KERALA UNIVERSITY OF FISHERIES & OCEAN STUDIES (KUFOS)

കേരള ഫിഷറീസ്-സമുദ്രപഠന സർവ്വകലാശാല

Syllabus

M. Tech. in Food Technology

(Food Safety and Quality Assurance)

2024-2026

Department of Food Safety and Quality Assurance

Faculty of Fisheries Engineering

KUFOS, PANANGAD P.O., KOCHI 682 506, KERALA, INDIA

0484-2700598; Fax: 0484-2700337; website: www.kufos.ac.in

Residential requirements

• The minimum and maximum duration of residential requirement for Masters' Degree Programme shall be as follows:

Minimum: 4 Semesters (Two Academic Years)

Maximum: 10 Semesters (5 Academic Years)

*Student may be allowed to discontinue temporarily only after completion of course work

In case a student fails to complete the degree programme within the maximum duration of residential requirement, his/ her admission shall stand cancelled.

Evaluation of course work and comprehensive examination

• For M. Tech., multiple levels of evaluation (First Test, Midterm and Final semester) is desirable.

semester final. However, the course teacher may be given freedom to evaluate in terms of assignment/ seminar/ first test.

Course work

Major courses	20
Minor courses	08
Supporting courses	06
Common courses	05
Seminar	01
Thesis Research	30
Total	70

Major courses:

Among the listed courses, the core courses compulsorily to be taken may be given *mark

Minor courses:

From the subjects closely related to a student's major subject

Supporting courses:

The subject not related to the major subject. It could be any subject considered relevant for student's research work (such as Statistical Methods, Design of Experiments, etc.) or necessary for building his/ her overall competence.

Common Courses:

The following courses (one credit each) will be offered to all students undergoing Master's degree programme:

1. Library and Information Services
2. Technical Writing and Communications Skills
3. Intellectual Property and its management in Agriculture
4. Basic Concepts in Laboratory Techniques
5. Agricultural Research, Research Ethics and Rural Development Programmes

The students may be allowed to register these courses/ similar courses on these aspects, if available online on SWAYAM or any other platform. If a student has already completed any of these courses during UG, he/ she may be permitted to register for other related courses with the prior approval of the Head of Department (HoD)/Board of Studies (BoS).

Syllabus of Common Courses for PG programmes

LIBRARY AND INFORMATION SERVICES (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; e-resources access methods.

TECHNICAL WRITING AND COMMUNICATIONS SKILLS (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.;

• Commonly used abbreviations in the theses and research communications;

• Illustrations, photographs and drawings with suitable captions; pagination, numbering of tables 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

1. Barnes and Noble. Robert C. (Ed.). 2005. Spoken English: Flourish Your Language.

2. Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.

3. Collins' Cobuild English Dictionary. 1995.

4. Harper Collins. Gordon HM and Walter JA. 1970. Technical Writing. 3rd Ed.

5. Holt, Rinehart and Winston. Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press.

6. James HS. 1994. Handbook for Technical Writing. NTC Business Books.

7. Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.

8. Mohan K. 2005. Speaking English Effectively. MacMillan India.

9. Richard WS. 1969. Technical Writing.

10. Sethi J and Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India.

11. Wren PC and Martin H. 2006. High School English Grammar and Composition. S. Chand & Co.

INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE (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

1. Erbisch FH and Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.

2. Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.

3. Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC and Aesthetic Technologies.

4. Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.

5. Rothschild M and Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.

6. Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium 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 Act 2001, and Rules 2003; The Biological Diversity Act, 2002.

BASIC CONCEPTS IN LABORATORY TECHNIQUES (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, sand bath, water bath, oil bath;
- 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

1. Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press. Xv Common Academic Regulations for PG and Ph.D. Programmes Restructured and Revised Syllabi of Post-graduate Programmes Vol. 4 xvi

2. Gabb MH and Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.

AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES (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

1. Bhalla GS and Singh G. 2001. Indian Agriculture – Four Decades of Development. Sage Publ.

2. Punia MS. Manual on International Research and Research Ethics. CCS Haryana Agricultural University, Hisar.

3. Rao BSV. 2007. Rural Development Strategies and Role of Institutions – Issues, Innovations and Initiatives. Mittal Publ.

4. Singh K. 1998. Rural Development – Principles, Policies and Management. Sage Publ.

Mandatory requirement of seminars

• 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.

Advisory System

Advisory Committee

• There shall be an Advisory Committee for every student consisting of not fewer than three members in the case of a candidate for Masters' degree. The Advisory Committee should have representatives from the major and minor fields amongst the members of the Post-graduate faculty accredited for appropriate P.G. level research. However, in those departments where qualified staff exists but due to unavoidable reasons Post-graduate degree programmes are not existing, the staff having Post-graduate teaching experience of two years or more may be included in the Advisory

Committee as member representing the minor.

• The Advisor should convene a meeting of the Advisory Committee at least once in a Semester. The summary record should be communicated to the Head of Department, and Dean for information.

