National Core Group-ICAR and its member **Dr. N.S. Rathore**, former DDG, **Dr. R.C. Agrawal** DDG and **Dr. G. Venkateshwarlu** former ADG (EQR), and **Dr. V.B. Singh,** Chiarman, former Dean, CDFST and Vice chancellor of MPUAT, Udaipur, Rajasthan and all BSMA Committee member of Food Technology for providing adequate guidance and encouragement through developed restructured and revised syllabi for course of PG and Ph.D. degree programme in the subject of Food Technology which led to the successful formulation and compilation of the syllabus.

I owe high esteemed respect and whole hearted thanks **to Dr. S. S. Narkhede** (DI and Dean and Chairman of DICC Committee, Dr.BSKKV, Dapoli), **Dr. D. N. Gokhale** (DI and Dean, VNMKV, Parbhani), **Dr. U. M. Khodke** (Associate Dean and Principal, CFT, VNMKV, Parbhani) and **Dr. Amol Dethe** (Controller Exam, MAUEB, MCAER, Pune) for

their support, proper coordination and valuable guidance during the process of syllabus designing.

I express my unequivocal sincere thanks to all Discipline coordinators, **Dr. U. D. Chavan** (Professor and Head, Department of Food Science and Technology, MPKV, Rahuri), **Prof. H. W. Deshpande** (Head, Department of Food Microbiology and Safety, CFT, VNMKV, Parbhani), **Dr. V. S. Pawar** (Head, Department of Food Process Technology, CFT, VNMKV, Parbhani) and **Dr. S. P. Sonawane** (Professor and Head, Agriculture Engineering Section, College of Agriculture, MPKV, Dhule) for their feedbacks and contribution in completing the task of revising and finalizing the syllabus of PG and Ph.D. degree programme in the subject of Food Technology as per ICAR Vth Dean Committee BSMA recommendations which is to be implemented in the Maharashtra State Agricultural Universities (SAU's) from Academic year 2022-23.

I acknowledge the valuable contributions made by all Head, academic staff of my institution for their contribution in typography, editing and compilation in an efficient manner.

The proposed revised and restructured new syllabus of M.Tech and Ph.D degree programmes in the area of Food Technology should render as an intellectually and more stimulating skill oriented discipline and an economically rewarding profession to shape the career of Food Technology graduate to serve for the betterment of country through their acquired knowledge and skill development.

I hope the new syllabus will serve as an important channel in creation of employment in terms of food technocrats, scientists, entrepreneurs, skilled human resource to serve in the national task of food safety and security management, entrepreneurship development, nutritional and economical security.

Dr. R. B. Kshirsagar
Professor and Head,
Department of Food Engineering, CFT,
VNMKV, Parbhani and
Broad Subject Coordinator
(Chairman of all Discipline sub Committee)

M.Tech. Degree Programme
(Food Technology)
in
Food Processing Technology

CONTENTS

Preamble

The efficient use of resources is the growing concern for all involved in food production, processing, distribution and retailing. The unique features of the raw materials of the food processing industries such as seasonality, perishability and variability in conjunction with sophistication required for processing to maintain high quality standards, necessitates special attention towards focused availability of qualified technical manpower, effective technologies and efficient machinery. The food industries in the country need modernization to face the challenges of the globalization. Government of India is also paying special attention to this important sector and associated stakeholders. Efficient utilization of resources will definitely help in manufacturing of nutritious and healthy food but also help in fostering economic development and therefore, improving livelihoods by promoting access to domestic, regional and international markets.

This has motivated the ICAR-BSMA Broad Subject committee framed by DICC and MCAER, Pune for Food Science and Technology to strive hard to enrich the content and syllabus of the MTech and PhD programmes in the area of Food Processing Technology. This will hopefully produce competent food technologists to handle resources from farm-to-fork and cater the various sectors of food processing industries.

By learning the innovative novel technologies and advancement in food processing technology and new packaging techniques are introduced. Moreover, a new course is introduced named as Industrial Manufacturing of food and beverage which gives exposure to understand raw material quality, processing and production of food and beverage on industrial scale. Many new courses are introduced, viz. Frozen and Concentrated Foods, Aseptic Processing and Packaging, Traditional Foods, Technologies of Convenience Foods, Food Powders and Premixes, Food Business Management. A new subject Global Food Laws and Regulations is introduced which helps the food industry to export the food product to the world as per their specifications and regulations. New courses like Novel Technologies for Food Processing and Shelf-Life Extension, Food Manufacturing Technology, Formulation of Standards of Food Products, Packaging and Labeling are introduced in PhD programme through which the students will develop and formulate new product, new technology and helps in developing the regulations of different food products.

The proposed revised and restructured curricula of the MTech and PhD programmes in the area of Food Processing Technology. and quality measures should render Food Technology as an intellectually more stimulating skill-oriented discipline and an economically rewarding profession to attract talent and investment.

(Implementation of New Curriculum)

The universities offering PG and Ph. D. degree programmes in Food Technology need to be supported for establishing specialized laboratories equipped with State-of-the Art Equipments for conducting hands on practical classes especially, Processing Technology, Safety and Quality instrumentation lab, Process Engineering pilot scale units

One time catch up grant should be awarded to each SAU, offering PG programmes in Food Technology for meeting expenditure for upgrading the course requirements.

Faculty training and retraining should be an integral component. For imparting total quality management, a minimum of two faculty in each department under an SAU should be given on job training in reputed national and international institutes. To execute the new PG and Ph.D. programmes in different discipline of Food Technology in effective manner, special funds from ICAR & MOFPI would be required for outsourcing of faculty from Indian/Foreign Universities for some initial years.

The already existing M.Tech. and Ph.D. Programmes in Food Technology will be considered at par with the recommended M.Tech. & Ph.D. programme by V Deans Committee for admission and employment.

Expected Outcome

- Revamping of post graduate programme in whole of Food Technology throughout the country.
- Imparting in-depth and comprehensive knowledge of the food technology and also arming the students with management skills and professional attitude.
- Development of human resource to cater the need of food processing Industries, governments, corporate sector and research organization in India and abroad.
- Exposure to the faculty to emphasize the need of innovation and mechanism to ensure the quality and excellence in the mandatory activity i.e. teaching research and extension.

Organization of Course Contents &Credit Requirements

Minimum Residential Requirement:
M. Tech : 4 Semesters Ph. D : 6 Semesters

Name of the Departments / Divisions

- Food Processing Technology
- Food Process Engineering
- Food Safety and Quality

Nomenclature of Degree Programme

(a) M. Tech. Programmes

i) M. Tech (Food Technology) in Food Processing Technology

(b) Ph. D. Programmes

i) Ph. D. (Food Technology) in Food Processing Technology

Code Numbers

- All courses are divided into two series: 500-series courses pertain to Master's level,and 600- series to Doctoral level.
- Credit Seminar for Master's level is designated by code no. 591, and the TwoSeminars for Doctoral level are coded as 691 and 692, respectively
- Deficiency courses will be of 400 series.
- Master's research: 599 and Doctoral research: 699

Course Contents

The contents of each course have been organized into:

- Objective – to elucidate the basic purpose.
- Theory units – to facilitate uniform coverage of syllabus for paper setting.
- Suggested Readings – to recommend some standard books as reference material. This does not obviously exclude such a reference material that may be recommended according to the advancement and local requirement.
- A list of international and national reputed journals pertaining to the discipline is provided at the end which may be useful as study material for 600/700 series courses as well as research topics.
- Lecture schedule and practical schedule has also be given at the end of each course to facilitate the teacher to complete the course in an effective manner.

Minimum Credit Requirements

Course Details	**Master's Degree**	**Doctoral Degree**
Major Courses	20	12
Minor Courses	08	06
Supporting / Optional	06	05
Common PGS Courses	05	-
Seminar	01	02
Research	30	75
Total	**70**	**100**

Academic Regulation

Sr.No.		M.Tech. (Food Tech.)	Ph.D. (Food Tech.)
1	Examination system and Weight age	(1) Course work Theory- Midterm – 30 % Semester end Theory 70 % Practical- Class room Record – 5 % Assignments – 10 % SE practical – 35% 2) written Comprehensive qualifying examination(after completion of 80 % of core and optional courses separately)	(1) Course work Theory- Midterm – 30 % Semester end Theory 70 % Practical- Class room Record – 5 % Assignments – 10 % SE practical – 35% 2) written Comprehensive qualifying examination(after completion of 80 % of core and optional / minor courses separately)
2	Grading of courses	10 point scale Deficiency Courses : Satisfactory / Unsatisfactory Non Credit Compulsory : S / US Research / Thesis : S / US	10 point scale Deficiency Courses : Satisfactory / Unsatisfactory Non Credit Compulsory : S / US Research / Thesis : S / US
3	Question paper setting of Semester End Theory Exam	External system	External system
4	Evaluation of SE Exam	Internal	Internal
5	Minimum passing grade in a course	55 %	65 %
6	Minimum CGPA to obtain for degree	5.5 / 10.0 points scale	6.5 / 10.0 point scale
7	Publications	The M.Tech. Thesis shall be accompanied with atleast One	The Ph.D.Thesis shall be accompanied with atleast Two

		manuscript of research articles on topic of research problem before the thesis submission of thesis	manuscript of research articles on topic of research problem before the thesis submission of thesis . Acceptance of One compulsory
8	Plagiarism Check	Plagiarism Check report to be appended in the thesis (50 % of less level of acceptance)	Plagiarism Check report to be appended in the thesis (75 % of less level of acceptance)
9	Research and Thesis*	i) External Evaluation ii) Viva-voce - Internal	i) External Evaluation by Two experts ii) Viva-voce - External
10	Degree Class / Division	5.5 to 6.49 – Pass Class 6.5 to 7.49 – Second Class 7.5 to 8.49 – First Class 8.5 and Above – First with distinction	6.5 to 7.49 – Second Class 7.5 to 8.49 – First Class 8.5 and Above – First with distinction

Eligibility for Admission

- **Master's Degree Programme**

i. B. Tech (Food Technology) / B.Tech. (Food Science) /B.Tech. (Food Science and Technology) or equivalent degree with four years duration of agriculture related Universities (SAUs) and having the Common Entrance Test in Food Technology facuty conducted by MAUEB, Pune.

ii. The candidate must have scored Overall Grade Point Average (OGPA) of at least 5.50/10.00 in ten-point scale.

- **Doctoral Degree Programme**

i. The candidate must have passed 4 years B. Tech (Food Technology)/ B. Tech Food Science or Equivalent degree with four years duration of agricultural related universities (SAUs).

ii. Master's degree in the concerned Discipline of Food Technology and having appearing the Common Entrance Test of Food Technology subject conducted by MAUEB, Pune.

iii. The candidate must have scored Overall Grade Point Average (OGPA) of at least 6.5/10.00 in ten-point scale.

Name of Department	**Specialization in Ph. D FoodTechnology**	**Eligibility criteria**
Food Technology	. Ph. D (Food Technology) in Food Processing Technology	M. Tech. (Food Technology) / M. Tech. (Food Science and Technology) / M. Tech. (Food Technology) in Food Processing Technology from agriculture related Universities (SAUs) and having the Common Entrance Test in Food Technology facuty conducted by MAUEB, Pune.
	Ph. D (Food Technology) in ood Process Engineering	M. Tech. (Food Technology) in Food Process Engineering
	Ph. D (Food Technology) in ood Safety and Quality	M. Tech. (Food Technology) in Food Safety and Quality

M. Tech. (Food Technology)in Food Processing Technologhy Course Structure

LIST OF CORE COURSES/ DEPARTMENT WISE SPECIALIZATION/ COMPULSORY/SUPPORTING COURSES

M. Tech (Food Technology) in Food Processing Technology

Course Code	Semester	Course Title	Credit Hrs.
Major courses		**Proposed**	
FPT 501	I	Emerging Technologies in Food Processing*	3 (2+1)
FPT 502	II	Emerging Technologies in Food Packaging*	3 (2+1)
FPT 503	III	Industrial Manufacturing of Food and Beverages*	3 (2+1)
FPT 508	I	Nutraceuticals and Specialty Foods	3 (2+1)
FPT 511	I	Traditional Foods	3 (2+1)
FPT 514	II	Food Ingredients and Additives	3 (2+1)
FPT 517	II	Enzymes in Food Processing	3 (2+1)
		Total	**21 (14+7)**
Note: Optional Major Subjects: The said courses are subjected to availability of infrastructure and facilities and to be decided by SAC committee			
FPT 504		Food Material and Product Properties	3 (2+1)
FPT 505		Cocoa and Chocolate Processing Technologies	3 (2+1)
FPT 506		Spices, Herbs and Condiments	2 (2+0)
FPT 507		Meat, Poultry, Fish and Egg Processing	3 (2+1)
FPT 509		Frozen and Concentrated Foods	2 (1+1)
FPT 510		Aseptic Processing and Packaging	3 (2+1)
FPT 512		Technologies of Convenience Foods	3 (2+1)
FPT 513		Food Powders and Premixes	3 (2+1)
FPT 515		Flavour Chemistry and Technology	3 (2+1)
FPT 516		Bioprocessing and Separation Technology	3 (2+1)
FPT 518		Food Process Automation and Modelling	2 (2+0)
FPT 519		Zero Waste Processing	2 (2+0)
FPT 520		Special Problem/ Summer Internship	2 (0+2)
Minor courses		**Proposed**	
FPE 508	I	Food Safety and Storage Engineering	3 (2+1)
FSQ 503	I	Advanced Food Chemistry	3 (2+1)
FSQ 504	II	Global Food Laws and Regulations	2 (2+0)
		Total	**8 (6+2)**

Note: Optional Minor Subjects: The said courses are subjected to availability of infrastructure and facilities and to be decided by SAC committee			
Minor courses from discipline of Food Process Engineering, Food Safety and Quality and Processing and Food Process Engineering			
FPE 502		Engineering Properties of Food Materials	3 (2+1)
FPE 504		Bioprocessing and Down Stream Engineering	3 (2+1)
FPE 506		Numerical Technique and Simulation	2 (1+1)
FSQ 506		Process and Products Monitoring for Quality Assurance	2 (2+0)
FSQ 508		Management of Food By-products and Waste	3 (2+1)
Supporting courses		**Proposed**	
FBM 501	I	Post-Harvest Management	3 (2+1)
FBM 503	III	Food Processing Entrepreneurship and Start up	1 (1+1)
FSQ 505	II	Food Safety Management Systems and Certification	2 (2+0)
		Total	**7 (5+2)**
Note: Optional Supporting Subjects: The said courses are subjected to availability of infrastructure and facilities and to be decided by SAC committee			
Supporting courses from discipline of Basic sciences, Food business management Food Process Engineering and Food Safety and Quality			
FBM 502		Food Business Management	2 (2+0)
FSQ 507		Quality Concepts and Chain Traceability	2 (2+0)
FPE 505		Energy Management and Auditing in Food Industry	3 (2+1)
FPE 510		Operation Research	3 (2+1)
BSH 501		Research Methodology	2 (2+0)
BSH 502		Food Informatics	2 (1+1)

Master Seminar			
FPT 591	**IV**	Seminar	1 (1+0)
Masters Research			
FPT 599	**III**	Research Work	10 (0+10)
	IV	Research Work	20 (0+20)

***Compulsory Courses**

Common Courses: (Non-Credit)

Course code	Semester	Course Title	Credits
PGS 501	I	Library and Information Services	0+1
PGS 502	I	Technical Writing and Communications Skills	1+0
PGS 503	II	Intellectual Property and its management in Agriculture	1+0
PGS 504	II	Basic Concepts in Laboratory Techniques	0+1
PGS 505	III	Agricultural Research, Research Ethics and Rural Development Programmes	1+0
		Total	**5 (3+2)**

Semester wise course layout

First Semester			
Major courses			
FPT 501	I	Emerging Technologies in Food Processing*	3 (2+1)
FPT 508	I	Nutraceuticals and Specialty Foods	3 (2+1)
FPT 511	I	Traditional Foods	3 (2+1)
Minor courses			
FSQ 503	I	Advanced Food Chemistry	3 (2+1)
FPE 508	I	Food Safety and Storage Engineering	3 (2+1)
Supporting			
FBM 501	I	Post-Harvest Management	3 (2+1)
Common courses (Non-credit)			
PGS 501	I	Library and Information Services	1+0
PGS 502	I	Technical Writing and Communications Skills	1+0
		Grand Total	**20 (14+6)**
Second Semester			
FPT 502	II	Emerging Technologies in Food Packaging*	3 (2+1)
FPT 514	II	Food Ingredients and Additives	3 (2+1)
FPT 517	II	Enzymes in Food Processing	3 (2+1)
Minor courses			
FSQ 504	II	Global Food Laws and Regulations	2 (2+0)
Supporting courses			
FSQ 505	II	Food Safety Management Systems and Certification	2 (2+0)
Common courses			
PGS 503	II	Intellectual Property and its management in Agriculture	1 (1+0)
PGS 504	II	Basic Concepts in Laboratory Techniques	1 (0+1)
		Grand Total	**15 (11+4)**
Semester III			
Major courses			
FPT 503	III	Industrial Manufacturing of Food and Beverages*	3 (2+1)
Supporting courses			
FBM 503	III	Food Processing Entrepreneurship and Start up	1 (0+1)
Common courses			
PGS 505	III	Agricultural Research, Research Ethics and Rural Development Programs	1 (1+0)
Research work			
FPT 599		**Research work**	10 (0+10)
		Grand Total	**15 (3+12)**
Semester IV			
Seminar			
FPT 591		Seminar	1 (1+0)
Research work			
FPT 599		Research work	20 (0+20)
		Grand Total	**21 (1+20)**

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Course Credits							
Semester	**Major**	**Minor**	**Supporting**	**Seminar**	**CC**	**R. Work**	**Total**
I	9	6	3	-	2	-	**20**
II	9	2	2	-	2	-	**15**
III	3	-	1	-	1	10	**15**
IV	-	-	-	1	-	20	**21**
Total	**21**	**8**	**6**	**1**	**5**	**30**	**71**

Course Content of M.Tech. (Food Tech.) in Food Processing Technology

Theory, Practical Syllabus and Teaching Schedule

A. Major Courses (Proposed)

FPT 501 Emerging Technologies in Food Processing 3 (2+1)

Theory

UNIT I:

Membrane Technology: Pressure activated membrane processes: MF, UF, NF and RO and their industrial application. Membrane distillation; Supercritical fluid extraction: Concept, property of super critical fluids SCF, extraction methods, application in food processing

UNIT II:

Microwave and radio frequency processing: Advantages, mechanism of heat generation, application in food processing: microwave blanching, sterilization and finish drying Hurdle technology: Concept and Principle, Preservation techniques as hurdles and their principles, hurdle tech foods.

UNIT III:

High Pressure processing: Concept, equipment for HPP treatment, mechanism of microbial and enzyme inactivation and its application in food processing, effect on food constituents. Ultrasonic processing: Properties of ultrasonic, types of equipment, application of ultrasonic as processing technique.

