

FIFTH SEMESTER**FQA 351 3 (2+1)****Food Plant Sanitation****(32 lectures + 16 practical)**

- Unit 1 Sanitation and food industry**
Sanitation, importance of sanitation in food plants, sanitation laws and guidelines, establishment of sanitary practices
- Unit 2 Food contamination sources**
Sources of contamination, contamination of foods, protection against contamination
- Unit 3 Personal hygiene and sanitary food handling**
Personal hygiene, employee hygiene, sanitary food handling, role of employee supervision, employee responsibility
- Unit 4 Cleaning compounds and sanitizers**
Classification, selection of cleaning compounds, handling and storage, precautions, sanitizing methods – thermal, steam, hot water, radiation, HHP, Vacuum/Steam/Vacuum, chemical sanitizers – chlorine, iodine, bromine, quaternary ammonium compound, acid sanitizers, detergent formulations, iodophores
- Unit 5 Pest and Rodent Control**
Insect infestation, cockroaches, rodents, birds, use of pesticides, integrated pest management
- Unit 6 Sanitary design and construction for food processing plant**
Site selection, site preparation, building construction considerations, pest control design, construction materials
- Unit 7 Water quality and treatment**
Characteristics of drinking water – physical (temperature, colour, turbidity, taste and odour), chemical (pH, hardness, alkalinity), microbiological (total plate count, E.Coli, Streptococcus faecalis), waste disposal – industrial waste, influent, effluent, biological oxygen demand, chemical oxygen demand, tolerance limits for industrial effluent discharged into surface water, water treatment – primary (screening, sedimentation, floatation), secondary (trickling filters, activated sludge method, lagoons), tertiary (chemical coagulation and flocculation process), utilization of waste from food processing industry
- Unit 8 Role of HACCP in sanitation**
HACCP, HACCP development, interface with GMP and SSOPs, HACCP principles, organization, implementation and maintenance

Practical Title

- 1 Sampling plans and microbial guidelines
- 2 Microbiological testing of water for coliform and faecal streptococci
- 3 Detection and enumeration of coliforms enterococci as indicator organism in foods
- 4 To determine hardness of water sample
- 5 To determine residual chlorine in water
- 6 To determine total dissolved solids and electrical conductivity in given water sample
- 7 To determine acidity of waste water
- 8 To determine alkalinity of waste water
- 9 Determination of biological oxygen demand of waste water
- 10 Determination of chemical oxygen demand of waste water
- 11 Assessing cleanliness and sterility of food equipments by swab method
- 12 To evaluate cleanliness of food equipments by rinse method
- 13 To assess cleanliness and sterility of food equipments by agar roll method
- 14 Visit to restaurants/hotels and microbial examination of plates, cups and other eating utensils
- 15 Testing the efficiency of detergents used in food plant

Text books

- 1 Principles of food sanitation, Springer by Norman G Marriott, Robert B Gravani
- 2 Food Plant Sanitation, Marcell Dekker Inc by Bernard L Bruinsma, J Richard Gorham

FPE 351 3 (2+1)
Process Equipment Design

(32 Lectures and 16 Practical)

- | | |
|----------------|--|
| Unit 1 | Materials and Properties
Materials for fabrication, mechanical properties, ductility, hardness, corrosion, protective coatings, corrosion prevention linings equipment, choice of materials, material codes. |
| Unit 2 | Design Considerations
Stresses created due to static and dynamic loads, combined stresses, design stresses and theories of failure, safety factor, temperature effects, radiation effects, effects of fabrication method, economic considerations. |
| Unit 3 | Design of Pressure and Storage Vessels
Operating conditions, design conditions and stress. Design of shell and its component, stresses from local load and thermal gradient, mountings and accessories. |
| Unit 4 | Design of Heat Exchangers
Design of shell and tube heat exchanger, plate heat exchanger, scraped surface heat exchanger, sterilizer and retort. |
| Unit 5 | Design of Evaporators and Crystallizers
Design of single effect and multiple effect evaporators and its components.
Design of rising film and falling film evaporators and feeding arrangements for evaporators.
Design of crystalliser and entrainment separator. |
| Unit 6 | Design of Agitators Separators
Design of agitators and baffles. Design of agitation system components and drive for agitation. Design of centrifuge separator. |
| Unit 7 | Design of Equipment Components
Design of shafts, pulleys, bearings, belts, springs, drives, speed reduction systems. |
| Unit 8 | Design of Freezing Equipment
Design of ice-cream freezers and refrigerated display system. |
| Unit 9 | Design of Dryers
Design of tray dryer, tunnel dryer, fluidized dryer, spray dryer, vacuum dryer, freeze dryer and microwave dryer. |
| Unit 10 | Design of Conveyors and Elevators
Design of belt, chain and screw conveyor, design of bucket elevator and pneumatic conveyor. |
| Unit 11 | Design of Extruders
Cold and hot extruder design, design of screw and barrel, design of twin screw extruder. |
| Unit 12 | Design of Fermenters
Design of fermenter vessel, design problems. |
| Unit 13 | Hazards and Safety Considerations
Hazards in process industries, analysis of hazards, safety measures, safety measures in equipment design, pressure relief devices. |