Advisor/ Co-guide/ Member, Advisory Committee from other collaborating University/ Institute/ Organization

• In order to promote quality Post-graduate research and training in cutting edge areas, the University may enter into Memorandum of Understanding (MOU) with other Universities/ Institutions for conducting research. While constituting an Advisory Committee of a student, if the Chairperson, Advisory Committee feels the requirement of involving of a faculty member/ scientist of such partnering university/ Institute/ Organization, he/ she may send a proposal to this effect to Director (Education)/ Dean PGS along with the proposal for consideration of Student's Advisory Committee (SAC).

• The proposed faculty member from the partnering institution can be allowed to act as Chairperson/ Co-guide/ Member, SAC, by mutual consent, primarily on the basis of intellectual input and time devoted for carrying out the research work at the particular institution. The faculty member/ scientist of partnering institutions in the SAC shall become a temporary faculty member of the University by following the procedure approved by the Academic Council. Allotment of students to the retiring persons Normally, retiring person may not be allotted M. Sc. Student if he/ she is left with less than 2 years of service. However, in special circumstances, permission may be obtained from the Director (Education)/ Dean PGS, after due recommendation by the concerned Head of the Department.

Changes in the Advisory Committee:

(i) Change of the Chairperson or any member of the Advisory Committee is not ordinarily permissible. However, in exceptional cases, the change may be effected with due approval of the Director of Education/ Dean PGS.

(ii) Normally, staff members of the university on extra ordinary leave or on study leave or who leave the University service will cease to continue to serve as advisors of the Post-graduate students of the University. However, the Director (Education)/ Dean PGS may permit them to continue to serve as advisor subject to the following conditions:

(a) The concerned staff member must be resident in India and if he/ she agrees to guide research and must be available for occasional consultations;

(b) An application is made by the student concerned duly supported by the Advisory Committee;

(c) The Head of the Department and the Dean of the College concerned agree to the proposal;

(d) The staff member, after leaving the University service is granted the status of honorary faculty's membership by the Vice-Chancellor on the recommendation of the Director (Education)/ Dean PGS for guiding as Chairperson or Member, Advisory Committee the thesis/ theses of the student(s) concerned only.

(iii) In case the Chairperson/ member of a Student's Advisory Committee retires, he/ she shall be allowed to continue provided that the student has completed his course work and minimum of 10 research credits and the retiring Chairperson/ member stays at the Headquarters of the College, till the thesis is submitted.

(iv) If the Chairperson/ member proceeds on deputation to another organization, he/ she may be permitted to guide the student provided his/ her new organization is at the Headquarters of the College and his/ her organization is willing for the same.

(v) The change shall be communicated to all concerned by the Head of Department.

Evaluation of research work

Prevention of plagiarism

• An institutional mechanism should be in place to check the plagiarism. The students must be made aware that manipulation of the data/ plagiarism is punishable with serious consequences.

Learning through online courses

• In line with the suggestion in new education policy and the initiatives taken by ICAR and MHRD in the form of e-courses, MOOCs, SWAYAM, etc. and also changes taking place globally in respect of learning through online resources it has been agreed to permit the students to enroll for online courses. It is expected that the provision of integrating available online courses with the traditional system of education would provide the students opportunities to improve their employability by imbibing the additional skills and competitive edge. The Committee recommends the following points while integrating the online courses:

1. Board of Studies (BoS) of each Faculty shall identify available online courses and a student may select from the listed courses. The interested students may provide the details of the on-line courses to the BoS for its consideration.

2. A Postgraduate student may take up to a maximum of 20% credits in a semester through online learning resources.

3. The host institute offering the course does the evaluation and provide marks/ grades. The BoS shall develop the conversion formula for calculation of GPA and it may do appropriate checks on delivery methods and do additional evaluations, if needed.

Internship during Masters programme

Internship for Development of Entrepreneurship in Agriculture (IDEA) Currently, a provision of 30 credits for dissertation work in M.Tech. An optional internship/ in-plant training (called as IDEA) in lieu of thesis/ research work is recommended which will give the students an opportunity to have a real-time hands-on experience in the industry.

The main objectives of the programme:

1. To promote the linkages between academia and industry

2. To establish newer University – Cooperative R&D together with industry for knowledge creation, research and commercialization

3. Collaboration between Universities and industries through pilot projects

4. To develop methods for knowledge transfer, innovation and networking potential

5. To enhance skill, career development and employability Following criteria for IDEA will be taken into consideration:

• At any point of time there will not be more than 50% of students who can opt under IDEA

• Major Advisor will be from Academia and Co-advisor (or Advisory Committee member) from industry

• Total credits (30) will be divided into 20 for internship/ in-plant training and10 for writing the report followed by viva-voce similar to dissertation

• Work place will be industry; however, academic/ research support would be provided by the University or both. MoU may be developed accordingly

• The IPR, if any, would be as per the University policy

Definitions of Academic Terms

Course means a unit of instruction in a discipline carrying a specific number and credits to be covered in a semester as laid down in detail in the syllabus of a degree programme.