UNIT IV:

Newer techniques in food processing: principle and application of High intensity light, pulse electric field, ohmic heating, IR heating, inductive heating, cold plasma, and pulsed X-rays in food processing and preservation, Cryo-processing of foods Nanotechnology: Principles and applications in foods.

Practical

- To evaluate the characteristics of treated water using RO system
- To study production and characteristics of treated water using, microfiltration, UF, NF and RO system
- To study the effect of ultrafiltration process on fruit juices quality
- To study suitability and production of fruit juices using ultrafiltration
- To study the effect of microfiltration process on milk quality
- To study super critical fluid extraction system and to carry out extraction of bioactive compound from selected samples
- To carry out extraction of lycopene from tomato using SCFE system
- To study microwave system and to evaluate the effect of different power on drying characteristics of selected vegetable products
- To study microwave blanching of vegetable and determination of blanching efficacy
- To study the ultrasonicator and evaluate the effect of ultrasonication on micro-organism in sample
- To study the ultrasonicator and to evaluate the effect of ultrasonication on extracted juice yield from fruit pomace
- To evaluate the different pre-treatment on oil yield from oil seed cake
- To prepare nano emulsion and study of their characteristics
- To study ohmic heating system and to study the processing of fruit pup using ohmic heating system
- To visit food industries utilizing advance food processing techniques

- To study the effect of different drying techniques/ hybrid drying techniques on fruits and vegetables.

Teaching Schedule

Theory

Lecture No	Topic	Weightage (%)
Unit I 1-4	Membrane Technology: Pressure activated membrane processes: MF, UF, NF and RO and their industrial application.	25%
5-9	Membrane distillation; Supercritical fluid extraction: Concept, property of super critical fluids SCF, extraction methods, application in food processing.	
Unit II 10-12	Microwave and radio frequency processing: Advantages, mechanism of heat generation, application in food processing: microwave blanching, sterilization and finish drying.	25%
13-18	Hurdle technology: Concept and Principle, Preservation techniques as hurdles and their principles, hurdle tech foods.	
Unit III 19-23	High Pressure processing: Concept, equipment for HPP treatment, mechanism of microbial and enzyme inactivation and its application in food processing, effect on food constituents.	25%
24-29	Ultrasonic processing: Properties of ultrasonic, types of equipment, application of ultrasonic as processing technique.	
Unit IV 30-34	Newer techniques in food processing: principle and application of High intensity light, pulse electric field, ohmic heating, IR heating, inductive heating.	25%
35-36	Cold plasma and pulsed X-rays in food processing and preservation, Cryo-processing of foods Nanotechnology: Principles and applications in foods.	
	Total	100

Practical

Practical No	Topic
1	To evaluate the characteristics of treated water using RO system
2	To study production and characteristics of treated water using, microfiltration, UF, NF and RO system
3	To study the effect of ultrafiltration process on fruit juices quality
4	To study suitability and production of fruit juices using ultrafiltration
5	To study the effect of microfiltration process on milk quality
6	To study super critical fluid extraction system and to carry out extraction of bioactive compound from selected samples
7	To carry out extraction of lycopene from tomato using SCFE system
8	To study microwave system and to evaluate the effect of different power on drying characteristics of selected vegetable products
9	To study microwave blanching of vegetable and determination of blanching efficacy
10	To study the ultrasonicator and evaluate the effect of ultrasonication on micro-organism in sample
11	To study the ultrasonicator and to evaluate the effect of ultrasonication on

	extracted juice yield from fruit pomace
12	To evaluate the different pre-treatment on oil yield from oil seed cake
13	To prepare nano emulsion and study of their characteristics
14	To study ohmic heating system and to study the processing of fruit pup using ohmic heating system
15	To visit food industries utilizing advance food processing techniques
16-18	To study the effect of different drying techniques/ hybrid drying techniques on fruits and vegetables

Text/Reference Books/Suggested Readings

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

FPT 502	Emerging Technologies in Food Packaging	3 (2+1)

Theory

UNIT I

Active and intelligent packaging: Active Packaging Techniques and intelligent Packaging Techniques, current use of novel Packaging Techniques, consumers and novel Packaging Oxygen, ethylene and other scavengers: Oxygen scavenging technology, selecting right types of oxygen scavenger, ethylene scavenging technology, carbon dioxide and other scavengers. Antimicrobial food packaging: Antimicrobial agents, constructing antimicrobial packaging systems, factors affecting the effectiveness of antimicrobial packaging.

UNIT II

Non-migratory bioactive polymers (NMBP): Advantages of NMBP, Inherently bioactive synthetic polymers: types and application, Polymers with immobilized bioactive compounds and their applications. Time Temperature labels and indicators (TTIs): Defining and classifying TTIs, Requirements for TTIs, development of TTIs, Maximizing the effectiveness of TTIs, Application of TTIs- to monitor shelf-life, and optimization of distribution and stock rotation, leakage indicators, oxygen indicators, micro indicators etc. Freshness indicator in packaging: Compounds indicating the quality of packaged food products, freshness indicators, pathogen indicators, other methods for spoilage detection. Self-heating /rehydrating packages.

UNIT III

Packaging-flavour interaction: Factors affecting flavor absorption, role of food matrix, role of differing packaging materials, flavour modification and sensory quality, Study of packaging materials compatibility with foods. Developments in modified atmosphere packaging (MAP): Permeability properties of polymer packaging, measurement of permeability – water and gases. Selection criteria of packaging films, Novel MAP gas, testing novel MAP applications, applying high oxygen MAP. Recycling packaging materials: Recyclability of packaging plastics, improving the recyclability of plastics packaging, testing safety and quality of recycled materials, uses of recycled plastics in packaging.

UNIT IV

Green plastics for food packaging: Problems of plastic packaging wastes, range of biopolymers, developing novel biodegradable materials. Edible Films and Coatings: Properties, types, sources, applications, advantages, disadvantages, theories of plasticization, challenges and opportunities.

PFS machine, seal and closures. Safety and legislative aspects of packaging: Regulatory considerations, plastic, metal, paper and glass packaging.

Practical

- Determination of WVTR in different packaging materials
- Determination of GTR in different packaging materials.
- Study of different ethylene scavengers and their analysis
- Study of different oxygen scavengers systems and their analysis
- Application of anti-microbial packaging for moisture sensitive foods
- Evaluation of chemical residue migration from package to food
- Application of MAP packaging in selected foods
- Study of TTI label, leakage indictors etc.
- Determination of oxidative changes in packaged foods
- Comparative evaluation of flexible and rigid packages for fragile foods
- Packaging of foods under inert atmosphere.

- To study textural characteristics of selected fruit/ vegetable under MAP storage
- Shelf life evaluation and mode up of packaged food product.
- Determination of oil and grease resistant test for packaging films
- Determination of respiration rate in fresh fruits and vegetables
- Determination of shelf life of fresh fruits and vegetables by using edible coating and films.
- Effect of edible coating and films on respiration behaviour, chemical, physical and sensory characteristics of fresh fruits and vegetables.
- Visit to food packaging material manufacturing industry

Teaching Schedule

Theory

Lecture No	Topic	Weightage (%)
Unit I 1-4	Active and intelligent packaging: Active Packaging Techniques and intelligent Packaging Techniques, current use of novel Packaging Techniques, consumers and novel Packaging.	20%
5-8	Oxygen, ethylene and other scavengers: Oxygen scavenging technology, selecting right types of oxygen scavenger, ethylene scavenging technology, carbon dioxide and other scavengers.	
9-12	Antimicrobial food packaging: Antimicrobial agents, constructing antimicrobial packaging systems, factors affecting the effectiveness of antimicrobial packaging.	
Unit II 13-15	Non-migratory bioactive polymers (NMBP): Advantages of NMBP, Inherently bioactive synthetic polymers: types and application, Polymers with immobilized bioactive compounds and their applications.	30%
16-18	Time Temperature labels and indicators (TTIs): Defining and classifying TTIs, Requirements for TTIs, development of TTIs, Maximizing the effectiveness of TTIs, Application of TTIs- to monitor shelf-life, and optimization of distribution and stock rotation, leakage indicators, oxygen indicators, micro indicators etc.	
19-20	Freshness indicator in packaging: Compounds indicating the quality of packaged food products, freshness indicators, pathogen indicators, other methods for spoilage detection. Self-heating /rehydrating packages.	
Unit III 21-22	Packaging-flavour interaction: Factors affecting flavor absorption, role of food matrix, role of differing packaging materials, flavour modification and sensory quality.	30%
23-24	Study of packaging materials compatibility with foods. Developments in modified atmosphere packaging (MAP): Permeability properties of polymer packaging, measurement of permeability – water and gases.	
25-26	Selection criteria of packaging films, Novel MAP gas, testing novel MAP applications, applying high oxygen MAP.	
27-32	Recycling packaging materials: Recyclability of packaging plastics, improving the recyclability of plastics packaging, testing safety and quality of recycled materials, uses of recycled plastics in packaging.	

	Recycling packaging materials: Recyclability of packaging plastics, improving the recyclability of plastics packaging, testing safety and quality of recycled materials, uses of recycled plastics in packaging.	
Unit IV 33-34	Green plastics for food packaging: Problems of plastic packaging wastes, range of biopolymers, developing novel biodegradable materials.	20%
35-36	Edible Films and Coatings: Properties, types, sources, applications, advantages, disadvantages, theories of plasticization, challenges and opportunities.	
37-38	PFS machine, seal and closures. Safety and legislative aspects of packaging: Regulatory considerations, plastic, metal, paper and glass packaging.	
	Total	**100**

Practical

Practical No	**Topic**
1	Determination of WVTR in different packaging materials
2	Determination of GTR in different packaging materials.
3	Study of different ethylene scavengers and their analysis
4	Study of different oxygen scavengers systems and their analysis
5	Application of anti-microbial packaging for moisture sensitive foods
6	Evaluation of chemical residue migration from package to food
7	Application of MAP packaging in selected foods
8	Study of TTI label, leakage indictors etc.
9	Determination of oxidative changes in packaged foods
10	Comparative evaluation of flexible and rigid packages for fragile foods
11	Packaging of foods under inert atmosphere.
12	To study textural characteristics of selected fruit/ vegetable under MAP storage
13	Shelf life evaluation and mode up of packaged food product.
14	Determination of oil and grease resistant test for packaging films
15	Determination of respiration rate in fresh fruits and vegetables
16	Determination of shelf life of fresh fruits and vegetables by using edible coating and films.
17	Effect of edible coating and films on respiration behaviour, chemical, physical and sensory characteristics of fresh fruits and vegetables.
18	Visit to food packaging material manufacturing industry

Text/Reference Books/Suggested Readings

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

Yam K & Lee D, 2012. Emerging Food Packaging Technologies, Woodhead Publishing.

FPT 503	Industrial Manufacturing of Food and Beverages	3 (2+1)

Theory

UNIT I

Grain products: Industrial manufacturing of grain based products: formulation, processes, machinery and material balance of baked, rolled, shredded, puffed, flaked, roasted products. Extrusion technology: Importance and applications of extrusion in food processing; Pre and post extrusion treatments; Manufacturing process of extruded products; Change of functional properties of food components during extrusion. Breakfast cereals, RTE/RTC foods, instant premixes, functional foods.

UNIT II

Fruit and vegetable products: Industrial manufacturing of fruit and vegetable based products: formulation, processes, machinery and material balance of minimally processed, Retorted products, IMF, high moisture stable foods, IQF; Machines and equipment for batch and continuous processing of fruit and vegetable products.

UNIT III

Chocolates and candies: Coating or enrobing of chocolate (including pan-coating); Maintenance, safety and hygiene of bakery plants. Fats and oils processing: Technology of refined oil, winterized oil, hydrogenated fat, Texturized fat, by-products of fat/oil processing industries – oil seed protein isolates; Quality standards of fats and fatty foods; Antioxidants and its mechanism of application.

UNIT IV

Beverages: Production technology of beer and wine; Non – alcoholic beverages: Carbonated beverages: carbonation equipment, - ingredients preparation of syrups-Filling system-packaging-containers and closures. Non-carbonated beverage: Coffee bean preparation-processing-brewing-decaffeination- instant coffee, Tea types black, green, Fruit juices and beverages, Flash pasteurization, Aseptic Packaging of beverages Tea/coffee and cocoa beverages, Grain based and malted beverages. Packaged drinking water: types, manufacturing processes, quality evaluation and raw and processed water, methods of water treatment, BIS quality standards of bottled water; mineral water, natural spring water, flavoured water, carbonated water.

Practical

- Preparation of cereals based fried snack foods
- Preparation of cereal, pulses based ready-to-eat snack food by extrusion cooking their quality evaluation
- Preparation of cereal grain based puffed products
- Development of instant food premixes
- Preparation of cereal and legume based roasted snack
- Preparation of flaked rice product
- To study the effect of roasting time and temperature on quality of pop-corn
- Determination of shelf-life and packaging requirements of snack food products
- Preparation of fruits/vegetable based ready to serve beverages and quality evaluation
- Heat classification of milk powders.
- Determination of degree of browning-chemical/physical methods.
- Determination of quality of packaged drinking water.
- Preparation of wine and beer
- Preparation of soy milk.
- Determination of quality of canned food.

Teaching Schedule

Theory

Lecture No	Topic	Weightage (%)
Unit I 1-2	Grain products: Industrial manufacturing of grain based products: formulation, processes, machinery and material balance of baked, rolled, shredded, puffed, flaked, roasted products.	20%
3	Extrusion technology: Importance and applications of extrusion in food processing; Pre and post extrusion treatments.	
4-5	Manufacturing process of extruded products; Change of functional properties of food components during extrusion.	
6	Breakfast cereals, RTE/RTC foods, instant premixes, functional foods.	
Unit II 7-9	Fruit and vegetable products: Industrial manufacturing of fruit and vegetable based products: formulation, processes, machinery and material balance of minimally processed.	20%
10-11	Retorted products, IMF, high moisture stable foods, IQF.	
12-14	Machines and equipment for batch and continuous processing of fruit and vegetable products.	
Unit III 15	Chocolates and candies: Coating or enrobing of chocolate (including pan-coating).	30%
16-17	Maintenance, safety and hygiene of bakery plants.	
18-20	Fats and oils processing: Technology of refined oil, winterized oil, hydrogenated fat, Texturized fat, by-products of fat/oil processing industries.	
21-24	Oil seed protein isolates; Quality standards of fats and fatty foods; Antioxidants and its mechanism of application.	
Unit IV 25-27	Beverages: Production technology of beer and wine; Non – alcoholic beverages: Carbonated beverages: carbonation equipment, - ingredients preparation of syrups-Filling system-packaging-containers and closures.	30%
28-32	Non-carbonated beverage: Coffee bean preparation-processing-brewing-decaffeination- instant coffee, Tea types black, green, Fruit juices and beverages, Flash pasteurization, Aseptic Packaging of beverages.	
33-35	Tea/coffee and cocoa beverages, Grain based and malted beverages. Packaged drinking water: types, manufacturing processes, quality evaluation and raw and processed water, methods of water treatment.	
36-38	BIS quality standards of bottled water; mineral water, natural spring water, flavoured water, carbonated water.	

Practical

Practical No	Topic
1	Preparation of cereals based fried snack foods
2-4	Preparation of cereal, pulses based ready-to-eat snack food by extrusion cooking their quality evaluation
5	Preparation of cereal grain based puffed products
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
11-12	Preparation of fruits/vegetable based ready to serve beverages and quality evaluation
13	Heat classification of milk powders.
14	Determination of degree of browning-chemical/physical methods.
15	Determination of quality of packaged drinking water.
16	Preparation of wine and beer
17	Preparation of soy milk.
18	Determination of quality of canned food.

Text/Reference Books/Suggested Readings

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

FPT 508	Nutraceuticals and Specialty Foods	3 (2+1)

Theory

UNIT I

Introduction: Defining nutraceuticals and functional foods. Nature, type and scope of nutraceutical and functional foods. Nutraceutical and functional food applications and their health benefits. Nutraceutical compounds and their classification based on chemical and biochemical nature, Innovations in Functional Food Industry for Health and Wellness, Development of biomarkers to indicate efficacy of functional ingredients. Nutraceuticals and Functional foods: Nutraceuticals / food components for specific disease such as cancer, heart disease, diabetes, obesity, anti-aging, arthritis, Prebiotics and probiotics; Omega and omega 6 fatty acids, Isoflavones, phenolic compounds, catechins, lycopene, glucosinolates.

UNIT II

Specialty Foods: Design of food for infants, children and old age. Functional Beverage: Selection of ingredients, health benefits and production. Extraction and delivery system: Non-thermal techniques, bioprocessing techniques, dehydration techniques, effect on bioactive ingredients. Delivery system and controlled release of nutraceuticals

UNIT III

Packaging, Storage, labelling: Packaging requirements, storage and storage kinetics on quality of nutraceuticals, interactions of various environmental factors. Marketing and safety aspects: Marketing and safety and regulatory issues for functional foods and nutraceuticals.

UNIT IV

Nutrigenomics: concept of personalized medicine. Use of nanotechnology in functional food industry. Biological functionality of cruciferous vegetables, tropical, subtropical and temperate fruits, herbs and spices.

Practical

- Determination of antioxidant activity of given food sample by different techniques viz DPPH, FRAP, ABTS, FRAP.
- Determination of total phenolic content of given food sample.
- Estimation of dietary fibres of given food sample.
- Estimation of lycopene in tomato.
- Estimation of carotenoids of given food sample.
- Determination of total flavonoid content of given food sample
- Effect of heat processing on ascorbic acid
- Determination of vitamins A.
- Estimation of pectic substances in plant sample
- Determination of beta carotene of given food sample.
- To determine gas chromatography for bioactive components analysis.
- To study the effect of drying on bioactive components of food sample
- To study the packaging requirement of functional foods.
- Determination and qualifications of some nutraceutical and functional food compounds by HPLC
- Estimation of β- glucan
- To study the storage kinetics of nutraceutical.
- Estimation of soluble/insoluble fibres of given food sample.