Practical Title

1. Design of pressure vessel
2. Design of shell and tube heat exchangers and plate heat exchanger
3. Design of sterilizers and retort
4. Design of single and multiple effect evaporators
5. Design of rising film and falling film evaporator
6. Design of crystallizer
7. Design of tray dryer
8. Design of fluidized bed dryer
9. Design of spray dryer
10. Design of vacuum dryer
11. Design of microwave dryer
12. Design of belt and chain conveyor
13. Design of screw conveyor
14. Design of bucket elevator and pneumatic conveyor

15. Design of twin screw extruder
16. Design of fermenter

Text books

1. Process equipment design by Joshi MV and Mahajan VV. Published by Macmillan India Ltd
2. Process equipment design by Brownell and Young. Published by John Wiley

Reference books

1. Process equipment design by Bhattacharya BC. Published by Macmillan India Ltd
2. Strength and elasticity of materials by Brooks WH. Published by Asia Publishing House

FPE 352 3 (2+1)
Bio Process Engineering

(32 Lectures + 16 Practical)

- | | |
|---------------|--|
| Unit 1 | Introduction
Introduction of bio-processing of foods, industrial fermentations in food processing, basis and principles of fermentation and operations. |
| Unit 2 | Biological Reactors
Process considerations, oxygen transfer, sparger systems, scale up, sterilization, cell culture, product recovery |
| Unit 3 | Fermentation
Introduction to Fermentation: Rate of microbial growth and death, fermentation kinetics, mass transfer diffusion, membrane transport, dialysis, nutrient uptake. Types of fermentation: submerged and solid state solid state, batch and continuous fermentation, scale up in fermentation. Fermenter construction, operation, measurement and control in fermentation.
Aeration and Agitation in Fermentation
Oxygen requirement, bubble aeration, mechanical agitation. |
| Unit 4 | Sterilization
Air sterilization, media sterilization
Product Recovery and Waste Utilization, Product recovery, biological waste treatment and inplant sanitation. Principle and use of biosensor. Production of vitamins, amino acids, organic acids, enzymes and antibiotics, alcohols |
| Unit 5 | Process Modelling
Structured models, continuous culture, mathematical analysis, computer aids for analysis and design |
| Unit 6 | Enzyme Engineering
Enzymatic reaction kinetics, immobilized enzymes, enzymatic reactors |

- | | |
|------------------|--|
| Practical | Title |
| 1. | To study the bacterial growth in batch culture. |
| 2. | To study the enumeration of micro organism by striking and pore plate method |
| 3. | To study food spoilage and calculate thermal resistance of microorganisms. |
| 4. | To measurement B.O.D. of effluent |
| 5. | To measurement C.O.D. of effluent |
| 6. | To study the fermenter operation and measure end products |
| 7. | To produce starter |
| 8. | To produce bakers yeast culture |
| 9. | To produce citric acid |
| 10. | To produce alcohol and alcoholic beverages |
| 11. | To produce beer |
| 12. | To produce wine |
| 13. | To produce enzymes |
| 14. | To produce amino acids |
| 15. | Visit to brewery |
| 16. | Visit to effluent treatment plant |

Text books

1. Bioprocess Engineering Principles by Pauline, M. Doran. Published by Academic Press.
2. Biochemical Engineering Fundamentals by Olson, J. E. Bailey and David F. Ollis. Published by McGraw-Hill Book Co. Inc., New York
3. Chemical Engineering Handbook by Perry R.H. Published by McGraw-Hill

Reference books

1. Thermobacteriology in Food Processing by Stumbo . Published by Academic Press, New York
2. Biochemical Engineering by Blanch, H. W. and Clark, D. S. Published by Marcel Dekker Inc., New York.
3. Food Canning Technology by Larousse, Jean and Brown, B. E., Published by Wiley-VCH,

FPE 353 3 (2+1)
Food Plant Utilities & Services

(32 Lectures + 16 Practical)