Credit means the unit of work load per week for a particular course in theory and/ or practical. One credit of theory means one class of one clock hour duration and one credit practical means one class of minimum two clock hours of laboratory work per week.

Credit load of a student refers to the total number of credits of all the courses he/ she registers during a particular semester.

Grade Point (GP) of a course is a measure of performance. It is obtained by dividing the per cent mark secured by a student in a particular course by 10, expressed and rounded off to second decimal place.

Credit Point (CP) refers to the Grade point multiplied by the number of credits of the course, expressed and rounded off to second decimal place.

Grade Point Average (GPA) means the total credit point earned by a student divided by total number of credits of all the courses registered in a semester, expressed and rounded off to second decimal place.

Cumulative Grade Point Average (CGPA) means the total credit points earned by a student divided by the total number of credits registered by the student until the end of a semester (all completed semesters), expressed and rounded off to second decimal place.

Overall Grade Point Average (OGPA) means the total credit points earned by a student in the entire degree programme divided by the total number of credits required for the P.G. degree, expressed and rounded off to second decimal place.

Minimum Credit to acquire: 70

M. Tech. Food Technology (Food Safety and Quality Assurance)

Major Courses

Course Code.	Course Title	Credit	Hours
FSQA 501	Techniques in Food Quality Analysis*	2+ 2	
FSQA 502	Microbiology of Food Spoilage and Pathogens*	2+ 1	
FSQA 503	Advanced Food Chemistry	2+ 1	
FSQA 504	Global Food Laws and Regulations	2+ 0	
FSQA 505	Food Safety Management Systems and Certification	2+ 1	
FSQA 506	Process and Products Monitoring for Quality Assurance	2+ 0	
FSQA 507	Quality Concepts and Chain Traceability*	2+ 0	
FSQA 508	Management of Food By-products and Waste	2+ 0	
FSQA 509	Special Problem/ Summer Internship	0+ 2	
FSQA 510	Toxicology of Food Ingredients and Products	2+ 1	
FSQA 511	Food Plant Utilities and Sanitation	2+ 0	

*Compulsory (Rest of the courses will be decided by the students advisory committee keeping the minimum limits set for award of degree).

Minor Courses

Course Code.	Course Title	Credit	Hours
FPT 502	Emerging Technologies in Food Packaging	2+ 0	
FPT 503	Industrial Manufacturing of Food and Beverages	2+ 1	
FPT 504	Food Material and Product Properties	2+ 1	
FPT 514	Food Ingredients and Additives	2+ 1	
FPT 510	Aseptic Processing and Packaging	2+ 1	
FPE 502	Engineering Properties of Food Materials	2+ 1	
FPE 504	Bioprocessing and Down Stream Engineering	2+ 1	
FPE 506	Numerical Technique and Stimulation	1+ 1	
FPE 508	Food Safety and Storage Engineering	2+ 1	

Supporting Courses

Course Code.	Course Title	Credit	Hours
BSH 501	Research Methodology	2+ 0	
BSH 502	Food Informatics	1+ 1	
FBM 501	Post-Harvest Management	2+ 1	
FBM 502	Food Business Management	2+ 0	
FBM 503	Food Processing Entrepreneurship and Start up	0+ 1	
FPE 515	Energy Management and Auditing in Food Industry	2+ 1	
FPE 510	Operation Research	2+ 1	

Common Courses

SL. No.	Course Title	Credits
1.	Library and Information Services	1
2.	Technical Writing and Communications Skills	1
3.	Intellectual Property and its Management in Agriculture	1
4.	Basic Concepts in Laboratory Techniques	1
5.	Agricultural Research, Research Ethics and Rural Development Programmes	1

These courses are available in the form of e-courses/MOOCs. The students may be allowed to register these courses/similar courses on these aspects, if available online on SWAYAM or any other platform. If a student has already completed any of these courses during UG, he/she may be permitted to register for other related courses with the prior approval of the HoD/BoS.

Seminar

Course Code	Course Title	Credit	Hours
FSQA 599	Seminar	0+ 1	

Course Contents

Major courses

I. Course Title: Techniques in Food Quality Analysis

II. Course Code: FSQA 501

III. Credit Hours: 2+ 2

IV. Theory

Unit I

Sampling Procedures, Calibration and Standardization: Sub- sampling and its procedures, LOD, LOQ, Internal standards, Reference standards and certified reference materials. Spectroscopy techniques: Operation, calibration and standardization procedures as applicable to particular technique. Principles and applications of pH Meter, Digital analyzer, Auto-analyzer, Ultraviolet-visible spectroscopy (UV-VIS), Infra-Red, Fourier-Transform Infrared Spectroscopy (FTIR), Near Infra-Red (NIR), Atomic Absorption spectroscopy (AAS).

Unit II

Chromatography Techniques: Principles, Components and applications of (i) Paper Chromatography-Ascending and Descending-One dimensional & Two-dimensional (ii) Thin layer chromatography (iii) Ion Exchange (iv) GC (v) GLC (vi) HPLC (vii) HPTLC (viii) GCMS (ix) LCMS (x) Amino acid Analyzer.