Teaching Schedule

Theory

Lecture No	Topic	Weightage (%)
Unit I 1-2	Introduction: Defining nutraceuticals and functional foods. Nature, type and scope of nutraceutical and functional foods.	40%
	Nutraceutical and functional food applications and their health benefits.	
	Nutraceutical compounds and their classification based on chemical and biochemical nature, Innovations in Functional Food Industry for Health and Wellness.	
	Development of biomarkers to indicate efficacy of functional ingredients.	
	Nutraceuticals and Functional foods: Nutraceuticals / food components for specific disease such as cancer, heart disease, diabetes, obesity, anti-aging, arthritis.	
	Prebiotics and probiotics; Omega and omega 6 fatty acids, Isoflavones, phenolic compounds, catechins, lycopene, glucosinolates.	
Unit II	Specialty Foods: Design of food for infants, children and old age.	20%
	Functional Beverage: Selection of ingredients, health benefits and production.	
	Extraction and delivery system: Non-thermal techniques, bioprocessing techniques, dehydration techniques, effect on bioactive ingredients.	
	Delivery system and controlled release of nutraceuticals.	
Unit III	Packaging, Storage, labelling: Packaging requirements, storage and storage kinetics on quality of nutraceuticals, interactions of various environmental factors.	20%
	Marketing and safety aspects: Marketing and safety and regulatory issues for functional foods and nutraceuticals.	
Unit IV	Nutrigenomics: concept of personalized medicine.	20%
	Use of nanotechnology in functional food industry.	
	Biological functionality of cruciferous vegetables, tropical, subtropical and temperate fruits, herbs and spices.	
	Total	**100**

Practical

Practical No	Topic
1-3	Determination of antioxidant activity of given food sample by different techniques viz DPPH, FRAP, ABTS, FRAP.
4	Determination of total phenolic content of given food sample.
5	Estimation of dietary fibres of given food sample.
6	Estimation of lycopene in tomato.
7	Estimation of carotenoids of given food sample.
8	Determination of total flavonoid content of given food sample
9	Effect of heat processing on ascorbic acid
10	Determination of vitamins A.

11	Estimation of pectic substances in plant sample
12	Determination of beta carotene of given food sample.
13	To determine gas chromatography for bioactive components analysis.
14	To study the effect of drying on bioactive components of food sample
15	To study the packaging requirement of functional foods.
16	Determination and qualifications of some nutraceutical and functional food compounds by HPLC.
17	Estimation of β- glucan
18	To study the storage kinetics of nutraceutical.
19	Estimation of soluble/insoluble fibres of given food sample.

Text/Reference Books/Suggested Readings

1. Chadwick R Henson S & Moseley B, 2003. Functional Foods, Springer-Verlag.
2. Jeffrey Hurst W, 2008. Methods of Analysis for Functional Foods and Nutraceuticals, CRC Press.
3. Shi J, Mazza G & Maguer M, 2002. Functional Foods, CRC Press.
4. Wildman R E C, 2006. Handbook of Nutraceuticals and Functional Foods, CRC Press.
5. Vattem DA & Maitin V, 2016. Functional Foods, Nutraceuticals and Natural Products, DEStech publications.
6. Grumezescu AM, 2016. Nutraceuticals: Nanotechnology in the Agri-Food Industry, Elsevier Inc
7. Rizvi SSH, 2010. Separation, extraction and concentration processes in the food, beverage and nutraceutical Industries, Woodhead Publishing.
8. Tomar SK, 2011. Functional Dairy Foods Concepts and Applications, Satish Serial Publishing House.
9. Gupta RK, Bansal S & Mangal M, 2012. Health Food Concept, Technology and Scope, Biotech Books.

FPT 511	Traditional Foods	3 (2+1)

Theory

UNIT I

Present status of traditional food products, Globalization of traditional food products; Plans and policies of the Government and developmental agencies. Overview of heat-desiccated, coagulated, fried, fermented traditional food products Process technology for Indian bread (chapatti), paratha, stuffed paratha, panipoori Process technology for Indian fried foods- poori, samosa, sev, fafda, chorafali, Jalebi Process technology for fermented traditional food and its improvement- pickle, idli, khaman, nan, dahi, dhokla, Spiced buttermilk etc. Process improvement in production of Indian sweets (Halwasan, kajukatli, carrothalwa, Rabdi, chocolate burfi, Chikki etc). Process improvement in production of puffed cereals and grains by microwave technique

UNIT II

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,Wada mix, Gotamix) Process technology for convenience traditional food products (ready to eat and serve –Curried vegetables, pulses and legumes), chutneys, paste Use of natural and permitted synthetic preservatives and new packaging systems for traditional food products

UNIT III

Techno-economic aspects for establishing commercial units for traditional products. Introduction to traditional foods of India, composition and nutritive values, microbial and biochemical diversity, quality and food safety challenges Processing& Preservation methods of Sweets & Desserts: Kulfi, Falooda, Kheer, khurchan, khoa/mawa, Rabri,jalebi, imarti, Gulab jamun, Peda, petha, rewdi, gajak, milk cake, balushahi, bal mithai, singoni, Ras-malayi,Gulqand, ghevar, rasgolla, chamcham, son halwa, son papri, several varieties of halwa, laddu, barfi & rasgolla.

UNIT IV

Traditional fermented foods: Idli, dosa, Vada, khamman dhokla, Dahi (Curd), Srikhand. Processing & Preservation methods of Snacks: Gujiya, kachauri, samosa, mirchibada, kofta, potato chips, banana-chips, mathri, bhujiya, fried dhals, bhujia, shakarpara, pakora, vada.

Processing & Preservation methods of Baked Products: Biscuits, Toast, Candies, Cookies, Breads, Roti, Naan, Tandoori Roti, parantha, kulcha, puri, bhatura. Processing & Preservation methods of Preserves & Beverages: Murabba, sharbat, pana, aam papad, sharbat, Coconut water, milk (khas, rose), Alcoholic Beverages Industrialization, Socioeconomic Conditions and Sustainability of Traditional Foods.

Practical

- To study the effect of different combination of salt and oil in quality of traditional fermented food product (pickle)
- To study the effect of different starter culture on taste and texture of idli
- To evaluate the shelf life of stuffed paratha under different storage conditions
- To study the effect of time and temperature on quality of fried food products (poori/ panipoori etc.
- To study effect of sugar and Artificial sweeteners in the preparation of kajukatli

- To study the microwave heating in drying of khaman/ dhokla
- To study the effect of cold extrusion on mixing of vermicelli
- To prepare instant carrot halwa mix
- To study the effect of different packaging material on shelf life of traditional Indian food products
- To study the effect of different natural food preservatives in traditional sweets
- Preparation of spiced buttermilk
- Preparation of puffed cereals and grains
- Preparation and quality evaluation of Instant Premixes (Puranmix)
- Preparation of quality evaluation of dried malted moth bean powder
- Preparation of Indian traditional confections (chikki)
- Visit to ethnic food industry (Instant mixes/Pickle making)

Teaching Schedule

Theory

Lecture No	**Topic**	**Weightage (%)**
Unit I 1-2	Present status of traditional food products, Globalization of traditional food products; Plans and policies of the Government and developmental agencies.	30%
3-4	Overview of heat-desiccated, coagulated, fried, fermented traditional food products Process technology for Indian bread (chapatti), paratha, stuffed paratha, panipoori.	
5-8	Process technology for Indian fried foods- poori, samosa, sev, fafda, chorafali, Jalebi Process technology for fermented traditional food and its improvement- pickle, idli, khaman, nan, dahi, dhokla, Spiced buttermilk etc.	
9-10	Process improvement in production of Indian sweets (Halwasan, kajukatli, carrothalwa, Rabdi, chocolate burfi, Chikki etc).	
11-12	Process improvement in production of puffed cereals and grains by microwave technique.	
Unit II 13-15	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).	20%
16-18	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,Wada mix, Gotamix).	
19-21	Process technology for convenience traditional food products (ready to eat and serve –Curried vegetables, pulses and legumes), chutneys, paste.	
22-23	Use of natural and permitted synthetic preservatives and new packaging systems for traditional food products.	
Unit III 24-26	Techno-economic aspects for establishing commercial units for traditional products. Introduction to traditional foods of India, composition and nutritive values, microbial and biochemical diversity, quality and food safety challenges.	20%
27-30	Processing & Preservation methods of Sweets & Desserts: Kulfi, Falooda, Kheer, khurchan, khoa/mawa, Rabri,jalebi, imarti, Gulab	

	jamun, Peda, petha, rewdi, gajak, milk cake, balushahi, bal mithai, singoni, Ras-malayi,Gulqand, ghevar, rasgolla, chamcham, son halwa, son papri, several varieties of halwa, laddu, barfi & rasgolla.	
Unit IV 31-33	Traditional fermented foods: Idli, dosa, Vada, khamman dhokla, Dahi (Curd), Srikhand.	30%
34-35	Processing & Preservation methods of Snacks: Gujiya, kachauri, samosa, mirchibada, kofta, potato chips, banana-chips, mathri, bhujiya, fried dhals, bhujia, shakarpara, pakora, vada.	
36-37	Processing & Preservation methods of Baked Products: Biscuits, Toast, Candies, Cookies, Breads, Roti, Naan, Tandoori Roti, parantha, kulcha, puri, bhatura.	
38-39	Processing & Preservation methods of Preserves & Beverages: Murabba, sharbat, pana, aam papad, sharbat, Coconut water, milk (khas, rose).	
40	Alcoholic Beverages Industrialization, Socioeconomic Conditions and Sustainability of Traditional Foods.	
	Total	**100**

Practical

Practical No	**Topic**
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/ panipoori etc.
5	To study effect of sugar and Artificial sweeteners in the preparation of kajukatli.
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.
9-11	To study the effect of different packaging material on shelf life of traditional Indian food products.
12	To study the effect of different natural food preservatives in traditional sweets.
13	Preparation of spiced buttermilk.
14	Preparation of puffed cereals and grains.
15	Preparation and quality evaluation of Instant Premixes (Puranmix).
16	Preparation of quality evaluation of dried malted moth bean powder.
17	Preparation of Indian traditional confections (chikki).
18	Visit to ethnic food industry (Instant mixes/Pickle making)

Text/Reference Books/Suggested Readings

1. K.H. Steinkrus. (1995) Handbook of Indigenous Fermented Foods. CRC Press
2. P. Wickramasinghe. (2007). The Food of India OM Book Service
3. R. P. Aneja, B.N. Mathur, R.C. Chandan, and A.K Banerjee (2002) Technology of Indian Milk Products, India Year Book Publications
4. Rakesh Mangal. (2013) Fundamentals of Indian Cooking: Theory and Practice.

FPT 514	Food Ingredients and Additives	3 (2+1)

Theory

UNIT I

Introduction: Role of food ingredients and additives in food processing, functions, classification, intentional and unintentional food additives, toxicology and safety evaluation of food additives, beneficial effects of food additives, food additives generally recognized as safe (GRAS), tolerance levels and toxic levels in foods-LD 50 values of food additives. Preservatives: General mechanism of action; basis of selection; classes; Chemical preservatives: characteristics, antimicrobial spectrum, mechanism of action, toxicology, regulations, application in food.

UNIT II

Antioxidants: Characteristics, types/classes/groups, mechanism of action/ working of antioxidants, functions, sources, application in food, limits and toxic effects of synthetic antioxidants, synergistic effects of antioxidants, role of free radicals in human body, Natural antioxidants. Flavouring agents: Flavour functions, selection; forms; sources; process of flavour creation; natural and synthetic flavouring; extractions methods; production process; application in food. Emulsifiers and Stabilizers: Characteristics/ functional properties; functions; basis of selection; types; mechanism of emulsion formation; mechanisms of emulsion stabilization and destabilization; application in food

UNIT III

Hydrocolloids: Definition: function and functional properties: sources; application in food. Sweeteners: Characteristics; classification/types; applications in food; Limits and toxicology of non-nutritive sweeteners. Colouring agents: Properties; functions; classification; sources of natural and synthetic colours: extraction; applications in food, levels of use, misbranded colours, colour stabilization.

UNIT IV

Starch, protein, and lipids, fibres and fructo-oligosaccharides: As functional ingredients; their isolation, modification, specifications, functional properties and applications in foods. Humectants, clarifying agents, Stabilizers and thickeners, Bleaching and maturing agents, Humectants, Sequestrants / chelating agents, Anti-caking agents, Buffering agents, Acidulants: definition; characteristics; sources; functions and their application in food processing.

Practical

- Determination of benzoic acid in food samples
- Estimation of sulphur dioxide in food samples
- Estimation of sorbic acid in cheese and yoghurt
- Determination of nitrate and nitrites in foods
- Detection and determination of aspartame by thin layer chromatography
- Liquid chromatographic determination of caffeine, benzoate and saccharin in soda beverage
- Identification of natural colours
- Isolation, identification and estimation of synthetic food colours
- TLC detection of antioxidants in fats and oils
- TLC detection of emulsifiers
- Detection of alginates in foods (chocolate, ice cream)
- GC determination of menthol in mentholated pan masala

- Isolation and modifications of protein, starch, lipids, fibres from the raw and processed food samples
- Estimation of various additives mentioned in unit IV

Teaching Schedule

Theory

Lecture No	Topic	Weightage (%)
Unit I 1-4	Introduction: Role of food ingredients and additives in food processing, functions, classification, intentional and unintentional food additives, toxicology and safety evaluation of food additives.	30%
4-7	Beneficial effects of food additives, food additives generally recognized as safe (GRAS), tolerance levels and toxic levels in foods-LD 50 values of food additives.	
8-10	Preservatives: General mechanism of action; basis of selection; classes; Chemical preservatives: characteristics, antimicrobial spectrum, mechanism of action, toxicology, regulations, application in food.	
Unit II 11-13	Antioxidants: Characteristics, types/classes/groups, mechanism of action/ working of antioxidants, functions, sources, application in food, limits and toxic effects of synthetic antioxidants, synergistic effects of antioxidants.	30%
13-15	Role of free radicals in human body, Natural antioxidants. Flavouring agents: Flavour functions, selection; forms; sources; process of flavour creation; natural and synthetic flavouring; extractions methods; production process; application in food.	
16-20	Emulsifiers and Stabilizers: Characteristics/ functional properties; functions; basis of selection; types; mechanism of emulsion formation; mechanisms of emulsion stabilization and destabilization; application in food.	
Unit III 21	Hydrocolloids: Definition: function and functional properties: sources; application in food.	20%
22-24	Sweeteners: Characteristics; classification/types; applications in food; Limits and toxicology of non-nutritive sweeteners.	
25-27	Colouring agents: Properties; functions; classification; sources of natural and synthetic colours: extraction; applications in food, levels of use, misbranded colours, colour stabilization.	
Unit IV 28-30	Starch, protein, and lipids, fibres and fructo-oligosaccharides: As functional ingredients; their isolation, modification, specifications, functional properties and applications in foods.	20%
33-35	Humectants, clarifying agents, Stabilizers and thickeners, Bleaching and maturing agents, Humectants, Sequestrants / chelating agents, Anti-caking agents, Buffering agents.	
36-38	Acidulants: definition; characteristics; sources; functions and their application in food processing.	
	Total	**100**

Practical

Practical No	Topic
1	Determination of benzoic acid in food samples
2	Estimation of sulphur dioxide in food samples
3	Estimation of sorbic acid in cheese and yoghurt
4	Determination of nitrate and nitrites in foods
5	Detection and determination of aspartame by thin layer chromatography
6-7	Liquid chromatographic determination of caffeine, benzoate and saccharin in soda beverage
8	Identification of natural colours
9-10	Isolation, identification and estimation of synthetic food colours
11	TLC detection of antioxidants in fats and oils
12	TLC detection of emulsifiers
13-15	Detection of alginates in foods (chocolate, ice cream)
16-17	GC determination of menthol in mentholated pan masala
18-19	Isolation and modifications of protein, starch, lipids, fibres from the raw and processed food samples.
20	Estimation of various additives mentioned in unit IV

Text/Reference Books/Suggested Readings

1. Branen A L, Davidson PM & Salminen S. 2001. Food additives, Marcel Dekker.
2. George A B. 1996. Encyclopaedia of Food and Colour Additives, CRC Press.
3. Nakai S & Modler H W. 2000. Food Proteins: Processing Applications, Wiley VCH.
4. Gerorge A B. 2004. Fenaroli's Handbook of Flavour Ingredients, CRC Press.
5. Branen A L, Davidson P M, Salminen S &Thorngate J H, 2001. Food Additives, Marcel Dekker.
6. Madhavi DL, Deshpande SS &Salunkhe DK, 1996. Antioxidants: Technological, Toxicological and Health Perspective, Marcel Dekker.
7. Stephen AM, 2006. Food Polysaccharides and Their Applications, CRC Press.
8. Smith J & Shum LH, 2011. Food Additives Data Book, Wiley-Blackwell.
9. Baines D and Seal R, 2012. Natural Food Additives, Ingredients and Flavorings, Woodhead Publishing.

FPT 517	Enzymes in Food Processing	3 (2+1)

Theory

UNIT I

Introduction: General Characteristics of Enzymes, Classes and Nomenclature of Enzymes, Enzymatic Reactions, Factors affecting enzyme activity, Enzyme Kinetic, Enzyme Inhibition Enzyme Production: Selection and sources of commercial Enzymes, Advantages of microbial enzymes, rDNA in enzyme engineering, Problems of scale up, Enzyme extraction and purification.

UNIT II

Immobilization: Techniques, Advantages and disadvantages, use of immobilized biocatalysts in food processing Enzymes for protein modification (hydrolysates and bioactive peptides), Enzymes for Lipid modification Enzymes in cereal processing: Application of enzymes in process of malting, brewing, milling, baking (fungal –amylase for bread making; maltogenic – amylases for anti-staling xylansandpentosanes as dough conditioners; lipases or dough conditioning; oxidases as replacers of chemical oxidants; synergistic effect of enzymes), production of high fructose corn syrup, glucose syrups.

UNIT III

Enzymes in fruit processing: Applications of enzyme in fruit juice clarification, removal of haziness and bitterness, Uses of enzymes in wine production Enzymes in meat, fish and milk processing: Meat tenderization and flavour development, fish processing (De-skinning, collagen extraction etc.,) Egg processing, Cheese processing.

UNIT IV

Flavour production: Role of enzymes (enzyme-aided extraction of plant materials for production of flavours, production of flavour enhancers such as nucleotides, MSG; flavours from hydrolysed vegetable/animal protein) Enzymes in the processing of fats and oils: specificity, stability and application of lipases and related enzymes Role of enzymes in hydrolysis of triglycerides, interesterification and randomization. Enzyme allergy.