- Unit 1 Introduction**
 Classification of various utilities and services in food industry
- Unit 2 Water use in Food Processing Industry**
 Water supply system : Pumps of different types, operational aspects, piping system for fresh water, chilled water etc., fittings and control, water requirement for cleaning and processing, water quality, water purification and softening
 Water use in food processing : Different types of water requirements in food processing plants, types of water use, waste water sources, water wastage minimization, water loadings per unit mass of raw material.
 Water conservation: Water and waste water management, economic use of water, water filtration and recirculation.
- Unit 3 Steam uses in Food Industry**
 Steam uses in food industry :Food processing operations in which steam is used, temperature, pressure and quantity of steam required in various food processing operations
 Steam generation system: Components of a boiler system, fuels used in boilers, energy analysis for a steam generation system, heat loss from boiler system, boiler design consideration.
 Energy conservation technologies for steam generation system, Energy saving through optimal design and operation of boiler, energy recovery from flue gas, energy recovery from blow down water, maintenance of boiler.
 Steam distribution system : Components of steam distribution, heat loss and energy efficiency of a steam distribution system.
 Energy conservation technologies for steam distribution system: Steam trap maintenance, condensate recovery, repairing of steam leaks, insulation improvements. Economical analysis of energy efficiency improvement, cogeneration.
- Unit 4 Electric Energy uses in Food Industry**
 Power and Electrical System : Types of electrical loads, electric loads, sources of energy losses in power and electrical systems, low power factor, improper motor load, poor control.
 Power management for demand control, power factor improvement, replacement with high efficiency motors, replacement with electronic adjustable motors.
 Energy conservation in heat exchangers: Energy conservation through heat transfer enhancement techniques, energy conservation through cleaning of fouling layer, energy conservation through optimization of heat exchanger design, energy conservation through heat exchanger network retrofit.
- Unit 5 Waste-Heat Recovery in Food Processing Facilities**
 Quantity and quality of waste heat in food processing facilities, waste heat utilization, heat exchangers for waste heat recovery, heat pumps for waste heat recovery.
- Unit 6 Thermal Energy Storage in Food Processing Facilities**
 Thermal energy storage system and materials, hot thermal energy storage, cooling energy storage.
- Unit 7 Compressed Air System**
 Main components of compressed air systems sources of energy losses from a compressed air system. Energy conservation technologies for compressed air systems, high efficiency motors, repairing of air leaks. Reduced air pressure reduced air inlet temperature, localized air delivery system.
- Unit 8 Waste Disposal and its Utilization**
 Industrial waste, sewage, influent, effluent, sludge, dissolved oxygen, biological oxygen demand, chemical oxygen demand.
- Unit 9 Planning and Design of Service Facilities in Food Industry**
 Estimation of utilities requirements : Lighting, ventilation, drainage, CIP system, dust removal, fire protection etc.
 Maintenance of facilities : Design and installation of piping system, codes for building, electricity, boiler room, plumbing and pipe colouring, maintenance of the service facilities.

Services required in offices, laboratories, locker and toilet facilities, canteen, parking lots and roads, loading docks, garage, repair and maintenance shop, ware houses etc.

Practical	Title
1.	To study operational aspects of water supply system and measures to conserve water in food processing plant
2.	To study the sizing and maintenance of various pumps used in food industry
3.	To estimate water requirement in food processing plant
4.	To study the waste disposal and management process in the food processing plants
5.	To study different types piping layout, fittings and control and process of regular checkups and maintenance
6.	To study different types of steam generation systems and its maintenance
7.	To study different types steam distribution systems, its maintenance and safety measures
8.	To study regular checkups and maintenance of electricity distribution system, wires, cables, switches, fuses and controls in food processing plant
9.	To study process of regular checkups and maintenance of process equipment
10.	To study the air compression and distribution system in processing plant
11.	To study the fire control operations and use of fire extinguisher
12.	To measure electrical power and energy used in the processing plants.
13.	To study the CIP system of dairy plant
14.	Study the various heat recovery systems in a processing plant.
15.	To study the effluent treatment plant
16.	To study thermal energy storage system

Text books

1. Energy Efficiency and Management in Food Processing Facilities, by Lijun Wang. Published by CRC Press, 2008
2. Energy-saving Techniques for the Food Industry by M. E. Casper. Published by Noyes Data Corp., 1977
3. Chilton's Food Engineering. Published by Chilton Co., 1979

Reference book

1. A Survey of Water Use in the Food Industry by W. E. Whitman, S. D. Holdsworth. Published by British Food Manufacturing Industries Research Association.