Unit III

Separation Techniques: Dialysis, Gel filtration, Electrophoresis: Principles, components and applications of (i) Paper (ii) Starch (iii) Gel (iv) Agar-gel (v) Polyacrylamide gel (vi) Moving boundary (vii) Immuno electrophoresis. Centrifugation: Types of centrifuge – Ordinary and Ultracentrifuge- Principle and applications.

Unit IV

Principle, Components and Applications of (i) Differential scanning calorimetry (DSC) (ii) Thermogravimetric analysis (TGA) (iii) Isothermal microcalorimetry (IMC) (iv) Thermomechanical analysis (TMA) (v) Isothermal titration caloritmetry (ITC) (vi) Dynamic elemental thermal analysis (DETA) (vii) Nuclear magnetic resonance (NMR) (viii) Scanning electron microscopy (SEM) (ix) Transmission electron microscopy (TEM) (x) X-ray diffraction technique (XRD) (xi) Rapid visco-analyzer (xii) Texture analyzer and (xiii) Micro-dough lab.

V. Practical

• Analysis and characterization of pigment in fruits by UV-VIS.

• Characterization of starches by FTIR spectroscopy.

• Assessment of microstructure of food components by SEM/Reviewing a micrograph obtained through SEM

• Study of thermal denaturation of proteins and food enzymes by DSC.

• Quantization of allergenic proteins by LCMS.

• Separate and identification of pesticides in food samples by HPLC.

• Identification and molecular characterization of proteins by SDS-PAGE.

• Quantization of lipids and fatty acids using TLC.

• Assessment of pasting properties of starches and flours/flour-blends using RVA.

• Analysis of textural properties of food products with texture analyzer.

• Comparative rheological study of wheat flour samples of different varieties.

• Differential thermal analysis (DTA) and Thermogravimatric Analysis of a food samples

• A rapid, visual demonstration of protein separation by gel filtration chromatography.

• Amino acid profiling of food samples

VI. Suggested Reading

• Ongkowijoyo P, Luna-Vital DA, de Mejia EG. 2018. Extraction Techniques and Analysis of Anthocyanins from Food Sources by Mass Spectrometry: An Update Food chemistry.

• Trimigno A, Marincola FC, Dellarosa N, Picone G and Laghi L. 2015. Definition of Food Quality by NMR-based Foodomics, Current Opinion in Food Science 4:99-104.

• Pare JRJ and Bélanger JMR. 2015. Instrumental Methods of Food Analysis: Elsevier.

• Cifuentes A. 2012. Food Analysis: Present, Future, and Foodomics, ISRN Analytical Chemistry.

• Skoog DA, Holler FJ and Nieman TA. 1998. Principles of Instrumental Analysis (5 Ed.): Harcourt, Singapore.

I. Course Title: Microbiology of Food Spoilage and Pathogens

II. Course Code: FSQA 502

III. Credit Hours: 2+ 1

IV. Theory

Unit I

Food Borne Pathogens, Host Invasion, Pathogenesis, Significance to public health Food hazards and risk factors, Pathogenic foodborne microorganisms – Salmonella, Pathogenic Escherichia coli and other enterobacteriaceae, Staphylococcus aureus, Listeria monocytogenes, Clostridium botulinum, Clostridium perfringens and Bacillus cereus Other Gram-positive pathogens, Campylobacter, Brucella, Aeromonas, Vibrio cholerae, Mycobacterium, Shigella.

Unit II

Fungal and viral food-borne disorders, Food-borne important animal parasites, Mycotoxins, Incidence and behavior of microorganisms in meat, poultry, milk and milk products, fresh agro produce, sea foods.

Unit III

Controlling pathogens and microbial toxin via food processing, Microbial growth and shelf life, Modeling of microbial growth, Safety concerns of food processed through non-thermal processing, management of microbial risk and toxin in foods through HACCP, Risk in antimicrobial nano-materials, Risk assessment and predictive modeling

Unit IV

Molecular approaches for detection and identification of food borne pathogens, Enzyme Immunoassay (EIA), Enzyme-linked immunosorbent assay (ELISA), Radioimmunoassay (RIA) – instrumentation and applications of each immunoassay technique. DNA: DNA purification, DNA Fingerprinting. PCR/RTPCR (Real time) based analysis and sequencing, Biosensors, Recombinant DNA technology; Microchip based techniques, cDNA and genomic libraries, immunochemical techniques.

V. Practical

- Preparation of common laboratory media and special media for cultivation of bacteria, yeast & molds.
- Isolation and identification of pathogens.

• Coliforms analysis of milk and water samples.

• Identification tests for bacteria in foods: IMVIC urease, catalase, coagulase, gelatin and fermentation (acid/gas).

• Determination of thermal death characteristics of bacteria.

• Determination of DNA and RNA of spoilage microorganism using PCR.