Practical

- To investigate some of the kinetic properties of invertase
- To study time course of the reaction catalysed by alkaline phosphatase.
- To investigate the thermal stability of horseradish peroxidase
- Quantitative estimation of endoglucanase
- Quantitative estimation of exoglucanase
- Quantitative estimation of β galactosidase
- Quantitative estimation of Pectinase
- Quantitative estimation of Protease
- Quantitative estimation of Lipase
- Immobilization of amylase by sodium alginate and comparative evaluation with native enzyme
- To immobilize yeast cells and demonstrate its biological activity by invertase assay
- To carry out amylase fermentation
- To carry out protease fermentation
- To carry out lipase fermentation

Teaching Schedule

Theory

Lecture No	Topic	Weightage (%)
Unit I 1-5	Introduction: General Characteristics of Enzymes, Classes and Nomenclature of Enzymes, Enzymatic Reactions, Factors affecting enzyme activity, Enzyme Kinetic, Enzyme Inhibition	20%
6-10	Enzyme Production: Selection and sources of commercial Enzymes, Advantages of microbial enzymes, rDNA in enzyme engineering, Problems of scale up, Enzyme extraction and purification	
Unit II 10-14	Immobilization: Techniques, Advantages and disadvantages, use of immobilized biocatalysts in food processing. Enzymes for protein modification (hydrolysates and bioactive peptides).	30%
15-18	Enzymes for Lipid modification Enzymes in cereal processing: Application of enzymes in process of malting, brewing, milling, baking (fungal –amylase for bread making; maltogenic – amylases for anti-staling xylansandpentosanes as dough conditioners.	
19-21	lipases or dough conditioning; oxidases as replacers of chemical oxidants; synergistic effect of enzymes), production of high fructose corn syrup, glucose syrups.	
Unit III 22-25	Enzymes in fruit processing: Applications of enzyme in fruit juice clarification, removal of haziness and bitterness.	20%
26-28	Uses of enzymes in wine production Enzymes in meat, fish and milk processing.	
29-30	Meat tenderization and flavour development, fish processing (De-skinning, collagen extraction etc.,) Egg processing, Cheese processing.	
Unit IV 31-34	Flavour production: Role of enzymes (enzyme-aided extraction of plant materials for production of flavours, production of flavour enhancers such as nucleotides, MSG; flavours from hydrolysed vegetable/animal protein)	30%
35-38	Enzymes in the processing of fats and oils: specificity, stability and application of lipases and related enzymes Role of enzymes in hydrolysis of triglycerides, interesterification and randomization. Enzyme allergy.	
	Total	**100**

Practical

Practical No	Topic
1	To investigate some of the kinetic properties of invertase
2	To study time course of the reaction catalysed by alkaline phosphatase.
3	To investigate the thermal stability of horseradish peroxidase
4	Quantitative estimation of endoglucanase
5	Quantitative estimation of exoglucanase
6	Quantitative estimation of β galactosidase
7	Quantitative estimation of Pectinase
8	Quantitative estimation of Protease
9	Quantitative estimation of Lipase

10-12	Immobilization of amylase by sodium alginate and comparative evaluation with native enzyme
13-14	To immobilize yeast cells and demonstrate its biological activity by invertase assay
15-16	To carry out amylase fermentation
17-18	To carry out protease fermentation
19-20	To carry out lipase fermentation

Text/Reference Books/Suggested Readings

1. Trevor Palmer (2008) Enzymes: Biochemistry, Biotechnology and Clinical Chemistry East West
1. 2.Allen I. Laskin (2007) Enzymes and Immobilized Cells in Biotechnology Benjamin/Cummings Pub. Co
2. 3.Mansi El-Mansi & Charlie Bryce (2011) Fermentation Microbiology and Biotechnology CRC Press
3. 4.Nicholes C. Price and Lewis Stevens 2000 Fundamentals of Enzymology Oxford University Press
4. 5.Gerald Reed (2007) Enzymes in Food Processing Academic Press
5. Whitehurst RJ & Oort MV (2010) Enzymes in Food Technology Blackwell Publ
6. Bayindirli A (2010) Enzymes in Fruit and Vegetable Processing: chemistry and engineering applications CRC Press.

B. Minor Courses (Proposed)

FPE 508	Food Safety and Storage Engineering	3 (2+1)

Theory

UNIT I

Overview of food microbiology: Foodborne illness, food spoilage, food fermentation, microbiological physiology and food preservation, microbiological analysis, safety management systems. Overview of foodborne pathogens: Bacterial pathogens, food borne viruses and parasites.

UNIT II

Chemical safety of foods: nature of chemical hazards in foods, food safety engineering and control of chemical hazards, food allergen control. Intrinsic and extrinsic parameters for microbial growth and heat inactivation: Intrinsic and extrinsic factors affecting microbial growth, factors affecting heat resistance, combining traditional peroration techniques.

UNIT III

Kinetics of microbial inactivation: Microbial inactivation kinetics based on food processing methods: thermal, pressure, pulsed electric field, microwave and radio frequency, ohmic and inductive heating etc. Kinetic parameter for the inactivation of pathogens: Salmonella, Listeria monocytogenes, Staphylococcus aureus, Escherichia coli, Bacillus cereus, Clostridium, Vibrio, other pathogens.

UNIT IV

Predictive microbial modelling: classification of models: Kinetic & probability, Empirical & mechanistic models, Primary, secondary & tertiary models, Deterministic & stochastic models; Description of main models, Modelling growth curves, Modelling inactivation/survival curves, Secondary models, Probability models; Applications of predictive microbial modelling: Hazard analysis critical control point (HACCP) & quantitative risk assessment (QRA), Microbial shelflife studies, Temperature function integration and temperature monitors, Product research and development, Design of experiments; Predictive microbial modelling and quantitative risk assessment.

UNIT V

Process-dependent microbial modeling: Predictive microbial kinetic models, Temperature dependent microbial growth kinetic models, Irradiation-dependent microbial growth model, Pulsed electric field-dependent microbial growth model, High-pressure-dependent microbial growth model; Process modeling; Integration of process and microbial growth kinetic models.

UNIT VI

Storage and handling systems for grains, horticultural and animal based produces; post-harvest physiology of fruits and vegetables; biochemical changes during storage, production, distribution; storage capacity estimate models, ecology, storage factors affecting losses, storage requirements.

Practical

- Rapid methods and automation in microbiology: trends and predictions
- Study on phage-based detection of foodborne pathogens
- Study on real-time PCR
- Study on DNA Array
- Study on immunoassay
- Offline and online assessments for food safety for industry

- Storage pest, insects and rodent control
- Study on storage systems and structures, Shelf life evaluation of packaged food products
- Recent advancements in storage and handling systems
- Hygienic design standards and codes for food processing equipment / system
- Case studies on food safety engineering, guidelines, regulations.

Teaching Schedule

Theory

Lecture No	**Topic**	**Weightage (%)**
Unit I 1-4	Overview of food microbiology: Foodborne illness, food spoilage, food fermentation, microbiological physiology and food preservation, microbiological analysis, safety management systems.	20%
5-8	Overview of food-borne pathogens: Bacterial pathogens, food borne viruses and parasites.	
Unit II 9-10	Chemical safety of foods: nature of chemical hazards in foods, food safety engineering and control of chemical hazards, food allergen control.	10%
11-12	Intrinsic and extrinsic parameters for microbial growth and heat inactivation: Intrinsic and extrinsic factors affecting microbial growth, factors affecting heat resistance, combining traditional peroration techniques.	
Unit III 13-15	Kinetics of microbial inactivation: Microbial inactivation kinetics based on food processing methods: thermal, pressure, pulsed electric field, microwave and radio frequency, ohmic and inductive heating etc.	20%
16-18	Kinetic parameter for the inactivation of pathogens: Salmonella, Listeria monocytogenes, Staphylococcus aureus, Escherichia coli, Bacillus cereus, Clostridium, Vibrio, other pathogens.	
Unit IV 19-20	Predictive microbial modelling: classification of models: Kinetic & probability, Empirical & mechanistic models, Primary, secondary & tertiary models, Deterministic & stochastic models; Description of main models.	20%
21-23	Modelling growth curves, Modelling inactivation/survival curves, Secondary models, Probability models; Applications of predictive microbial modelling: Hazard analysis critical control point (HACCP) & quantitative risk assessment (QRA).	
24-26	Microbial shelflife studies, Temperature function integration and temperature monitors, Product research and development, Design of experiments; Predictive microbial modelling and quantitative risk assessment.	
Unit V 27-28	Process-dependent microbial modeling: Predictive microbial kinetic models, Temperature dependent microbial growth kinetic models.	10%
29	Irradiation-dependent microbial growth model.	
30-32	Pulsed electric field-dependent microbial growth model, High-pressure-dependent microbial growth model.	
33	Process modeling; Integration of process and microbial growth kinetic models.	
Unit VI 34	Storage and handling systems for grains, horticultural and animal based produces.	

35-36	Post-harvest physiology of fruits and vegetables; post-harvest physiology of fruits and vegetables.	20%
37-38	biochemical changes during storage, production, distribution; storage capacity estimate models, ecology, storage factors affecting losses, storage requirements.	
	Total	**100**

Practical

Practical No	**Topic**
1-2	Rapid methods and automation in microbiology: trends and predictions
3-4	Study on phage-based detection of foodborne pathogens
5	Study on real-time PCR
6-7	Study on DNA Array
8-9	Study on immunoassay
10-11	Offline and online assessments for food safety for industry
12-13	Storage pest, insects and rodent control
14-15	Study on storage systems and structures, Shelf life evaluation of packaged food products
16-17	Recent advancements in storage and handling systems
18-19	Hygienic design standards and codes for food processing equipment / system
20-21	Case studies on food safety engineering, guidelines, regulations.

Text/Reference Books/Suggested Readings

1. Sun, D. W. (2015). Handbook of food safety engineering. Wiley Black Well Academic Press, Elsevier Ltd
2. International Organization for Standardization. (2018). Food Safety Management Systems: Requirements for Any Organization in the Food Chain. ISO.
3. Shejbal J (1980). Controlled Atmosphere Storage of Grains. Elsevier, Vijayaraghavan S. (1993). Grain Storage Engineering and Technology. Batra Book Service
4. Chakraverty A. & Singh R.P. (2014). Postharvest technology and food process engineering. CRC Press
5. Chakraverty A., Mujumdar A.S. & Ramaswamy H.S. (2002). Handbook of Postharvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. CRC Press
6. ISO 22000 Food safety management systems - Requirements for any organization in the food chain. Technical Committee ISO/TC 34, Food products and updates
7. Case Studies & Field Reports - Food Safety Engineering.

FSQ 503	Advanced Food Chemistry	3 (2+1)

Theory

UNIT I

Composition, nutritional and functional value of food: Water activity and sorption phenomenon, Engineered foods and influencing water activity and shelf-life; Chemical reactions of carbohydrates–oxidation, reduction, with acid & alkali; Maillard reaction, Caramelization, Ascorbic acid oxidation, Resistant Starch, Soluble and Insoluble fibre, Pigments and approaches to minimize the impact of food processing, Molecular Mobility.

UNIT II

Structure and Properties of proteins; electrophoresis, sedimentation, amphoterism, denaturation, viscosity, gelation, texturization, emulsification, foaming, protein-protein and other interactions in food matrix; Lipids: melting point, softening point, smoke, flash and fire point, turbidity point, polymorphism and polytypism; polymerization and polymorphism, flavor reversion, autooxidation and its prevention, fat in food matrix like fat globule in milk, PUFA, MUFA, CLA, ω - fatty acids, trans fatty acids, phytosterol, etc.

UNIT III

Description of food flavours; Flavour enhancers, Food acids their tastes and flavours, Principles and techniques of flavour encapsulation, types of encapsulation; Factors affecting stabilization of encapsulated flavour and their applications in food industry.

UNIT IV

Processing and packaging induced chemicals and their control – acrylamide, nitrosamines, carcinogenic and genotoxicchlorpropanols such as 3-monochloropropane-1,2diol (3-MCPD), PAHs (in grilled and smoked products), dioxine, histamine, ethyl carbamate, furan, bisphenol A or phthalates from plastic materials, microplastics, 4-methylbenzophenone and 2- isopropylthioxanthone from inks, mineral oil from recycled fibers or semicarbazide from a foaming agent in the plastic gasket.

Practical

- Estimation of protein content in food samples using spectroscopic methods
- Study of effect of heat on protein denaturation using enzymes
- Study of effect of various salt solutions on solubility of proteins
- Separation of milk proteins by salting out method
- Separation of proteins using chromatographic methods
- Fractionation of proteins
- Extraction and purification of essential oil/ flavouring compound of a natural source
- Study the process of starch retrogradation, gelatinization and modification
- Estimation of crude and dietary fibres in given food sample
- Analysis of resistant starches
- Estimation of various antioxidants, polar compounds and free fatty acids in frying oils
- Extraction and purification of natural plant pigment
- Functional properties and isoelectric point of proteins
- Qualitative and quantitative evaluation of processing and packaging induced chemicals
- Qualitative identification of different flavouring compounds

Teaching Schedule

Theory

Lecture No	Topic	Weightage (%)
Unit I 1-4	Composition, nutritional and functional value of food.	25%
5-6	Water activity and sorption phenomenon, Engineered foods and influencing water activity and shelf-life.	
7-10	Chemical reactions of carbohydrates–oxidation, reduction, with acid & alkali.	
9-11	Maillard reaction, Caramelization, Ascorbic acid oxidation.	
12-15	Resistant Starch, Soluble and Insoluble fibre, Pigments and approaches to minimize the impact of food processing, Molecular Mobility.	
Unit II 16-18	Structure and Properties of proteins; electrophoresis, sedimentation, amphoterism, denaturation, viscosity, gelation, texturization, emulsification, foaming, protein-protein and other interactions in food matrix.	25%
19-21	Lipids: melting point, softening point, smoke, flash and fire point, turbidity point, polymorphism and polytypism; Lipids: melting point, softening point, smoke, flash and fire point, turbidity point, polymorphism and polytypism;	
22-24	Polymerization and polymorphism, flavor reversion, autooxidation and its prevention, fat in food matrix like fat globule in milk.	
25-28	PUFA, MUFA, CLA, ω - fatty acids, trans fatty acids, phytosterol, etc.	
Unit III 29-30	Description of food flavours; Flavour enhancers, Food acids their tastes and flavours.	25%
31-33	Principles and techniques of flavour encapsulation, types of encapsulation; Factors affecting stabilization of encapsulated flavour and their applications in food industry.	
Unit IV 34-35	Processing and packaging induced chemicals and their control – acrylamide, nitrosamines, carcinogenic and genotoxicchlorpropanols such as 3-monochloropropane-1,2diol (3-MCPD).	25%
36-38	PAHs (in grilled and smoked products), dioxine, histamine, ethyl carbamate, furan, bisphenol A or phthalates from plastic materials, microplastics, 4-methylbenzophenone and 2- isopropylthioxanthone from inks, mineral oil from recycled fibers or semicarbazide from a foaming agent in the plastic gasket.	
	Total	**100**

Practical

Practical No	Topic
1	Estimation of protein content in food samples using spectroscopic methods
2	Study of effect of heat on protein denaturation using enzymes
3	Study of effect of various salt solutions on solubility of proteins
4	Separation of milk proteins by salting out method
5	Separation of proteins using chromatographic methods
6	Fractionation of proteins

7	Extraction and purification of essential oil/ flavouring compound of a natural source
8-10	Study the process of starch retrogradation, gelatinization and modification
11	Estimation of crude and dietary fibres in given food sample
12	Analysis of resistant starches
13	Estimation of various antioxidants, polar compounds and free fatty acids in frying oils
14-15	Extraction and purification of natural plant pigment
16	Functional properties and isoelectric point of proteins
17	Qualitative and quantitative evaluation of processing and packaging induced chemicals
18	Qualitative identification of different flavouring compounds

Text/Reference Books/Suggested Readings

1. O.R. Fennema, Ed., (2008). Food Chemistry, Marcel and Dekker, Inc., New York, NY.
2. Belitz, H. D., Grosch, W., & Schieberle, P. (2009).. Food chemistry. Springer.
3. Peter Varelis, Laurence Melton and Fereidoon Shahidi (2019). Encyclopedia of Food Chemistry, Elsevier.
4. Cheung, Peter C. K., Mehta, Bhavbhuti M. (2015) Handbook of Food Chemistry. Springer

FSQ 504	Global Food Laws and Regulations	2 (2+0)

Theory

UNIT I

International Plant Protection Convention, world organization for animal health (OIE), sanitary and phytosanitary measures (SPS), Codex Alimentarius, FAOLEX, OECD Agriculture and Fisheries, International Trade Centre's Standards Map, FAO Food safety and quality emergency. Prevention, JFSCA, Fundamental Principles of food safety governance, Risk Analysis as a Method to Determine the Regulatory Outcome, Increasing Responsibility of Businesses (Private) Risk Assessors, Concept of harmonization of global food laws,

UNIT II

EU Food Safety Standards - Regulation 178 of 2002, The European food safety authority (EFSA), A critical overview of the EU food safety policy and standards, COMESA Food Safety Standards - An overview, Case Studies in Food Safety Standards in EU-COMESA Trade, Private voluntary standards (PVS) and EU food safety standards, FDA Food safety modernization Act (FSMA), FSPCA Preventive Controls for Human Food, Foreign Supplier Verification Programs (FSVP), Food Facility Registration, FDA - Current Good Manufacturing Practices (CGMPs)

UNIT III

Hazard Analysis & Critical Control Points (HACCP) guidelines, Foreign Food Facility Inspection Program, International and Interagency Coordination, Registration of Food Facilities, Seafood Imports and Exports, Regulation on GM Foods, Regulations on Irradiated foods, Global Regulations on Health Foods, International Law on Adequacy of thermal processing, Grain Fumigation for Export, Law of trading horticultural Products, Safety Frame Applied to Food Applications of Nanotechnology.

UNIT IV

Review of Indian Regulatory Scenario in Food and Food Products - Food Safety and Standards (FSS) Act, 2006, FSS Rules and Regulations, Agricultural Produce Act, 1937 (Grading and Marketing), Export (Quality Control & Inspection), Act, 1963 and Rules, Bureau of Indian Standards relevant to food safety, Legal Metrology Act, International Food Control Systems/ Laws

Teaching Schedule

Theory

Lecture No	Topic	Weightage (%)
Unit I 1-2	International Plant Protection Convention, world organization for animal health (OIE), sanitary and phytosanitary measures (SPS).	25%
3-5	Codex Alimentarius, FAOLEX, OECD Agriculture and Fisheries, International Trade Centre's Standards Map.	
6-9	FAO Food safety and quality emergency Prevention, JFSCA, Fundamental Principles of food safety governance.	
10-12	Risk Analysis as a Method to Determine the Regulatory Outcome, Increasing Responsibility of Businesses (Private) Risk Assessors.	
13-14	Concept of harmonization of global food laws. Concept of harmonization of global food laws.	
Unit II 15-16	EU Food Safety Standards - Regulation 178 of 2002, The European food safety authority (EFSA), A critical overview of the EU food safety	

	policy and standards.	25%
17-18	COMESA Food Safety Standards - An overview, Case Studies in Food Safety Standards in EU-COMESA Trade, Private voluntary standards (PVS) and EU food safety standards.	
19-20	FDA Food safety modernization Act (FSMA), FSPCA Preventive Controls for Human Food, Foreign Supplier Verification Programs (FSVP).	
21-22	Food Facility Registration, FDA - Current Good Manufacturing Practices (CGMPs). Food Facility Registration, FDA - Current Good Manufacturing Practices (CGMPs).	
Unit III 23-24	Hazard Analysis & Critical Control Points (HACCP) guidelines.	25%
25-26	Foreign Food Facility Inspection Program, International and Interagency Coordination, Registration of Food Facilities, Seafood Imports and Exports, Regulation on GM Foods.	
27-30	Regulations on Irradiated foods, Global Regulations on Health Foods, International Law on Adequacy of thermal processing.	
31-33	Grain Fumigation for Export, Law of trading horticultural Products, Safety Frame Applied to Food Applications of Nanotechnology.	
Unit IV 34-35	Review of Indian Regulatory Scenario in Food and Food Products.	25%
36-37	Food Safety and Standards (FSS) Act, 2006, FSS Rules and Regulations, Agricultural Produce Act, 1937 (Grading and Marketing).	
38-40	Export (Quality Control & Inspection), Act, 1963 and Rules, Bureau of Indian Standards relevant to food safety, Legal Metrology Act, International Food Control Systems/ Laws.	