• Detection of DNA of trace components allergens, like nuts using ELISA.

• DNA/RNA based microarray experiment.

• Demonstration of DNA fingerprinting.

• Determination of growth and activity of microorganisms in incubator.

• Determination of preservatives and food colours using Biosensor.

• Process time calculation for an indicator organism

• Microbes responsible recall – case studies.

VI. Suggested Reading

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

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

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

• Juneja VK, Dwivedi HR and ofos JN. (Eds) 2017, Microbial Control and Food Preservation – Theory and Practice, Springer

• Schmidt RH and Rodrick GE. 2013 Food Safety Handbook Wiley

I. Course Title: Advanced Food Chemistry

II. Course Code: FSQA 503

III. Credit Hours: 2+1

IV. 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, auto-oxidation and its prevention, fat in food matrix like fat globule in milk, PUFA, MUFA, CLA, cis – 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, 2-diol (3-MCPD), PAHs (in grilled and smoked products), dioxine, histamine, ethyl carbamate, furan, bisphenol A or phthalates from plastic materials, microplastics, 4-methylbenzophenone and 2-isopropylthioxanthone from inks, mineral oil from recycled fibres or semicarbazide from a foaming agent in the plastic gasket.

V. 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

VI. Suggested Reading

• Fennema OR, Ed., 2008. Food Chemistry, Marcel and Dekker, Inc., New York, NY.

• Belitz HD, Grosch W and Schieberle P. 2009. Food Chemistry. Springer.

• Varelis P, Melton L and Shahidi F. 2019. Encyclopedia of Food Chemistry. Elsevier.

• Cheung P, Mehta CK and Bhavbhuti M. 2015. Handbook of Food Chemistry. Springer

I. Course Title: Global Food Laws and Regulations

II. Course Code: FSQA 504

III. Credit Hours: 2+0

IV. 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

V. Suggested Reading

• Osiemo O. 2018. Food Safety Standards in International Trade: The Case of the EU and the COMESA, CRC

• Villarreal AM. 2018. International Standardization and the Agreement on Technical Barriers to Trade, Cambridge University Press

• Meulen B, Bremmers H, Purnhagen K, Gupta N, Bouwmeester HL and Geyer L. 2014. Governing Nano Foods: Principles-Based Responsive Regulation

• Understanding the Codex Alimentarius, 3rd ed., 2006.

• Vapnek J and Spreij M. 2005. Perspectives and Guidelines on Food Legislation, with a new model food law for the Development Law Service FAO Legal Office

• US FDA Website

• European Food Safety Authority (EFSA) website

I. Course Title: Food Safety Management Systems and Certification

II. Course Code: FSQA 505

III. Credit Hours: 2+0

IV. 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.

V. Suggested Reading

• Salazar E. 2013. Understanding Food Safety Management Systems: A Practical Approach to the Application of ISO-22000:2005, Create Space Independent Publishing Platform.

• ISO 22000 Standard Procedures for Food Safety Management Systems, 2008, Bizmanualz, Inc.

• Dillon M and Griffith C (ed). 2001. Auditing in the Food Industry – From Safety and Quality to Environmental and Other Audits, CRC Press

• Inteaz A. 2003. Food Quality Assurance: Principles and Practices, CRC Press

• Respective certification documents

I. Course Title: Process and Products Monitoring for Quality Assurance

II. Course Code: FSQA 506

III. Credit Hours: 2+0

IV. 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 on line 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.

V. Suggested Reading

• Rodríguez MEP. 2018. Process Monitoring and Improvement Handbook, Second Edition 2018 by ISBN: 978-0-87389-974-1

• Food Process Monitoring Systems 1993, Springer

I. Course Title: Quality Concepts and Chain Traceability

II. Course Code: FSQA 507

III. Credit Hours: 2+0

IV. Theory

Unit I

Quality – Concepts, Quality as winning strategy, Total quality management TQM: Introduction, definitions and principles of operation, Tools and Techniques, such as, quality circles, 5 S Practice, Total quality control (TQC), Total employee involvement (TEI), Problem solving process, Quality function deployment (QFD), Failure mode and effect analysis (FMEA), Fault Tree Analysis (FTA), 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 the examination), 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.

V. 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

• Grant EL and Leavenworth RS. 1996.,7th Ed 1996, Statistical Quality Control, McGraw- Hill

I. Course Title: Management of Food By-products and Waste

II. Course Code: FSQA 508

III. Credit Hours: 2+1

IV. 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 biodegradable plastic, 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.

V. 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 $CaCO_3$), Sulphate (as SO_4), Total organic 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

VI. 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

• Guillermo et. al. A Methodology for Sustainable Management of Food Waste 2017, Waste and Biomass Valorization, Volume 8, Issue 6, pp 2209–2227

• Agricultural Waste Management Systems, Chapter 9, USDA Agricultural Waste Management Field Handbook https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=31493.wba

• Oreopoulou, Vasso, Russ, Winfried (Eds.) Utilization of By-Products and Treatment of Waste in the Food Industry, 2007, Springer

• Anil Kumar Anal (Editor), 2017, Food Processing By-Products and their Utilization, Wiley- Blackbell

I. Course Title: Toxicology of Food Ingredients and Products

II. Course Code: FSQA 510

III. Credit Hours: 2+1

IV. Theory

Unit I

General Concepts in Food Toxicology: Definitions, General principles of food toxicology, Toxicology terminologies – Acute, Subacute, Subchronic and Chronic toxicity and other important terminologies; Classification of toxicants, Food Allergy, Food Toxicity, Food Idiosyncrasy, Common food adulterants, Risk assessment, Common techniques for identification/quantification of food toxins, LD50 and LC50 oral-dermal-inhaled, feeding trials and in vitro tests for toxicology.

Unit II

Toxicology of Food additives: Food additives toxicity, Safety Determination of direct and Indirect Food Additives, Acceptable daily intake (ADI), estimated daily intake (EDI), Interaction in food matrix, Evaluation of new and emerging ingredients, Toxicological Study Requirements as per FSSAI for the approval of non-specified foods/food ingredients,

Unit III

Toxicants and contaminants in food: algal toxins, plant toxins and anti-nutrients, dietary estrogens and antiestrogens, Inherent toxins & allergens, process induced toxicants, toxins from packaging, fumigants, safety challenges in of genetically engineered foods, pesticides, heavy metals, carcinogens, polycyclic aromatic hydrocarbons etc.,

Unit IV

Nutraceuticals and functional foods: toxicity and toxicological clearance from regulator, Interactions of prescription drugs, food, alcohol and nutraceuticals. National and international regulatory aspects of health foods and nutraceuticals.

V. Practicals

- Determination of trypsin inhibitors in legumes
- Estimation of phytates/oxalates in cereals/legumes
- Determination of Acrylamide and 5-hydroxymethylfurfural formation in reconstituted potato chips during frying
- Determination of Hydroxymethylfurfural in Baby Foods

• Metals and toxic Metals e.g. Cd, Hg etc.

• Pesticide residues e.g. Dioxin, Aldrin, Malathion etc.

• Mycotoxins, Argemone, Khesari dal, Ergot, Karnal bunt, Dhatura, etc.

• Allergens, Antibiotic & hormone residues, Veterinary drug residue,

• Other new contaminants and toxins (For example: Cyclopiazonic acid in Buckwheat flour)

• Determination of Naturally Occurring Toxic Substances (NOTS) and Deoxynivalenol (DON)

• Elisa for toxins and allergens

VI. Suggested Reading

• Introduction to Food Toxicology: By Takayuki Shibamoto and Leonard F. Bjeldanes. 2nd edition; Academic Press

• Safety Evaluation of Certain Contaminants in Food, WHO Food Additives Series: 63, FAO JECFA Monographs 8, http://www.fao.org/3/a-at881e.pdf

• Chapter 30: Food Toxicology. In Casarett and Doull's Toxicology: The Basic Science of Poisons by Curtis D. Klaassen. 8th edition; McGraw-Hill Medical Publishing Division

• Food Toxicology: Current Advances and Future Challenges by Ashish Sachan, Suzanne Hendrich, 2017, Apple Academic Press

• Food Toxicology by Debasis Bagchi, Anand Swaroop, 2016, CRC Press

• General Standard for Contaminants and Toxins in Food and Feed (CODEX STAN 193- 1995) www.fao.org/input/download/standards/17/CXS_193e_2015.pdf

I. Course Title: Food Plant Utilities and Sanitation

II. Course Code: FSQA 511

III. Credit Hours: 2+0

IV. Theory

Unit I

General principles of food plant Design and layout, CIP system, sanitizers used in food industry. Personnel hygiene and assessment of surface sanitation by swab and rinse method

Unit II

Sanitation of coolers/chillers/freezers, Design of warehouses, conventional & modern storage structures for fruits, vegetables, meat and marine products, pest and rodent control

Unit III

Waste disposal for Food Plant Hygiene and Sanitation, ETP design and layout, Food hygiene and safety in transportation, with a focus on warehouse storage and refrigerated ships, Process water quality and treatments at plant level, Process plant sanitation – chemistry and water in CIP

Unit IV

Preparation of a sanitation schedule for food preparation area, testing of sanitizers and disinfectants, Steam generation and performance, Boiler operation, forced and induced draught. Flue gas composition and performance analysis, Process air generation, air requirement & supply system. Air Moving and vacuum equipment, Power supply system for food process plants and plant earthing.

V. Suggested Reading

- Marriott NG and Gravani RB. 2006. Principles of Food Sanitation, 5th edition
- Rao DG. 2010. Fundamentals of Food Engineering, PHI learning Private Ltd.
- James A. 2013. The Supply Chain Handbook, Distribution Group.
- FAO, US. 1984. Design and Operations of Cold Store in Developing.