Text/Reference Books/Suggested Readings

1. OnsandoOsiemo, 2018, Food Safety Standards in International Trade: The Case of the EU and the COMESA, CRC
2. Andrea Barrios Villarreal, 2018, International Standardization and the Agreement on Technical Barriers to Trade, Cambridge University Press
3. Bernd Meulen, Harry Bremmers, Kai Purnhagen, Nidhi Gupta, Hans Bouwmeester L. and Leon Geyer, 2014, Governing Nano Foods: Principles-Based Responsive Regulation
4. Understanding the Codex Alimentarius, 3rd ed., 2006.
5. JessicaVapnek and Melvin Spreij, 2005, Perspectives and guidelines on food legislation, with a new model food law for the Development Law Service FAO Legal Office
6. US FDA Website
7. European Food Safety Authority (EFSA) website.

Course content of Supportint Courses (Proposed)

FBM 501	Post-Harvest Management	3 (2+1)

Theory

UNIT I

Post-harvest handling of F&V. Maturity indices, harvesting and post-harvest handling of fruits and vegetables. Respiration and ripening process. Factors affecting respiration and ripening. Pre and post-harvest factors affecting quality on post-harvest shelf life. Chemicals used for hastening and delaying ripening of fruits and vegetables. Methods of storage – precooling, prestorage treatments, low temperature storage, controlled atmospheric storage, hypobaric storage, irradiation and low cost storage structures, Cleaning & Washing machinery and methods for grading.

UNIT II

Packing technology for export. Fabrication of types of containers, cushioning material, vacuum packing, poly shrink packing, specific packing for export of mango, banana, grapes kinnow, sweet orange and mandarin etc. Principles of preservation by heat, low temperature, chemicals and fermentation. Cut fruits and vegetables.

UNIT III

Post-harvest practices for safe storage of food grains. Preparation of threshing, threshers for different crops, parts, terminology, care and maintenance. Winnowing, manual and power operated winnowers. Groundnut decorticators- hand and power operated principles of working. Maize shellers & castor shellers. Drying- grain drying method and equipment. Grain storage and practices.

UNIT IV

Post-harvest technology for major spices (black pepper, cardamom, coriander, cinnamon, ginger, onion and garlic, paprika, saffron, turmeric), their post-harvest diseases and storage pests and their management; Packaging and storage of spices and spice powders.

Practical

- Macro quality analysis, grading, packaging.
- Harvesting indices of different vegetable crops;
- Grading and packing of vegetables;
- Practice in judging the maturity of various fruits and vegetables.
- Conservation of zero energy cool chambers for on farm storage.
- Determination of physiological loss in weight (PLW), total soluble solids (TSS), total
- sugars, acidity and ascorbic and content in fruits and vegetables. Packing methods and
- types of packing and importance of ventilation.
- Pre cooling packing methods for export or international trade. Methods of prolonging
- storage life.
- Effect of ethylene on ripening of banana, sapota, mango, sapota.
- Identification of equipment and machinery used is preservation of fruits and vegetables.
- Preservation by drying and dehydration.
- Visit to local processing units.
- Visit to local market yards and cold storage units.
- Visit to local market and packing industries.

Teaching Schedule

Theory

Lecture No	Topic	Weightage (%)
Unit I 1-2	Post-harvest handling of F&V. Maturity indices, harvesting and post-harvest handling of fruits and vegetables.	30%
3-6	Respiration and ripening process. Factors affecting respiration and ripening. Pre and post-harvest factors affecting quality on post-harvest shelf life.	
7-9	Chemicals used for hastening and delaying ripening of fruits and vegetables. Methods of storage – precooling, prestorage treatments, low temperature storage, controlled atmospheric storage, hypobaric storage, irradiation and low cost storage structures.	
10	Cleaning & Washing machinery and methods for grading.	
Unit II 11-16	Packing technology for export. Fabrication of types of containers, cushioning material, vacuum packing, poly shrink packing, specific packing for export of mango, banana, grapes kinnow, sweet orange and mandarin etc.	20%
17-19	Principles of preservation by heat, low temperature, chemicals and fermentation. Cut fruits and vegetables.	
Unit III 20-23	Post-harvest practices for safe storage of food grains. Preparation of threshing, threshers for different crops, parts, terminology, care and maintenance.	30%
24-27	Winnowing, manual and power operated winnowers. Groundnut decorticators- hand and power operated principles of working.	
28-31	Maize shellers & castor shellers. Drying- grain drying method and equipment. Grain storage and practices.	
Unit IV 32-35	Post-harvest technology for major spices (black pepper, cardamom, coriander, cinnamon, ginger, onion and garlic, paprika, saffron, turmeric), their post-harvest diseases and storage pests and their management.	20%
36-38	Packaging and storage of spices and spice powders.	
	Total	**100**

Practical

Practical No	Topic
1	Macro quality analysis, grading, packaging.
2	Harvesting indices of different vegetable crops.
3	Grading and packing of vegetables.
4	Practice in judging the maturity of various fruits and vegetables.
5	Conservation of zero energy cool chambers for on farm storage.
6-10	Determination of physiological loss in weight (PLW), total soluble solids (TSS), total sugars, acidity and ascorbic and content in fruits and vegetables. Packing methods and types of packing and importance of ventilation.
11	Pre cooling packing methods for export or international trade. Methods of prolonging storage life.
12	Effect of ethylene on ripening of banana, sapota, mango, sapota.

13-14	Identification of equipment and machinery used is preservation of fruits and vegetables.
15	Preservation by drying and dehydration.
16	Visit to local processing units.
17	Visit to local market yards and cold storage units.
18	Visit to local market and packing industries.

Text/Reference Books/Suggested Readings

1. Pantastico B. Post Harvest Physiology, Handling and Utilization of Tropical and Subtropical Fruits and Vegetables. The AVI Publishing Co. Inc, Westport
2. Ryall, AL and Lipton WJ. Handling, storage and transportation of Fruits & Vegetables. Vol I. The AVI Pub. Company
3. Ryall, AL and Peltzer, WT. Handling, Storage and Transportation of Fruits and Vegetables – Vol II. The AVI Pub. Co.
4. Rydstm Heele, S, Post Harvest Physiology and Pathology of Vegetables. Marcel Dekker.

FBM 503	Food Processing Entrepreneurship and Start-up	1(1+1)

Theory

Unit I

Assessing overall business environment in the Indian economy. Overview of Indian social, political and economic systems and their implications for decision making by individual entrepreneurs. Globalisation and the emerging business/entrepreneurial environment.

Unit II

Concept of entrepreneurship; entrepreneurial and managerial characteristics; managing an enterprise; motivation and entrepreneurship development; importance of planning, monitoring, evaluation and follow up; managing competition; entrepreneurship development programs; Social Responsibility of Business.

Unit III

SWOT analysis, Generation, incubation and commercialization of ideas and innovations. Government schemes and incentives for promotion of entrepreneurship. Government policy on Small and Medium Enterprises (SMEs)/ SSIs. Export and Import Policies relevant to food sector. Venture capital. Contract farming and joint ventures, public-private partnerships. Overview of horti inputs industry. Characteristics of Indian food processing and export industry. Communication Skills: Structural and functional grammar; meaning and process of communication, verbal and non-verbal communication; listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, précis writing, summarizing, abstracting; individual and group presentations, impromptu presentation, public speaking; Group discussion. Organizing seminars and conferences.

Teaching Schedule

Theory

Lecture No	Topic	Weightage (%)
Unit I 1-2	Assessing overall business environment in the Indian economy.	20%
3-4	Overview of Indian social, political and economic systems and their implications for decision making by individual entrepreneurs.	
5-6	Globalization and the emerging business/entrepreneurial environment.	
Unit II 7-8	Concept of entrepreneurship; entrepreneurial and managerial characteristics; managing an enterprise; motivation and entrepreneurship development.	20%
9-10	Importance of planning, monitoring, evaluation and follow up; importance of planning, monitoring, evaluation and follow up.	
11-12	Managing competition; entrepreneurship development programs; Social Responsibility of Business. Managing competition; entrepreneurship development programs; Social Responsibility of Business.	
Unit III 13-14	SWOT analysis, Generation, incubation and commercialization of ideas and innovations. Government schemes and incentives for promotion of entrepreneurship.	
15-16	Government policy on Small and Medium Enterprises (SMEs)/ SSIs. Export and Import Policies relevant to food sector. Venture capital.	

	Contract farming and joint ventures, public-private partnerships. Overview of horti inputs industry.	60%
17-18	Characteristics of Indian food processing and export industry. Communication Skills: Structural and functional grammar; meaning and process of communication, verbal and non-verbal communication; listening and note taking, writing skills, oral presentation skills; field diary and lab record.	
19-20	Indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, précis writing, summarizing, abstracting; individual and group presentations. Impromptu presentation, public speaking; Group discussion. Organizing seminars and conferences.	
	Total	**100**

Practical/Assignments/Case studies

- Study of a regulated market,
- Study of a fruit and vegetable market,
- Study of State and Central Warehousing Corporation
- Study of functioning of a regional rural bank and commercial bank for loan.
- Study of food processing enterprise,
- Formulation of project reports for financing food Industry,
- Working out repayment plans,
- Legal Issues in Product Development, Marketing and Market Segments
- Case studies: Innovations in Dairy industry, Bakery industry, fats and oils industry, fruit and vegetable industry, primary and secondary processing of cereals, brewing industry.

Note: In practical of plant design and project engineering a plant design problem should be assigned to a group of (3-4) students. The students should carry out the conceptual design, flow sheeting, material and energy balance calculations, and cost and profitability analysis of any Food Plant.

Text/Reference Books/Suggested Readings

i. Hu, R. 2005. *Food Product Design A Computer-Aided Statistical Approach*, Technomic Publishers.

ii. Moskowitz H R, Saguy S. and Straus T. 2006. *An Integrated Approach to New Food Product Development,* CRC Press

iii. Moskowitz H R, Porretta S. and Silcher M. 2006. *Concept Research in Food Product Design And Development*, Blackwell Publishing Ltd.

iv. Peters MS and Timmerhaus KD. 2005. *Plant Designs and Economics for Chemical Engineers*, McGraw Hill, 5th Edition,

v. Ahmad T. 2009. *Dairy Plant Engineering and Management*., Kitab Mahal, 8th Edition.

FSQ 505	Food Safety Management Systems and Certification	2 (2+0)

Theory

UNIT I

Food safety management systems and its requirements for any organization in the food chain, Block chain concept, Global food safety initiative (GFSI), PAS 220, Prerequisite programs on food safety for food manufacturing, Audits: Introduction, objectives, documentation, responsibilities.

UNIT II

Food safety plan overview, Good manufacturing practices and other prerequisite programs, GAP and GMP, Preliminary Steps in Developing a food safety plan, Resources for food safety plans, HACCP, TACCP and VACCP.

UNIT III

Biological/ Chemical/ Physical and Economically motivated food safety hazards, Process preventive controls, Food allergen preventive controls, Sanitation preventive controls, supply chain preventive controls, verification and validation Procedures, Record Keeping Procedures, Recall Plan

UNIT IV

FSMS and FSSC 22000. ISO 22003, ISO 20005 and traceability in food chain, ISO 14000 series – certification and its importance, ISO 17025 - General requirements for the competence of testing and calibration laboratories, BRC Standard, BRC Storage and Distribution, SQF, Southern Rocklobster Seafood, Retailer programs like Woolworths, Coles, Costco and ALDI, Concept of Auditing.

Teaching Schedule

Theory

Lecture No	Topic	Weightage (%)
Unit I 1-2	Food safety management systems and its requirements for any organization in the food chain.	25%
3-6	Block chain concept, Global food safety initiative (GFSI), PAS 220, Prerequisite programs on food safety for food manufacturing.	
7-9	Audits: Introduction, objectives, documentation, responsibilities.	
Unit II 10-12	Food safety plan overview, Good manufacturing practices and other prerequisite programs, GAP and GMP.	25%
13-15	Preliminary Steps in Developing a food safety plan, Resources for food safety plans, HACCP, TACCP and VACCP.	
Unit III 16-20	Biological/ Chemical/ Physical and Economically motivated food safety hazards.	25%
21-26	Process preventive controls, Food allergen preventive controls, Sanitation preventive controls, supply chain preventive controls.	
27-32	Verification and validation Procedures, Record Keeping Procedures, Recall Plan.	
Unit IV 33-35	FSMS and FSSC 22000. ISO 22003, ISO 20005 and traceability in food chain, ISO 14000 series – certification and its importance.	25%
36-38	ISO 17025 - General requirements for the competence of testing and calibration laboratories, BRC Standard, BRC Storage and Distribution,	

	SQF. Southern Rocklobster Seafood, Retailer programs like Woolworths, Coles, Costco and ALDI, Concept of Auditing.	
	Total	**100**

Text/Reference Books/Suggested Readings

1. Erasmo Salazar, 2013, Understanding Food Safety Management Systems: A Practical Approach to the Application of ISO-22000:2005, Create Space Independent Publishing Platform.
2. ISO 22000 Standard Procedures for Food Safety Management Systems, 2008, Bizmanualz, Inc.
3. Mike Dillon and Chris Griffith (ed), 2001 Auditing in the food industry - From safety and quality to environmental and other audits, CRC Press
4. Alli, Inteaz, 2003, Food Quality Assurance: Principles and Practices, CRC Press
5. Respective certification documents.

I	**Course Title**	:	**SEMINAR**
II	**Course Code**	:	FPT 591
III	**Credit Hours**	**:**	1(1+0)
	Objective		It has been agreed to have mandatory seminars one in Masters (One Credit). The students should be encouraged to make presentations on the latest developments and literature in the area of research topic. This will provide training to the students on preparation for seminar, organizing the work, critical analysis of data and presentation skills

I	**Course Title**	:	**RESEARCH WORK**
II	**Course Code**	:	FPT 599
III	**Credit Hours**	**:**	30(0+30)

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*** Currently M. Sc. (Food Technology) degree programme at Mahatma Phule Krishi Vidyapeeth, Rahuri is temporary suspended due to lack of manpower. It will be started as M. Tech. (Food Technology) Food Processing Technology in future.**

Note :	Optional Major Subjects: The said courses are subjected to availability of infrastructure and facilities and to be decided by SAC committee

FPT 504	Food Material and Product Properties	3 (2+1)

Theory

Unit I

Introduction: Biomaterials and their properties in relation to processing and product development. Physico-chemical characteristics: Shape, sphericity, size, volume, microstructure, density, porosity, surface area, coefficients of friction and angle of repose and influence of constituents on processing.

Unit II

Mechanical and rheological properties: Flow behaviour of granular and powdered food materials, rheological models, creep phenomenon, stress – strain - time effects and relationships, and techniques of model fitting, Elastic vs. textural characteristics and textural profile analysis of food products.

Unit III

Thermal, electrical and optical properties: Specific heat, thermal conductivity, phase transition, thermodynamics-basic principles and laws, Thermodynamic properties of moist air, kinetics of water absorption, heat capacity, thermal diffusivity, electrical resistance and conductance, dielectric constant, reflectivity, transmittivity and absorptivity of incident rays. Food microstructure: Methods and systems for food microstructure, determination of light microscopy, transmission electron microscopy, scanning electron microscopy, other instrumentation and techniques, image analysis: image acquisition, image processing, measurement analysis.

Unit IV

Functional properties: Dextrinization, Gelatinisation, Crystallisation, gelation, foaming, coagulation, denaturation and syneresis, foaming, emulsification. Sensory attributes: Sensory properties and correlation with objective indices, microstructure and its relation to texture from their mechanical models and its examination. Sorption behaviour of food: sorption isotherm, modelling.

Practical

- To determine physical dimension and shape for suitability of processing andpackaging of food materials
- To determine bulk, true density and porosity of samples

- To determine the angle of repose using rough and smooth surface
- Analysis of powder characteristics using powder flow analyser.
- To determine the mixing and strength characteristics of wheat flour using faringograph/ mixograph/ mixolab
- To determine the amylolytic activity using falling number of wheat flour
- Development of stress and strain curve and to study viscosity of Newtonian and non-Newtonian fluid
- Effect of temperature on viscosity profile of a food sample
- Texture profile analysis of foods samples.
- Effect of temperature on textural profile of food
- Determination of thermal properties of foods using DSC.
- To estimate dielectric constant of foods
- Organoleptic evaluation of food materials
- TEM and SEM, image analysis and image processing techniques
- To determine water activity of food
- To determine colour value of food, viz. Lab, whiteness index, yellow index, browningindex

Suggested Reading

- Rao MA and Rizvi SSH, 1986. Engineering Properties of Foods, Marcel Dekker.
- Aguilera JM & Stanley DW, 1999. Microstructural Principles of Food Processing and Engineering, Springer.
- Mohsenin NN, 1986. Physical Properties of Plant and Animal Materials, Gordon & Breach Science.
- Bourne MC, 1981. Food Texture and Viscosity; Concept and Measurement, Academic Press. Steffe JF, 1992. Rheological Methods in Food Process Engineering, Freeman Press. Aguilera JM, 1999. Microstructure: Principles of Food Processing Engineering, Springer.
- Rahman MS, 2009. Food Properties Handbook, CRC Press.
- Serpil S & Sumnu SG, 2006. Physical Properties of Foods, Springer-Verlag.
- Pomeranz Y, 1991. Functional Properties of Food Components, Academic Press

FPT 505	Cocoa and Chocolate Processing Technologies	3 (2+1)

Theory

Unit I

Introduction: Cocoa, Occurrence, chemistry of the cocoa bean, analysis of cocoa beans, processing of raw bean, changes taking place during fermentation of cocoa bean Cocoa processing: processing of cocoa bean- Cleaning, roasting, alkalization, cracking and fanning; Nib grinding for cocoa liquor, cocoa butter and cocoa powder; processing of roast bean; chemical changes during various stages of processing

Unit II

Chocolates: Types, ingredients, chemistry of chocolate manufacture, Mixing, Refining, Conching, Tempering, moulding etc. to obtain chocolate slabs, chocolate bars. Dark, milk and white chocolate and their manufacturing processes

Unit III

Enrobed and other confectionary products: Compound Coatings & Candy Bars, Temperingtechnology, Chocolate hollow figures, Chocolate shells, Enrobing technology, Manufactureof candy bars, Presentation and application of vegetable fats. Production of chocolate mass

Unit IV

Packaging, quality and storage of chocolates.