Minor courses

I. Course Title: Emerging Technologies in Food Packaging

II. Course Code: FPT 502

III. Credit Hours: 3 (2+ 1)

IV. 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.

V. Practicals

- 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

VI. Suggested Reading

- Ahvenainen R, 2001. *Novel Food Packaging Techniques*, CRC Press.
- Robertson GL, 2012. *Food Packaging*, CRC Press.

• Hanlon, JF, Kelsey RJ and Forcinio H. 1998. *Handbook of Package Engineering*, CRC Press.

• Painy FA, 1992. *A Handbook of Food Packaging*, Blackie.

• Rooney ML, 1988. *Active Food Packaging*, Chapman & Hall.

• Coles R and Kirwan M, 2011. *Food and Beverage Packaging Technology*, Wiley-Blackwell.

• Han J and Han J, 2005. *Innovations in Food Packaging*, Academic Press.

I. Course Title: Industrial Manufacturing of Food and Beverages

II. Course Code: FPT 503

III. Credit Hours: 3 (2+ 1)

IV. 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.

V. Practicals

- 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.

VI. Suggested Reading

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

I. Course Title: Food Material and Product Properties

II. Course Code: FPT 504

III. Credit Hours: 3 (2+ 1)

IV. 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.

V. Practicals

- To determine physical dimension and shape for suitability of processing and packaging 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, browning index

VI. 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. *Micro Structure: 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

I. Course Title: Food Ingredients and Additives

II. Course Code: FPT 514

III. Credit Hours: 3 (2+ 1)

IV. 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.

V. 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

VI. Suggested Reading

- Branen AL, Davidson PM and Salminen S. 2001. Food Additives, Marcel Dekker.
- George AB. 1996. *Encyclopaedia of Food and Colour Additives*, CRC Press.
- Nakai S and Modler HW. 2000. *Food Proteins: Processing Applications*, Wiley VCH.
- Gerorge AB. 2004. *Fenaroli's Handbook of Flavour Ingredients*, CRC Press.
- Branen AL, Davidson PM, Salminen S and Thorngate JH, 2001. *Food Additives*, Marcel Dekker.
- Madhavi DL, Deshpande SS and Salunkhe DK. 1996. *Antioxidants: Technological, Toxicological and Health Perspective*, Marcel Dekker.
- Stephen AM. 2006. *Food Polysaccharides and Their Applications*, CRC Press.
- Smith J and Shum LH. 2011. *Food Additives Data Book*, Wiley-Blackwell.
- Baines D and Seal R. 2012. *Natural Food Additives, Ingredients and Flavorings,* Woodhead Publishing

I. Course Title: Aseptic Processing and Packaging

II. Course Code: FPT 510

III. Credit Hours: 3 (2+ 1)

IV. 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.

V. 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.

VI. Suggested Reading

• Robertson GL, 2012. *Food Packaging: Principles and Practices*, CRC Press.

• David JRD, Graves RH and Szemplenski T, 2016. *Handbook of Aseptic Processing and Packaging*, CRC Press.

• Reuter H, 1993. *Aseptic Processing of Foods*, CRC Press.

• Willhoft EM, 1993. *Aseptic Processing and Packaging of Particulate Foods*, Springer.

I. Course Title: Bioprocessing and Down Stream Engineering

II. Course Code: FPE 504

III. Credit Hours: 2+ 1

IV. 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 continuous fermentation, 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.

V. 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.

VI. 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 food processing*. Springer

I. Course Title: Numerical Techniques and Simulation

II. Course Code: FPE 506

III. Credit Hours: 1+1

IV. 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 software
- 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, DesignExpert(DX), Minitab, Matlab
- Practice on design optimization softwares i.e. Solid works, ANSYS.

VI. 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*. Prentice Hall.
- 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 & Sons publication
- Granato D and Ares G. 2014. *Mathematical and statistical methods in food science and technology*. IFT Press, Wiley Blackwell
- Standard software for modelling, analysis and simulations

I. Course Title: Food Safety and Storage Engineering

II. Course Code: FPE 508

III. Credit Hours: 2+1

IV. 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 shelf-life 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.

V. 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.

VI. Suggested Reading

- Sun DW. 2015. *Handbook of food safety engineering*. Wiley Black Well Academic Press, Elsevier Ltd
- International Organization for Standardization. 2018. *Food Safety Management Systems: Requirements for Any Organization in the Food Chain*. ISO.
- Shejbal J. 1980. Controlled Atmosphere Storage of Grains. Elsevier.
- Vijayaraghavan S. 1993. Grain Storage Engineering and Technology. Batra Book Service
- Chakraverty A and Singh RP. 2014. Postharvest technology and food process engineering. CRC Press
- Chakraverty A, Mujumdar AS and Ramaswamy HS. 2002. *Handbook of Postharvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices*. CRC Press

• ISO. 22000 Food safety management systems – Requirements for any organization in the food chain. Technical Committee ISO/TC 34, Food products and updates • Case Studies and Field Reports – Food Safety Engineering