V. Practical

- Anatomical structure of cocoa beans
- Effect of fermentation on cocoa beans
- Roasting of cocoa beans
- Effect of roasting on cocoa beans
- Effect of packaging on quality of cocoa beans
- Production of cocoa liquor
- Production of cocoa butter
- Effect of crunching on chocolate
- Effect of tempering on chocolate
- Fat expulsion during chocolate storage
- Production of milk chocolate
- Production of dark chocolate
- Effect of packaging on quality of chocolate
- Effect of storage temperature on chocolate quality

VI. Suggested Reading

- Minifie, BW, 1999. *Chocolate, Cocoa and Confectionery Technology*. SpringerScience & Business Media.

FPT 506	Cocoa and Chocolate Processing Technologies	2 (2+0)

Theory

Unit I

Introduction: Status and scope of spice processing industries in India; Spices, Herbs and seasonings: sources, production, selection criteria, classification on the basis of origin, physical characteristic. Major spices: Post-Harvest Technology composition, processed products of following spices (1) Ginger (2) Chilli (3) Turmeric (4) Onion and garlic (5) Pepper (6) Cardamom.

Unit II

Minor spices, herbs and leafy vegetables: All spice, Annie seed, sweet Basil, Caraway seed, Cassia, Cinnamon, Clove, Coriander, cumin, Dill seed, nutmeg, mint, Rose merry, saffron,sage Processing technology of Spices: Chemical composition, processing methods, equipment's used; recent developments in processing.

Unit III

Processing effect on spice quality: Effect of processing on spice quality, contamination of spices with microorganisms and insects.

Unit IV

Spice Essential Oils: methods of extraction, isolation, and encapsulation, Spice Oleoresins: method of extraction, isolation, separation equipment Spices quality evaluation: Criteria for assessment of spice quality.

V. Suggested Reading

• Reineccius G. 2005. *Flavour Chemistry and Technology*. CRC Press.

• Heath HB, 1986. *Flavour chemistry and Technology*. AVI Publ.

• Piggott JR, Paterson A. 1994. *Understanding Natural Flavours*. Springer US

FPT 507	Meat, Poultry, Fish and Egg Processing	3 (2+1)

Theory

Unit I

Meat Industry: Meat and meat products in India-an Industrial profile. Meat production and trade practices. Prospects and problems in production of fresh meat in India, Research and Development activities on meat, fish and poultry products. Gross and microstructure of muscle. Mechanism of muscle contraction and relaxation: Organization of skeletal muscle from gross structure to molecular level. Muscle Communication (sarcolemma, sarcoplasmic reticulum, Innervation). Muscle metabolism. Different types of connective tissues and their relevance to properties of meat. Myofilament proteins and their major functions. Nervous tissue, nerves and the nature of stimuli, membrane potential in nerve and muscle, Events that occur during relaxation and contraction.

Unit II

Cattle and beef, sheep and mutton, pig and pork and their fabrication: Breeds, Preslaughter care, ante and post-mortem, slaughter, handling of offal (edible and inedible). Cuts of beef, pork and mutton. Meat inspection and grading: Application and Enforcement of inspection laws, elements of inspection (sanitation, antemortem inspection, post-mortem inspection, condemnation, product inspection, laboratory inspection, labelling). Identification of inspected products, product inspection, types of grades, factors used to establish quality grades, conformation, fleshing and finish.

Unit III

Properties of fresh meat: Perception of tenderness, Factors effecting tenderness, connective tissue, collagen, sarcomere contractile state, Myofibrillar tenderness, marbling. Methods to improve tenderness (Electrical stimulation, aging, Meat colour, Pigments associated with colour, Chemical state of pigments, methods to improve meat colour. Water holding capacity (Net charge effect and stearic effect) Molecular Techniques in meat products, cultured meat etc. Poultry meat: Kind of poultry, processing of poultry. Special poultry products, Breaded poultry, Smoked turkey, packagedprecooked chicken, Freeze dried poultry meat. Egg and eggprocessing: Egg quality, egg preservation, egg powder production

Unit IV

Meat analogues and restructured meat products: Textured plant proteins, processes for preparation of meat analogues and restructured meat products. Fish processing and fish products: Chemical/Nutritional composition of Fish, Fish in human diet: protein,

carbohydrates, lipids, vitamins etc. Selection of raw material for processing of streaking and filleting of fish; production of fish paste, fish oils, sauce, fish protein concentrates. Irradiation of fish and fisheries products, packaging of fish products, quality control and quality assurance. Allergens, toxins and infectious diseases from meat, poultry and fish products.

- **Practical**
- To study the effect of low and high oxygen atmosphere on meat colour.
- To study the chemistry of myoglobin as it relates to the colour of the molecule.
- To understand and compare the action of two meat tenderizing enzymes by applyingthe technique of electrophoresis.
- To study the structure of the muscle under compound microscope.
- Perform the slaughtering of the poultry birds.
- Identification of different internal organs of poultry birds and their utilization forproduct preparation.
- Dressing of Fish.
- Determination of total volatile acids in fish,
- Determination of buffering capacity of fish muscle.
- Rapid estimation of hypoxanthine concentration in chill stored fish.
- Determination of glycine in fish muscle.
- Determination of protein fractions in fresh fish.
- Cut out test for canned fishery products.
- Determination of glycogen in fish muscle.
- Industrial visit to meat industry.

Suggested Reading

- Henricksons. 1978. *Meat Poultry and Sea Food Technology*/ Prentice Hall
- Robert RJ. 2012. *Fish Technology*/ Wiley-Blackwell
- Mountney GJ. 1988. *Poultry Meat and Egg Production*/ Springer, Netherlands
- Kerry J, Kerry J. 2002. *Meat Processing*/ Woodhead Publishing and David Ledwood
- Levie A. 1979. *Meat Hand Book*, Avi Pub
- Weiss GH. 1971. *Poultry Processing*. Noyes Data Corporation
- Wheaton FW and Lawson TB. 1985. *Processing of Aquatic Food Products* JohnWiley & Sons.
- Mead G. 2004. *Poultry meat processing and quality* Woodhead Publishing

- Sinha R. 2017. *HACCP in Meat, Poultry and Fish Processing*/ Random Publications
- Sahoo J and Chatli MK. 2015. *Textbook on Meat, Poultry and Fish Technology*/ DayaPub. House.
- Badapanda KC. 2012. *Basics of Fisheries Science*/ Narendra Publishing House
- Sahoo J, Sharma DK and Chatli MK. 2016. *Practical Handbook on Meat Science andTechnology*/ Daya Pub. House

FPT 509	Frozen and Concentrated Foods	2 (1+1)

Theory

Unit I

Freezing: Glass transitions in frozen foods and biomaterials, Microbiology of frozen foods, Thermo-physical properties of frozen foods, Freezing loads and Freezing time calculation, Innovations in freezing process, freezing methods and equipment. Facilities for the Cold Chain: Cold store design and maintenance, Transportation and storage of of frozen foods, Retail display equipment and management.

Unit II

Quality and safety of frozen foods: Quality and safety of frozen meat and meat product, poultry and poultry products, eggs and egg products, fish and shellfish, and related products, frozen vegetables and fruits, frozen dairy products, frozen ready meals and confectioners.

Unit III

Packaging of frozen foods: Selection of packaging materials, Plastic and paper packaging of frozen foods, Shelf-life prediction of frozen foods.

Unit IV

Concentrated milk: Production and quality of evaporated and condensed milk. Concentrated juice products: Production and quality of fruits and vegetable juice concentrate, puree and paste, tomato juice concentrates, mango pulp etc.

Practical

- Measure the glass transition temperature of food
- Calculate freezing load of food sample
- Calculate freezing time of a frozen foods
- Effect of cold chain on quality of fruits and vegetables
- Effect of cooling on egg quality
- Effect of chilling on meat quality
- Effect of freezing on meat quality
- Production of concentrated milk and check its quality
- Production of evaporated milk and check its quality
- Effect of clarification n juice quality
- Effect of juice concentration on juice concentrate
- Effect of cold and hot break on tomato pulp quality
- Production tomato puree and paste and check its quality

VI. Suggested Reading

- Erickson MC & Hung YC, 1997. *Quality in Frozen Foods*, Springer.
- Hui YH, Legarretta IG, Lim, MH, Murrell KD & Nip WK, 2004. *Handbook of FrozenFoods*, CRC Press.
- Kennedy C J, 2000. Managing Frozen Foods, Elsevier.

FPT 510	Aseptic Processing and Packaging	3(2+1)

Theory

Unit I

Introduction: present and future of aseptic processing, Advantages and disadvantages, processing of semi-solid and fluid and particulate foods. Aseptic processing operations: pre-sterilization, loss of sterility, water-to-product and product-to-water separation, cleaning, control, CIP.

Unit II

Quality Assurance: Effect of aseptic processing on nutrients, microorganisms, in process and post-process assurance, HACCP, regulatory aspects of processing and packaging, Shelf-life modules.

Unit III

Sanitary design and Equipments requirements: Pumps, Heat exchangers, homogenizers,aseptic process and packaging system for retail and institutional packages.

Unit IV

Packaging of aseptic processed foods: Packaging materials characteristics, aseptic filling, sterilization of packaging materials, package design, aseptic packaging system, type of pack and equipments: Fill and seal, Form, fill and seal, Erect, fill and seal, Thermoform, fill, sealed, Blow mold, fill, seal; geometry, materials and size of retail and bulk package, seal and closures.

Practical

- Effect of aseptic processing on microbial quality of juice-based beverage
- Effect of aseptic processing on vitamins in selected foods.
- Effect of aseptic processing on minerals in selected foods.
- Effect of aseptic processing on colour pigments in selected foods.
- Effect of aseptic processing on browning of milk
- Effect of aseptic processing on viscosity of milk
- Effect of aseptic processing on proteins in selected foods
- Effect of different chemical sterilant on microbial quality of packaging material
- To estimate chemical sterilant residue on packaging materials
- Estimation of package integrity and leakage
- Shelf-life models and prediction.

Suggested Reading

- Robertson GL, 2012. *Food Packaging: Principles and Practices*, CRC Press.
- David JRD, Graves RH and Szemplenski T, 2016. *Handbook of Aseptic Processingand ackaging*, CRC Press.
- Reuter H, 1993. *Aseptic Processing of Foods*, CRC Press.
- Willhoft EM, 1993. *Aseptic Processing and Packaging of Particulate Foods*,Springer.

FPT 512	Technologies of Convenience Foods	3 (2+1)

Theory

Unit I

Overview of grain-based snacks: whole grains – roasted, toasted, puffed, popped and flakes Coated grains- salted, spiced and sweetened Flour based snack– batter and dough-based products; *savoury* and *farsans*;formulated chips and wafers, papads.Fruit and vegetable-based snacks: chips, wafers, papads etc. Coated nuts – salted, spiced and sweetened products-*chikkis, fried groundnut pakora,*

Unit II

Technology of ready- to- eat baked food products, drying, toasting, roasting and flaking, coating, chipping Extruded snack foods: Formulation and processing technology, flavouringand packaging

Unit III

Ready-to-cook food products- different puddings and curried, Vegetables, meat and meat food products etc. Technology of instant cooked rice, carrot and other cereals-based food products Technology of ready to eat instant premixes based on cereals, pulses etc. Technology for RTE puffed snack- sand puffing, hot air puffing, explosion puffing, gunpuffing etc.

Unit IV

Equipment for frying, baking and drying, toasting, roasting and flaking, popping, blending,coating, chipping.

Practical

- Preparation of cereals based fried snack foods
- Preparation of legume based fried snack foods
- Preparation of cereal, pulses based ready-to-eat snack food by extrusion cooking andtheir quality evaluation
- Preparation of cereal grain based puffed products
- To study the effect of frying time and temperature on potato chips
- Development of instant food premixes
- Preparation of cereal and legume based roasted snack
- Preparation of flaked rice product
- To study the effect of roasting time and temperature on quality of pop-corn
- Determination of shelf-life and packaging requirements of snack food products
- Preparation of cereal and legume based roasted snack foods by vacuum frying

- Visit to industries manufacturing snack foods.

Suggested Reading

- Edmund WL 2001. *Snack Foods Processing*. CRC Press
- Frame ND 1994. *Technology of Extrusion Cooking*, Blackie Academic.
- Gordon BR 1997. *Snack Food* AVI Publ.
- Samuel AM. 1976. *Snack Food Technology*. AVI Publ.
- Manley D. 2000. *Technology of Biscuits, Crackersand Cookies* CRC Press
- Deny AV and Dobraszczyk BJ. 2001. *Cereals and Cereal Products,* Aspen Publishers
- Ram S and Mishra B. 2010. Cereals: Processing and Nutritional Quality, New IndiaPublishers

FPT 513	Food Powders and Premixes	3 (2+1)

Theory

Unit I

Food powder properties: Particle size, shape, particle size distribution, density, Crystalline and amorphous microstructure of powders, cohesive forces in powders, adhesive forces and surface energies, stickiness of powders, surface structure of powders, fluidity of powders, compressibility of powders, mixing property of powders, segregation of powder particles, flow and packing properties Handling of food powders: Basic flow patterns in storage vessels, storage vessel design, mass-flow operation, the Jenike silo design method, the flow-no flow criterion, Powder conveying: Belt, screw, chain, pneumatic

Unit II

Size reduction and enlargement: Principles, equipment, criteria for selecting comminution process, aggregation and agglomeration, instantization Encapsulation: Priniples, methods ofencapsulation, viz. spray drying, coacervation, extrusion, co-crystallization

Unit III

Powder Production: Spray, drum and freeze-drying process and equipments Undesirable properties: Attrition, segregation, caking, dust explosion hazards, laboratory testing to assess explosion characteristics of dust clouds, safety from dust cloud explosion hazards Food powder rehydration: Principles of powder rehydration- wettability and sink ability, dispersibility, solubility, improvement of rehydration properties Surface composition of food powders: Microscopy and spectroscopy techniques for analysing the surface of food powder, factors affecting food powder surface composition, impact of powder surface composition onpowder functionality.

Unit IV

Packaging and Storage: Packaging requirements, design of package, effect of environmental factors on quality of food powders, shelf life test and prediction Food Premix: Formulation, processing and packaging of Vitamin premix, mineral premix, fibres premix for food supplements

Practical

- Estimation of bulk properties: bulk density, true density, porosity
- Estimation of reconstitution powder properties: wettability, dispersibility, solubility
- Effect of moisture on lump formation and caking
- Estimate flowability of food powders
- Estimate hygroscopicity of powder
- Estimate glass transition and sticky point temperature of food powder
- Effect of bulk properties on packaging
- Measurement of particle size using particle size analyser
- Measurement of surface properties of food powder using SEM
- Packaging of food powders
- Effect of storage on quality of food powders
- Production of various vitamin premix and its application
- Production of various mineral premix and its application

Suggested Reading

- Hong Yan. 2005. *Food Powders: Physical Properties, Processing, and Functionality*/Springer US.
- Bhandari BS, Bansal N, Zang M, Schuck P. 2013. *Handbook of Food Powders-Process and Properties*/ Woodhead Publishing
- Yasuo Arai. 1996. *Chemistry of Powder Production* Springer Netherlands
- Masuda H, Higashitani K and Yoshida H. 2006. *Powder Technology: Fundamentalsof Particles, Powder beds, and Particle Generation*/ CRC press

FPT 515	Flavour Chemistry and Technology	3 (2+1)

Theory

Unit I

Introduction: classification of food flavour, chemical compounds responsible forflavours, difficulties of flavour chemistry research. Anatomy of chemical senses. Chemical compounds classes and their flavour response. Flavour intensifiers: Flavour intensifiers and their effects, Chemistry and technology of various flavour intensifiers. Flavour Extraction: Methods of flavour extraction, isolation, separation and equipments.

Unit II

Flavour development during biogenesis: Flavour Compounds from Carbohydrates and Proteins, Lipid oxidation. Flavour formulation: Creating and formulating flavour, Synthetic flavours, Blended flavouring, flavour, creation for new products, Delivery of flavours from food matrices. Flavouring compounds during food processing: Volatile and non-volatile flavouring compounds, non-enzymatic browning reactions.

Unit III

Flavour analysis: Sensory evaluation, discrimination analysis, descriptive analysis, Instrumental analysis (Absorption Spectroscopy (W/VIS), chromatography, mass spectrometry) Food Flavours in different food products: Principal components and properties, baked products, cheese, milk, meat, fish, wine, coffee, tea, chocolate, fruit and vegetable products and fermented foods

Unit IV

Flavour encapsulation and stabilization: Principles and techniques of flavour encapsulation, types of encapsulation, factors affecting stabilization of encapsulated flavour and their applications in food industry, Packaging and flavour compounds interaction, packaging andstorage

Practical

- Qualitative identification of different flavouring compounds
- Extraction of essential oil/ flavouring compound of basil leave by hydro distillation
- Extraction of essential oil/ flavouring compound of basil leave by SCFE
- Comparison of the quality of flavouring component obtained by hydro distillation andSCFE
- Extraction of essential oil/ flavouring compound of ginger by SCFE
- Effect of storage conditions on flavouring compound of ginger

- Preparation of flavour emulsions and their stability
- To study effects of staling on food flavours and its adverse effects
- Separation, purification and identification of some flavouring compounds by GC/ MS.
- Sensory evaluation of different flavours
- To check effect of cooking on flavour of food sample
- To check effect of fermentation on food flavour
- To study sugar caramelization reaction for flavour development
- Development of blended food flavour-based products
- To study effects of storage conditions on food flavour
- Encapsulation of flavouring compounds
- To study effects of overdoses of flavours
- To study flavour development on roasting/ baking

Suggested Reading

- Reineccius G. 2005. *Flavour Chemistry and Technology*/ CRC Press
- Heath HB. 1986. *Flavour Chemistry and Technology*/ AVI Publ.
- Piggott JR, Paterson A. 1994/ *Understanding Natural Flavours*. Springer US
- Morton ID, Macleod AJ. 1990. *Food Flavour* Elsevier Science
- Ashurst PR. 1994. *Food Flavourings* Blackie
- Taylor AJ and Linforth RST. 2010. *Food Flavour Technology*/ Blackwell PublishingLtd
- Hui YH. 2010. *Handbook of Fruit and Vegetable Flavours* Wiley & Sons, Inc
- Bruckner B and Wyllie SG. 2008. *Fruit and vegetable flavour: Recent advances andfuture prospectus* CRC Press.
- Ferreira V and Lopez R. 2013. *Flavour Science* Academic Press

FPT 516	Bioprocessing and Separation Technology	3(2+1)

Theory

Unit I

Introduction to various separation processes, Gas-Liquid, Gas–Solid, Liquid-Liquid, Liquid- Solid separation; Concept of phase equilibrium, Stage equilibrium, Stage efficiency, Equilibrium concentration; Single stage contact equilibrium, counter current multiple contact stages, Concept of equilibrium line and operating line, Determination of optimum number of contact stages by analytical and graphical method; Rate of extraction, Rate of gas absorption, Individual and over all mass transfer coefficient; Calculation of tower height for gas absorption for both dilute and concentrated solution. Construction and working mechanism of different extraction equipments like single stage extraction, Multiple stage static bed system, Bollmann extractor,Hildebrandt extractor, Rotocell extractor.

Unit II

Various separation processes Solid Separation Process, Introduction, Concept of size, Shape, Cut-size, Sieving, Magnetic separation, Eddy-current separation, Wet separation, Ballistic separation, Colour separation, Wet Separation Process, liquid solid and liquid- liquid separation by hydro cyclones, Surface velocity classifier, Elutriators, Impingement separator, Electrostatic precipitation, Distillation: Introduction, boiling point diagram, differential or simple distillation, Flash or equilibrium distillation, Continuous rectification with and without reflux, Reflux ratio, Optimum reflux ratio, Batch distillation, Application of distillation in food processing.

Unit III

Membrane Separation Technology: Introduction to micro-filtration, Ultrafiltration, Reverse osmosis, Electro dialyses, dialyses, physical characteristics of membrane separation, Factors affecting reverse osmosis process, Concentration polarization, Design of reverse osmosis and ultra-filtration systems, Operation layout of the modules, Electrodialysis, per vaporization, Fabrication of membranes, Application of membrane technology in food industry.

Unit IV

Powder Technology: Classification of powder, Separation of powder, Sieving, Air classification, Factors affecting air classification, Cyclone application, Air separation, Particle size distribution, Supercritical Fluid Extraction: Introduction, Properties of SCF, Food application, Application of SCFE in analytical technique, Pharmaceutical application.

Practical

- Determination of contact equilibrium in counter current and multiple contact model systems.
- Determination of rate of extraction in gas-liquid, gas-solid, liquid-liquid andliquidsolid systems.
- Study of working mechanisms of different extraction equipments.
- Evaluation of physical separation techniques based on size, shape and densities, magnetic, eddy current, ballistic and colour separation,
- Use of air classification, hydyocyclones, electrostatic and distillation techniques for fractionation and separation, application studies on Microfiltration,
- Ultrafiltration, reverse osmosis and dialysis.

Suggested Reading

- Saravacos GD and Maroulis ZB. 2011. *Food Process Engineering Operations* CRC Press
- Smith PG. 2011. *Introduction to Food Process Engineering* Springer

FPT 518	Food Process Automation and Modelling	2(2+0)

Theory

Unit I

Principles of modelling: Linear programming-concepts, graphical and algebraic solution; Simplex method; Duality theory; post-optimality analysis; Sensitivity analysis; Transportation and assignment models; Computer applications to LP, queuing theory; Project scheduling and management by PERT-CPM; Integer programming; Non-linear programming; Simulation; Goal programming; Decision theory; Markov chains; Sequencing problem. Food process modelling: The principles of modelling, kinetic modelling, the modelling of heat and mass transfer; introduction diffusion equation, the Navier-stokesequations, heat and mass transfer in porous media Luikov's equation. Modelling thermal processes: cooling and freezing, modelling product heat load during cooling & freezing. Modelling foods with complex shapes, numerical solution of the heat conduction equation with phase change. Modelling thermal processes: heating, introduction, processing of packed and solid foods, continuous heating and cooling processes, Modelling food quality and microbiological safety. Case Studies in Modelling, Control in Food Processes.

Unit II

Food process equipment design: Design considerations of agricultural and food processing equipment. Design of food processing equipment, Dryers, design of dryers. Determination of heat and air requirement for drying grains. Types of heat exchanger. Design of heat exchangers and evaporators. Design of material handling equipment like belt conveyor, screw conveyor, bucket elevator and pneumatic conveyors. Digital image processing: digital representation of image, morphological image processing – dialation, erosion, opening and closing, line and edge detection, thresholding, segmentation, techniques for finding length, breadth, perimeter, surface area, eccentricity and surface roughness of solids. Machine Vision-Based Measurement Systems for Fruit and Vegetable Quality Control in Postharvest. Genetic algorithm optimization: traditional optimization techniques and their limitations, non-traditional method, fitness function in biological evolution, computational procedure for optimization of independent parameters using Genetic algorithm. Artificial neural network modelling: Developing predictive model between independent and dependent parameters by using Artificial neural network –Neural network architecture, weights and bias values of neurons, least square method for NN parameters optimization, matrix representation and computation of the values of NN parameters.

Unit III

Automation in different unit operations of food processing: Raw food material sorting, grading, size reduction, mixing and agitation, thermal processing, dehydration, packaging, CIP, quality control. Bottle Washing Machine Automation, Bottling Plant Drive System, Demineralization Plant Control System, Labelling Machine Control system, Charger level automation, Reverse Osmosis plant automation, Thermal plant automation, Dehydration and freezing plant automation.

Suggested Reading

- Najim K. 1989. Process Modeling and Control in Chemical Engineering - CRC Press
- Das H. 2005. Food Processing Operations Analysis. Asian Books Private Limited
- Ahmed J and Rahman S. 2012. Handbook of Food Process Design.Wiley-Blackwell
- Tijskens LMM, Hertog MLATM and Nicolai BM. 2001. Food Process Modelling.Woodhead Publishing
- Bernd H. 2017. Measurement, Modeling and Automation in Advanced FoodProcessing. Springer International Publishing
- Moreira RG. 2001. Automatic Control for Food Processing Systems Aspen publishers

FPT 519	Zero Waste Processing	2(2+0)

Theory

Unit I

Introduction: Food processing waste and by-product, ISO 14000 for environmental management system, biochemical and nutritional aspects of food processing byproducts. Waste minimization: Chain management issues and good housekeeping Procedures, minimise energy use in food Processing, minimise water use in food processing.

Unit II

Food waste separation: microbiological risk management, Effects of postharvest changes in quality on the stability of plant co-products, Separation technologies for food wastewater treatment and product recovery.

Unit III

Co-product recovery techniques: Enzymatic extraction and fermentation for the recovery of food processing products, Supercritical fluid extraction and other technologies for extraction of high-value food processing co-products, Membrane and filtration technologies, recovery ofnutraceuticals, micronutrients, functional ingredients, Natural dyes.

Unit IV

Waste management and co-product recovery: Meat, cereal, dairy, fish, fruit and vegetable, vegetable oil, plantation crops processing, waste management of food packaging. Food processing wastewater treatment and gas production from solid food processing

Suggested Reading

- Waldron K. 2009. *Handbook of Waste Management and Co-product Recovery inFood Processing* Woodhead Publishing
- Arvanitoyannis IS. 2007. *Waste Management for the Food Industries* Academic Press
- Nout MJR and Sarkar PK. 2013. *Valorisation of Food Processing By-Products* CRCPress

Note :	Optional Minor Subjects: The said courses are subjected to availability of infrastructure and facilities and to be decided by SAC committee
	Minor courses from discipline of Food Process Engineering or Food Safety and Quality

FPE 502	Engineering Properties of Food Materials	3 (2+1)

Theory

Unit I

Physical characteristics of different food grains, fruits and vegetables; shape and size, volume and density, porosity, surface area, water activity. Thermal properties: Specific heat, thermal conductivity, thermal diffusivity, phase transition, methods of determination, steady state, transient heat flow. Electrical properties; Dielectric loss factor, loss tangent, temperature dependent electrical conductivity and dielectric constant, method of determination, energy absorption from high-frequency electric field.

Unit II

Magnetic properties: paramagnetism, ferromagnetism, diamagnetism, magnetization, applications for magnetic field forces, magnetic resonance; Electromagnetic properties: electric polarization, temperature dependency, frequency dependency, microwave, conversion of microwaves into heat, penetration depth of microwaves, applications; Optical properties: refraction, colorimetry, near infrared, ultraviolet, applications; Acoustical properties: sound, ultrasonic sound and applications; Radioactivity: types of radiation, radioactive decay, measurement of ionizing radiation, natural radioactivity, applications.

Unit III

Contact stresses between bodies, hertz problems, firmness and hardness, mechanical damage, dead load and impact damage, vibration damage, friction, effect of load, sliding velocity and surface roughness. Friction in agricultural materials, rolling resistance, angle of internal friction, angle of repose, flow of bulk granular materials, aero dynamics of agricultural products, drag coefficients, terminal velocity.

Unit IV

Rheological properties and classification of fluid foods: measurement methods and techniques; Mechanisms and relevant models; Effect of temperature; Compositional factors affecting flow behavior; Viscosity of food dispersions – dilute and semidilute systems, concentration effects.

Unit V

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 VI

Large deformations and failure in foods: fracture, rupture and other related phenomena; Relationship between instrumental and sensory data; Texture Profile Analysis; Instrumental measurements – Empirical and Fundamental methods; Rheometers and Texture Analyzers; Measurement of Extensional viscosity; Acoustic measurements on crunchy foods.

Unit VII

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, structureproperty relations angels.

Unit VIII

Examining food microstructures: light microscopy transmission electron microscopy, scanning electron microscopy, other instrumentation and techniques, image analysis: image acquisition, image processing and analysis.

Practical

- Viscosity measurements of fruit juices and semisolid food products
- Comparative analysis of Newtonian and non-Newtonian fluids
- Development of stress and strain curve and to study viscosity of Newtonian and non-newtonian fluids
- Temperature dependent and shear dependent rheology
- Pasting analysis of food; Determination of thermal conductivity, specific heat andglass transition temperature using differential scanning colorimetry (DSC)
- Texture analysis of fruits and vegetable-based products
- Texture analysis of baked foods products (bread/ biscuit)
- Starch characterization using starch master; Dough rheology using doughlab or farinograph
- Determination of microstructures in selected foods using light microscopy

- TEM and SEM, image analysis and image processing techniques; Evaluation of phasetransition in colloidal systems, evaluation of structure texture function relations
- Case studies on food properties and applications.

Suggested Reading

- Rao MA, Rizvi SS, Datta AK and Ahmed J. 2014. *Engineering Properties of Foods*.CRC
- Figura OL. and Teixeira AA. 2007. *Food Physics: Physical Properties - Measurementand Applications*. Springer Science & Business Media.
- Sahin S and Sumnu SG. 2006. *Physical Properties of Foods*. Springer Science andBusiness Media.
- Mohsenin NN. 1980. *Thermal properties of foods and agricultural materials*. NewYork. USA.
- Mohsenin NN. 1986. *Physical properties of plant and animal materials*. Gordon andBreach Science Publishers.
- Peleg M and Bagley EB. 1983. *Physical Properties of Foods*. In *IFT basic symposiumseries* (*USA*). AVI Pub. Co.
- Ronal J, Felix E, Bengt H, Hans F, Meffert Th., Walter EC and Gilbert V. 1983.
  Physical Properties of Foods. Applied Science Publishers.
- Bourne M. 2002. *Food texture and viscosity: concept and measurement*. Elsevier.
- Norton IT, Spyropoulos F and Cox P. 2010. *Practical food rheology: an interpretiveapproach*. John Wiley & Sons.

FPE 504	Bioprocessing and Down Stream Engineering	3 (2+1)

Theory

Unit I

Introduction: Interaction of biochemical engineering, biochemistry and microbiology, Reaction kinetics, kinetics of batch and continuous cultures, process variables, biocatalyst and enzyme kinetics, scope and present status in India in relation to food industry.

Unit II

Fermenter and bioreactors: Transport phenomenon in microbial systems, types of reactor, working principles, aeration and agitation, sterilization and sanitation, advances in continuousfermentation, developments in solid-state fermentation for food applications.

Unit III

Alcoholic beverages: Production of alcoholic beverages: raw materials, culture fermentation technology of non-distilled beverages (beer and wine) and distilled alcoholic beverages(brandy, whiskey, vodka, rum, gin).

Unit IV

Single Cell Proteins: Single cell proteins production, substrates, factors effecting SCP production, composition, uses, economic parameters and constrains including safety aspects.

Unit V

Organic acids/acidulants: Raw materials, Starters and fermentation conditions, recovery and applications, Case studies production of acetic acid (vinegar), citric acid, lactic acid and gluconic acid.

Unit VI

Biocatalysts in food processing: Sources of enzymes, advantages of microbial enzymes, mechanism of enzyme function, Production and purification of enzymes, immobilization and applications of biocatalysts in food processing, enzyme biosensors.

Unit VII

Down-stream processing: Handling of materials in microbial systems, filtration, centrifugation, sedimentation, chromatography, membrane separation (UF and NF) and electrophoresis, separation and disintegration of cells for product recovery operations. Biological waste treatment and in-plant sanitation.

Unit VIII

Modeling, simulation and scale-up: Bioprocess modeling and simulation and its application in industrial fermentation, scale-up of fermentation processes, design and analysis of biological fermenter and bioreactors.

Practical

- Studying biochemical changes during handling of important food items
- Study of fermenter and fermentation process
- Study of bioprocess instrumentation and control system
- Study of bacterial growth in batch culture
- Production and maintenance of starter culture
- Production of enzyme, extraction and purification
- Production of SCP; Production of microbial pigments
- Production of amino acids
- Production of alcohol and alcoholic beverages
- Visit to brewery
- Visit to effluent treatment plant
- Bioprocess modeling and simulation
- Case Studies & Reports.

Suggested Reading

- Schügerl K and Zeng AP. 2010. *Advances in Biochemical Engineering Biotechnology: Tools and Applications of Biochemical Engineering Science*. Springer
- Scheper Th.(Ed). *Advances in Biochemical Engineering and Biotechnology* Series. Springer
- Ghose TK and Fiechter A. 1971. *Advances in Biochemical Engineering-I. Indian Journal of Physics*, 47, 189-192.
- James EB and David FO. 1986. *Biochemical Engineering Fundamentals*. McGraw- Hill Book Co. Inc., New York
- Scheper T, Bajpai P, Bajpai PK, Dochain D, Dutta NN, Ghosh AC, Mathur RK, Mukhopadhyay A, Perrier M, Rogers PL, Shin HS, Wang B. 1996. *Biotreatment, downstream processing and modelling*. Springer

- Doran PM. 1995. *Bioprocess engineering principles*. Elsevier
- Perry JH. 2007. *Chemical engineers' handbook*, 8e. McGraw-Hill Professional
- Stumbo CR. 2013. *Thermobacteriology in food processing*. Elsevier
- Stanbury PF, Whitaker A and Hall SJ. 2013. *Principles of fermentation technology*.Elsevier
- Hitzmann B 2017. *Measurement, modeling and automation in advanced foodprocessing*. Springer

FPE 506	Numerical Techniques and Simulation	2 (1+1)

Theory

Unit I

Modelling and Simulation: Fundamentals of modeling and simulation; Different steps for modeling and simulation, Types of models; Advantages of modeling and simulation, Application areas of simulation.

Unit II

Solution of partial differential equations models: Differential laplace, Poisson, parabolic and hyperbolic equations, Bender – Schmidt method, finite difference method, finite volume method.

Unit III

Optimization: Optimization theory and methods, Graphical and numerical methods of optimization; experimental optimization; linear and nonlinear un-constrain and constrain optimization, multivariate optimization, genetic algorithm, goal driven optimization.

Unit VI

Modelling and simulation applications of some food engineering operations: Thermal processing, convection & osmotic dehydration, spray & freeze drying, deep fat frying; extrusion process; filtration processes; distillation and Extraction processes.

Unit V

Computational fluid dynamics (CFD) applications in food processing.

V. Practical

- Introduction to various features in different spreadsheet softwares
- Solving problems using functions and/or add-Ins and/or Analysis Tool pack in spreadsheets
- Use of software packages for summarization and tabulation of data, obtaining descriptive statistics, graphical representation of data
- Testing linearity and normality assumption, Testing the goodness of fit of different models
- Testing the hypothesis for one sample t-test, two sample t-test, paired t-test, test for large samples - Chi-squares test, F test, Analysis of variance
- Practice on modelling and simulation softwares i.e. MATLAB, FLUENT, GAMBIT, EDEM, Solid works, ANSYS

- Practice on process optimization softwares i.e. SAS, SPSS, Origin Pro, Design Expert(DX), Minitab, Matlab
- Practice on design optimization softwares i.e. Solid works, ANSYS.

Suggested Reading

- Das H. 2005. Food *Processing Operations Analysis.* Asian Books Private Limited
- Denn MM. 1986. *Process Modeling*. Longman
- Holland CD. 1975. *Fundamentals and Modeling of Separation Processes*. PrenticeHall.
- Luyben WL. 1990. *Process Modeling Simulation and Control for Chemical Engineers* 2ed. McGraw Hill.
- Najim K. 1990. *Process Modeling and Control in Chemical Engineering*. CRC
- Aris R. 1999. *Mathematical Modeling, Vol. 1: A Chemical Engineering Perspective* (*Process System Engineering*). Academic Press.
- Kreyszig E. 2005. *Advanced Engineering Mathematics*. John Wiley & Sonspublication Granato D and Ares G. 2014. *Mathematical and statistical methods in food scienceand technology*. IFT Press, Wiley Blackwell
- Standard software for modelling, analysis and simulations

FSQ 506	Process and Products Monitoring for Quality Assurance	2 (**2+0**)

Theory

Unit I

Variability of the Production Process - Control chart of the middle values and ranges, Medians and ranges, Middle values and standard deviations, Largest and smallest selected value and other individual values.

Unit II

Automation of the Control of Production Processes, Fluorescence cytometry for the rapid analysis of food microorganisms, Infrared spectroscopic methods.

Unit III

Machine vision for the food industry, Ultrasonic methods, Sampling procedures for online quality.

Unit IV

Evaluation the Capability of Production Process and Machine, Chemical sensors RFID, Analysis of the Current State of the Regulation of Manufacturing Processes

Suggested Reading

Rodríguez MEP. 2018. *Process Monitoring and Improvement Handbook,* Second Edition2018 by ISBN: 978-0-87389-974-1 *Food Process Monitoring Systems* 1993, Springer

FSQ 508	Management of Food By-products and Waste	3 (**2+1**)

Theory

Unit I

Management of Food Waste, Principles of sustainable systems and Green chemistry, Waste management purpose and strategies, Waste & its consequences in pollution and global warming, Food waste classification, Mitigation measures for food processing wastes, Food waste Handling and Management laws – National and international.

Unit II

Approaches to Solid Waste Management - Bio gas and electricity generation, Bioactive compounds extraction, Sourcing natural colour, Valorization, Biofueling, Biofertilizers, Bio-ethanol, Activated carbon, Biochar, other biological approaches, Use for biodegradableplastic, biofertilizers and environmental bioremediation.

Unit III

Approaches to Effluent Waste Management Basic unit operations in wastewater treatment, Anaerobic digestion of organic residues and wastes, Fundamentals and applications of anaerobic digestion for sustainable treatment of food industry wastewater, Effluent treatment strategies for dairy/ brewery/ winery, Common biological treatment processes and on-site treatment systems.