I. Course Title: Research Methodology

II. Course Code: BSH 501

III. Credit Hours: 2+0

IV. 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, Research design, 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 Publishing
- Wilson 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-Blackwell
- Saguy PI. *Computer aided techniques in Food Technology*, 1983, Taylor and Francis

I. Course Title: Food Informatics

II. Course Code: BSH 502

III. Credit Hours: 2+0

IV. 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 lifecycle tracing and tracking — ICT tools and technique

V. Suggested Reading

- Food Informatics: Applications of Chemical Information to Food Chemistry MartinezMayorga,
- Karina-Medina-Franco,
- Food Informatics: Sharing Food Knowledge for Research and Development Nicole J.J.P. Koenderinkl, J. Lars Hulzebosl, Hajo Rijgersbergl and Jan L. Top

I. Course Title: Post-Harvest Management

II. Course Code: FBM 501

III. Credit Hours: 2+ 1

IV. 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 postharvest shelf life. Chemicals used for hastening and delaying ripening of fruits and vegetables. Methods of storage – precooling, pre-storage 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.

V. 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.
-

VI. Suggested Reading

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

I. Course Title: Food Business Management

II. Course Code: FBM 502

III. Credit Hours: 2+0

IV. 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 approaches 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 prospects of 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).

VI. Suggested Reading

- David D and Erickson S. 1987. *Principles of Agri Business Management*. Mc Graw Hill Book Co., New Delhi.
- Acharya SS and Agarwal NL. 1987. *Agricultural Marketing in India*. Oxford & ISH Publishing Co., New Delhi.
- Cundiff Higler. 1993. *Marketing in the International Environment*, Prentice Hall of India, New Delhi.
- Batra GS and Kumar N. 1994. *GAD Implications of Denkel Proposals* – Azmol Publications Pvt., New Delhi.
- Phill Kottler. 1994. *Marketing Management* – Prentice Hall of India, New Delhi.

I. Course Title: Food Processing Entrepreneurship and Start-up

II. Course Code: FBM 503

III. Credit Hours: 1+1

IV. 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.

Unit IV

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.

V. 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.

VI. Suggested Reading

- Hu, R. 2005. *Food Product Design A Computer-Aided Statistical Approach*, Technomic Publishers.
- Moskowitz H R, Saguy S. and Straus T. 2006. *An Integrated Approach to New Food Product Development,* CRC Press
- Moskowitz H R, Porretta S. and Silcher M. 2006. *Concept Research in Food Product Design And Development*, Blackwell Publishing Ltd.
- Peters MS and Timmerhaus KD. 2005. *Plant Designs and Economics for Chemical Engineers*, McGraw Hill, 5th Edition,
- Ahmad T. 2009. *Dairy Plant Engineering and Management*., Kitab Mahal, 8th Edition.

I. Course Title: Energy Management and Auditing in Food Industry

II. Course Code: FPE 515

III. Credit Hours: 2+1

IV. Theory

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; CO_2, 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 food processing facilities, building envelop audit, energy consumption and saving opportunities.

V. Practical

- Study and practice with energy assessment and auditing instruments
- Performance assessment of motors and variable speed drives
- Performance assessment of pump, fans and blowers
- Performance assessment of refrigeration system
- Performance 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 facilities
- Case studies & field reports.

VI. 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

I. Course Title: Operation Research

II. Course Code: FPE 510

III. Credit Hours: 2+ 1

IV. Theory

Unit I

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

Unit II

Linear programming problem: Mathematical formulation of the linear programming problem and 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).

V. Practical

- Studies on application of Linear Programming on food product standardization
- Studies on use of Transportation and Assignment Problems in food plant operations

- Studies on Economic Order Quantity and Replacement Model
- Studies on Sequencing of food plant operations; Studies on Queuing Model
- Network Analysis using CPM and PERT.

VI. 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 Management Decisions*. Prentice Hall of India, New Delhi
- Taha HA. 2007. *Operations Research: An Introduction*. Pearson Prentice Hall, New Jersey • Goel 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 and Practices*. 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.

Supporting Courses

The following courses are being offered by various disciplines (The list is only indicative). Based on the requirement, any of the following courses may be opted under the supporting courses. If required, the contents may be modified to suit the individual discipline with approval of the concerned BoS.

Code	Course	Title	Credit Hours
STAT	501	Mathematics for Applied Sciences	2+ 0
STAT	502	Statistical Methods for Applied Sciences	3+ 1
STAT	511	Experimental Designs	2+ 1
STAT	512	Basic Sampling Techniques	2+ 1
STAT	521	Applied Regression Analysis	2+ 1
STAT	522	Data Analysis Using Statistical Packages	2+ 1
MCA	501	Computers Fundamentals and Programming	2+ 1
MCA	502	Computer Organization and Architecture	2+ 0
MCA	511	Introduction to Communication Technologies Computer Networking and Internet	1+ 1
MCA	512	Information Technology in Agriculture	1+ 1
BIOCHEM	501	Basic Biochemistry	3+ 1
BIOCHEM	505	Techniques in Biochemistry	2+ 2