Unit IV

Case studies, commercially viable practices and success stories of value-added products of waste and by-products from processing of different plant and animal food products, Food waste for pulp & paper, flavorings and aromas production

Practical

- Study of waste utilisation processes by site visit/ site plan studies
- Characterization of effluent for Dissolved solids (TDS), Suspended solids, BoD, CoD,
- Nitrogen (as N), Phosphorus (as P), Alkalinity (as CaCO3), Sulphate (as SO4), Totalorganic carbon (TOC)
- Characterization of food waste as feedstock for anaerobic digestion
- Various treatments in use for waste disposal: study on operational precautions;
- Extraction of banana fibre,
- Utilisation of ghee residue in caramel toffee;
- Extraction of volatile oils from organic waste;

- Use of fruit/vegetable residue for the production of cellulose;
- Use of mango kernels for manufacturing of starch;
- Production of pectin/citric acid from organic waste

Suggested Reading

- Wastewater treatment and use in agriculture - FAO irrigation and drainage paper 47,http://www.fao.org/docrep/t0551e/t0551e00.htm#Contents
- Waste Biomass Valor (2017) 8:2209–2227 DOI: 10.1007/s12649-016-9720-0

Note :	Optional Supporting Subjects: The said courses are subjected to availability of infrastructure and facilities and to be decided by SAC committee Supporting courses from discipline of Basic sciences, Food business management Food Process Engineering and Food Safety and Quality

FBM 502	**Food Business Management**	2 (**2+0)**

Theory
UNIT I

Business management; introduction, theories and functions, food industry management; marketing management and human resource development, personal management. Sectors in food industry and scale of operations in India. Human resource management, study the basics about HR and related policies and capacity mapping approach for better management. Consumer Behavior towards food consumption, consumer surveys by various institutes and agencies, Various journals on consumer behaviour and market research, Internet based data search.

UNIT II

Materials management – types of inventories, inventory costs, managing the inventories, economic order quantity (EOQ). Personnel management – recruitment, selection and training, job specialization. Marketing management – definitions, planning the marketing programmes, marketing mix and four P' s. Financial management – financial statements and rations, capital budgeting. Project management – project preparation evaluation measures.

UNIT III

International trade; basics, classical theory, theory of absolute advantage. theory of comparative, modern theory, free trade- protection, methods of protection, quotas, bounties, exchange control, devaluation, commercial treaties, terms of trade, balance of payments, EXIM policy, foreign exchange, mechanics of foreign exchange, GATT, WTO, role of WTO, International Trade in agriculture. World trade agreements related with food business, export trends and prospectsof food products in India.

UNIT IV

World consumption of food; patterns and types of food consumption across the globe. Ethnic food habits of different regions. Govt. institutions related to international ad trade; APEDA, Tea board, spice board, wine board, MOFPI etc. management of export import organization, registration, documentation, export import logistics, case studies. Export and

import policies relevant to horticultural sector. Project: Consumer Survey on one identified product - both qualitative and quantitative analysis (say, Consumer behavior towards Pickles and Chutneys).

Suggested Reading

1. David D and Erickson S. 1987. Principles of Agri Business Management. Mc Graw HillBook Co., New Delhi.
2. Acharya S S and Agarwal N L. 1987. Agricultural Marketing in India. Oxford & ISH Publishing Co., New Delhi.
3. Cundiff Higler. 1993.Marketing in the International Environment, Prentice Hall of India,New Delhi.
4. Batra G S & Kumar N. 1994. GAD implications of Denkel proposals - Azmol PublicationsPvt., New Delhi.
5. Phill Kottler .1994. Marketing Management - Prentice Hall of India, New Delhi.

FSQ 507	Quality Concepts and Chain Traceability	2 (**2+0**)

Theory

Unit I

Quality – Concepts, Quality as wining strategy, Total quality management TQM: Introduction, definitions and principles of operation, Tools and Techniques, such as, quality circles, 5 S Practice, Total quality control (TQC), Total employee involvement (TEI), Problem solving process, Quality function deployment (QFD), Failure mode and effect analysis (FMEA), Fault Tree Analysis (FTA), Kizen, Poka-Yoke, QC Tools, PDCA Cycle, Quality Improvement Tools, TQM implementation and limitations, JH – Autonomous maintenance

Unit II

Introduction, Content, Methods, Advantages and Limitation of: Just –in –Time and Quality Management KANBAN system, Total productive maintenance (TPM), QS 9000. Basic concept, Principle, methodology of contemporary trends: Lean manufacturing, Agile manufacturing, World class manufacturing, Concurrent engineering, Bench marking, Cost of quality (COQ) system.

Unit III

Reliability engineering fundamentals; Failure data analysis; Failure rate; mortality curve; Concept of burn in period; Useful life and wear out phase of a system; Mean time to failure (MTTF); Mean time between failure, (MTBF) and mean time to repair (MTTR); Reliability in terms of Hazard rate and failure density, Measurement systems analysis for accuracy, Probability for quality.

Unit IV

SQC -Statistical quality control– X/ R/ p and c chart, Shewhart and types of control charts, Process capability analysis, process capability index. Acceptance sampling by variables and attributes, design of sampling plans, single, double, sequential and continuous sampling plans, design of various sampling plans for food industry (Note:SQC tables can be used in theexamination), Capability analysis. Statistical process control.

Unit V

Traceability in food safety management, Applications of traceability, Traceability challenges, Traceability requirements and standards: ISO 22005, Traceability implementation & application: Traceability data & process flow, Traceability process participants, Traceable item, Batch/Lot and Traceability links management, Food authenticity

tools.

Suggested Reading

Montgomery, Jennings andPfund. 2010. *Managing, Controlling and Improving Quality*,Wiley Arora KC. 2016 (4th Edition). *Total Quality Management*, S K Kataria& Sons Pub

FPE 505	Energy Management and Auditing in Food Industry	3 (2+1)

Unit I

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.

Unit II

Energy Auditing Basics: ASHRAE definitions of energy audits, the audit process, pre-site and post-site work, audit report.

Unit III

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.

Unit IV

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.

Unit V

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.

Unit VI

Energy and Water Conservation Technologies Applied to Food Processing Facilities: Conservation in steam generation and consumption system, energy conservation in heat exchangers, conservation in compressed air system, conservation in power and electrical systems, waste-heat recovery and thermal energy storage in foodprocessing facilities, building envelop audit, energy consumption and saving opportunities.

V. Practical

- Study and practice with energy assessment and auditing instrumentsPerformance assessment of motors and variable speed drives Performance assessment of pump, fans and blowers
- Performance assessment of refrigeration systemPerformance assessment of heat exchangers Performance assessment of furnace Performance assessment of boilers
- Conservation possibilities in dairy processing facilities Conservation possibilities in grains and oilseeds milling plants
- Conservation possibilities in sugar and confectionary processing facilities Conservation possibilities in fruit and vegetable processing facilities Conservation possibilities in bakery processing facilities
- Conservation possibilities in meat processing facilitiesCase studies & field reports.

Suggested Reading

- Wang L. 2009. *Energy Efficiency and Management in Food Processing Facilities*. CRC Press Thumann A, Niehus T and Younger WJ. 2013. *Handbook of Energy Audits* 9e. Fairmont Press
- Klemes J, Smith R and Kim JK. 2008. *Handbook of water and energy management in food processing*. Elsevier.
- Christopher CS. 2007. *Electric Water: The Emerging Revolution in Water and Energy*. New Society Publishers
- BEE-NPC Cases studies

FPE 510	Operation Research	3(2+1)

Theory

Unit I

Introduction to operations research: Elementary concepts and objectives of OperationsResearch, Applications of operations research in decision making.

Unit II

Linear programming problem: Mathematical formulation of the linear programming problemand its graphical solution, Simplex method.

Unit III

Transportation problem: Definition and mathematical formulation, Initial basic feasible solution, Optimal solution. Assignment problem: Introduction and mathematical formulation, Solution of assignment problem.

Unit IV

Inventory control: Introduction and general notations, Economic lot size models with known demand. Replacement theory: Introduction and elementary concepts, Replacement of items deteriorating with time.

Unit V

Sequencing problem: Introduction and general notations, Solution of a sequencing problem.

Unit VI

Queuing theory: Introduction and classification of queues, Solution of queuing models.

Unit VII

Project planning and network analysis: Introduction and basic definitions in Network Analysis, Rules for drawing network analysis, Critical path method (CPM), Project evaluation and review technique (PERT).

Practical

- Studies on application of Linear Programming on food product standardization Studies on use of Transportation and Assignment Problems in food plant operationsStudies on Economic Order Quantity and Replacement Model
- Studies on Sequencing of food plant operations; Studies on Queuing ModelNetwork Analysis using CPM and PERT.

Suggested Reading

- Ackoff RK and Sassioni MW. 1978. *Fundamentals of Operations Research*. Wiley Eastern,New Delhi
- Wagner HM. 1978. *Principles of Operations Research, with Applications to ManagementDecisions*. Prentice Hall of India, New Delhi
- Taha HA. 2007. *Operations Research: An Introduction*. Pearson Prentice Hall, New JerseyGoel BS and Mittal SK. 1985. *Operations Research*. Pragati Prakashan, Meerut Panneerselvam R. 2012. *Operations Research*. PHI Learning Pvt. Ltd.
- Prasanna C. 2009. *Projects*. Tata McGraw-Hill Publication, New Delhi.
- Nicolas JM. 2003. *Project Management for Business and Technology – Principles andPractices*. Pearson Prentice Hall
- Kerzner H and Kerzner HR. 2017. *Project Management: a Systems Approach to Planning,Scheduling, and Controlling*. John Wiley & Sons.
- Gopalakrishnan P and Ramamoorthy VE. 2005. *Textbook of Project Management*. Macmillan.

BSH 501	Research Methodology	2 (2+0)

Theory

Unit I

Introduction to Research, Objective and importance of research, Types of research, steps involved in research, Ethical considerations in research, Defining research problem, Researchdesign, Methods of research design, Laboratory safety considerations.

Unit II

Sampling techniques, Classification of Data, Methods of Data Food informatics Collection, designing of experiments, characteristics of a good design: selection of variables, design matrix, factorial design, fractional factorial design, Principal Component Analysis, Taguchi methods.

Unit III

Data Analysis and interpretation Data analysis, Statistical techniques and choosing an appropriate statistical technique, Optimization techniques, Bioassays- direct and indirect.

Unit IV

Hypothesis, Hypothesis testing, sampling and Non-sampling errors, Data processing software, statistical inference, Interpretation of results.

Unit V

Technical Writing and reporting of research, referencing and referencing styles, Research journals, Indexing and citation of journals, acknowledgement, conflict of interest, Intellectual property, plagiarism.

V. Suggested Reading

- Creswell JW. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*.Sage publications, 2013.
- Kumar R. *Research Methodology: A Step by Step Guide for Beginners,* 2nd Edition, SAGE,2005.
- Kothari CR, Garg G. *Research Methodology Methods and Techniques*, New Age International publishers, Fourth Edition.
- Bower JA. 2009. *Statistical Methods for Food Science*, Blackwell PublishingWilson A. *Handbook of Science Communication*, 1998, CRC Press Montgomery DC. 2017. *Design and Analysis of Experiments*, Willey

- Snecdecor GW and Cochran WG. 1991. *Statistical Methods,* 8th Edition, Wiley-BlackwellSaguy PI. *Computer aided techniques in Food Technology*, 1983, Taylor and Francis

BSH 502	Food Informatics	2 (2+0)

Theory

Unit 1

Informatics: Meaning and purpose, Making food-related information available for food researchers, Smart Data searching, Data Retrieval, File search or text search in file on a system, Meta Search Engines. Major centers of food research in India and abroad

Unit 2

Data bases and Management in Food Processing, Data storage and distribution by using various information technology tools and methods, Computer vision for food detection, segmentation and recognition, 3D reconstruction for food portion estimation Augmented reality for food monitoring.

Unit 3

Evaluation protocols of dietary monitoring/management systems, Mobile computing for dietary assessment Smartphone technologies for dietary behavioral patterns, Dietary behavioral pattern modelling using sensors and/or smartphones

Unit 4

Laboratory Information Management System (LIMS) introduction and applications, LIMS in the food safety workflow, Wearable Food Intake Monitoring Technologies, Computerized food composition (nutrients, allergens) analysis

Unit 5

Chemometric techniques - to gain fundamental understanding of complex food systems through the combination of data from independent measurement techniques, Product lifecycletracing and tracking – ICT tools and technique

Suggested Reading

- *Food Informatics: Applications of Chemical Information to Food Chemistry* Martinez-Mayorga,
- Karina-Medina-Franco,
- *Food Informatics: Sharing Food Knowledge for Research and Development* Nicole J.J.P.Koenderink1, J. Lars Hulzebos1, Hajo Rijgersberg1 and Jan L. Top

COMMON COURSES SYLLABUS

PGS 501	LIBRARY AND INFORMATION SERVICES	1 ((0+1)

Objective

To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines, etc.) of information search.

Practical

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/ Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; eresources access methods.

PGS 502	TECHNICAL WRITING AND COMMUNICATIONS SKILLS	1(0+1)

Objective

To equip the students/ scholars with skills to write dissertations, research papers, etc. To equip the students/ scholars with skills to communicate and articulate in English (verbal as well as writing).

Practical (Technical Writing)

- Various forms of scientific writings- theses, technical papers, reviews, manuals, etc.;
- Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion);
- Writing of abstracts, summaries, précis, citations, etc.; 2. Gabb MH and Latchem WE. 1968.
- *A Handbook of Laboratory Solutions*. Chemical Publ. Co.
- Commonly used abbreviations in the theses and research communications;

- Illustrations, photographs and drawings with suitable captions; pagination, numbering oftables and illustrations;
- Writing of numbers and dates in scientific write-ups;Editing and proof-reading;
- Writing of a review article;
- Communication Skills - Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors), Concord, Collocation, Phonetic symbols and transcription;Accentual pattern: Weak forms in connected speech;
- Participation in group discussion;Facing an interview;
- Presentation of scientific papers.

Suggested Readings

- Barnes and Noble. Robert C. (Ed.). 2005. *Spoken English: Flourish Your Language*. *Chicago Manual of Style*. 14th Ed. 1996. Prentice Hall of India.
- *Collins' Cobuild English Dictionary*. 1995.
- Harper Collins. Gordon HM and Walter JA. 1970. *Technical Writing*. 3rd Ed.
- Holt, Rinehart and Winston. Hornby AS. 2000. *Comp. Oxford Advanced Learner'sDictionary of Current English*. 6th Ed. Oxford University Press.
- James HS. 1994. *Handbook for Technical Writing*. NTC Business Books.
- Joseph G. 2000. *MLA Handbook for Writers of Research Papers*. 5th Ed. Affiliated East-West Press.
- Mohan K. 2005. *Speaking English Effectively*. MacMillan India.Richard WS. 1969. *Technical Writing*.
- Sethi J and Dhamija PV. 2004. *Course in Phonetics and Spoken English*. 2nd Ed. PrenticeHall of India.
- Wren PC and Martin H. 2006. *High School English Grammar and Composition*. S. Chand &Co.

PGS 503	INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE	1**(1+0)**

Objective

The main objective of this course is to equip students and stakeholders with knowledge of Intellectual Property Rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Theory

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings

- Erbisch FH and Maredia K.1998. *Intellectual Property Rights in Agricultural Biotechnology*. CABI.
- Ganguli P. 2001. *Intellectual Property Rights: Unleashing Knowledge Economy*.McGraw-Hill.
- *Intellectual Property Rights: Key to New Wealth Generation*. 2001. NRDC and AestheticTechnologies.
- Ministry of Agriculture, Government of India. 2004. *State of Indian Farmer*. Vol. V. Technology Generation and IPR Issues. Academic Foundation.
- Rothschild M and Scott N. (Ed.). 2003. *Intellectual Property Rights in Animal Breeding andGenetics*. CABI.
- Saha R. (Ed.). 2006. *Intellectual Property Rights in NAM and Other Developing Countries: ACompendium on Law and Policies*. Daya Publ. House.
- The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act2001, and Rules 2003; The Biological Diversity Act, 2002.

PGS 504	BASIC CONCEPTS IN LABORATORY TECHNIQUES	1 (0+1)

Objective

To acquaint the students about the basics of commonly used techniques in laboratory.

Practical

- Safety measures while in Lab; Handling of chemical substances;
- Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers,micropipettes and vaccupets;
- Washing, drying and sterilization of glassware;Drying of solvents/ chemicals;
- Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions;
- Preparation of different agro-chemical doses in field and pot applications;Preparation of solutions of acids;
- Neutralisation of acid and bases;
- Preparation of buffers of different strengths and pH values;
- Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer,magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath;
- Electric wiring and earthing;
- Preparation of media and methods of sterilization;Seed viability testing, testing of pollen viability; Tissue culture of crop plants;
- Description of flowering plants in botanical terms in relation to taxonomy.

Suggested Readings

- Furr AK. 2000. *CRC Hand Book of Laboratory Safety*. CRC Press. 2. Gabb MH and LatchemWE. 1968. *A Handbook of Laboratory Solutions*. Chemical Publ. Co.

PGS 505	AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURALDEVELOPMENT PROGRAMMES	1 (1+0)

Objective

To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

Theory

UNIT I

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

UNIT II

Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

UNIT III

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/ Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings

- Bhalla GS and Singh G. 2001. *Indian Agriculture - Four Decades of Development*. SagePubl.
- Punia MS. *Manual on International Research and Research Ethics.* CCS HaryanaAgricultural University, Hisar.
- Rao BSV. 2007. *Rural Development Strategies and Role of Institutions - Issues, Innovationsand Initiatives*. Mittal Publ.
- Singh K. 1998. *Rural Development - Principles, Policies and Management*. Sage Publ.

List of Journals

1) Journal of nutritional science
2) Journal of food and drug analysis
3) Food and Energy Security
4) Asian journal of agriculture and food science
5) Nature Sustainability
6) Comprehensive Reviews in Food Science and Food Safety
7) Trends in Food Science and Technology
8) Annual review of food science and technology
9) Global Food Security
10) Advances in Nutrition
11) Food Hydrocolloids
12) Nature Food
13) Food Policy
14) Critical Reviews in Food Science and Nutrition
15) Food Chemistry
16) NJAS - Wageningen Journal of Life Sciences
17) Food Security
18) Current Opinion in Food Science
19) Current Nutrition Reports
20) Meat Science
21) Food and Waterborne Parasitology
22) Nutrition and Healthy Aging
23) Nutrients
24) Food Research International
25) Food Packaging and Shelf Life
26) Journal of Dairy Science
27) Postharvest Biology and Technology
28) Food Science and Human Wellnes
29) Innovative Food Science and Emerging Technologies
30) Food Quality and Preference
31) Applied and Environmental Microbiology
32) Food Microbiology

33) Journal of Food Engineering

34) Food Control

35) Molecular Nutrition and Food Research

36) LWT - Food Science and Technology

37) Frontiers in Nutrition

38) Journal of Food and Drug Analysis

39) Food Chemistry: X

40) Food and Function

41) International Journal of Food Microbiology