FPT 351 4 (3+1)**Processing Technology of Fruits and Vegetables****(48 Lectures + 16 Practical)**

- Unit 1 Production and Processing Status of Fruits and Vegetable**
Importance of fruit and vegetable in world agriculture; nutritive value of fruits and vegetable and their role in human diet; production status of fruits and vegetables in India; export potential of processed and raw fruits and vegetable produce
- Unit 2 Unit Operations in Canning**
Raw material procurement, washing, blanching, peeling of fruits and vegetables; canning of fruits and vegetables-washing, peeling, filling, brining, liding, exhausting, sealing, processing, cooling etc.; types of container glass container, tin container; acid resistant, sulphur resistant can; canning equipment
- Unit 3 Freezing of Fruits and Vegetables**
Freezing of fruits and vegetables- purpose of freezing, pre freezing methods, quick freezing, individual quick freezing; freezing temperatures for fruits and vegetables; frozen storage of fruits and vegetables
- Unit 4 Factors Affecting Quality of Fruits and Vegetable**
Various environmental and cultural factors affecting fruits and vegetable quality; Post harvest factors affecting the quality; controlled atmosphere storage (CAS) and modified atmosphere storage (MAS), effect of controlled atmosphere packaging (CAP) and modified atmosphere packaging on shelf-life of fresh fruits and vegetables
- Unit 5 Fruits and Vegetables Processing – Liquid Products**
Methods of preparation of juices, squashes, syrups, sherbet and cordials; extraction, deaeration and filtration; FPO specification for juices, squashes, syrups sherbet, cordials etc.; equipment for juice processing, Aseptic processing
- Unit 6 Fruits and Vegetables Processing – Solid and semi solid Products**
Jam, jelly and marmalade- theory and ingredients; crystallized fruits and fruit preserves; FPO specifications for jam, jelly and marmalades; chutney, pickles, sauce, puree, paste, ketchup and tomato products
- Unit 7 Process Technologies and Quality Control**
Technology of processing fruit/vegetable- processing of selected fruits (mango and banana) and vegetables (tomato and curried vegetable); determination of various quality parameters of processed fruits and vegetable products- salt content, sulphur dioxide content, acidity etc

Practical Title

1. To study the respiration rate of fruits/ vegetable at different storage conditions using head space analyser
2. To study the effect of ascorbic acid, potassium meta bisulphite on inhibition of enzymatic browning
3. Canning of fruits-Mango/Guava/Papaya
4. Canning of vegetables- Peas/Mushroom
5. Preparation of fruit jam from Apple/ Mango/ Aonla /Strawberry
6. Preparation of fruit jelly: Sweet orange/mandarin/Guava
7. Qualitative determination of pectin content by alcohol test / jelmeter test in fruit extract
8. Quantitative determination of pectin content by jelmeter test in fruit extract
9. Preparation of fruit preserve – aonla
10. Preparation of ready to serve (RTS) from mango/ litchi/ lemon
11. Preparation of squash- lemon/ mandarin/ litchi and sherbet
12. Determination of SO₂ content in preserved fruit pulp sample
13. Determination of salt content in canned vegetable product
14. Preparation of fruit leather -mango leather
15. Preparation and preservation of tomato puree and ketchup
16. Determination of lycopene content in given tomato product (spectrophotometric method)

Text books

1. Preservation of Fruits and Vegetables, by Girdhari Lal, G L Siddappa and G L Tandon
Publisher-Indian Council of Agricultural Research, New Delhi.
2. Fruit and Vegetable Preservation: Principles and Practices by RP Srivastava and S Kumar
(Second Edition), Publisher-International Book Distributing Co. Lucknow.

Reference books

1. Post harvest physiology of Perishable plant Products. By Stanley J. Kays. C B S.
2. Commercial Fruits and Vegetable Products by W.V. Cruess. AVI Publishers
3. Post harvest technology of Fruits and Vegetables by P.H. Pandey, Saroj Prakasham
4. Managing frozen foods Edited by C J. Kennedy, Woodhead Publishing Limited, Abington, Cambridge, England
5. Fruit and Vegetable Processing by M E Dauthy, FAO Agricultural Services Bulletin No.119, 1995.

FPT 352 4 (3+1)**Processing Technology of Milk and Milk Products****(48 Lectures + 16 Practical)**

Unit 1	Production and Processing Status Historical development of dairy in India; development of milk co-operatives- Amul; National Dairy Development Board (NDDB); operation flood/ white revolution; production and utilization of milk; milk consumption pattern; basis for pricing of milk; marketing channel for milk in India and abroad
Unit 2	Composition and Properties of Milk Definition of milk, milk composition, factors affecting composition of milk; milk fat; milk sugar; milk proteins; vitamins, minerals; physico-chemical properties of milk
Unit 3	Processing of Milk Milk – procurement and purchase; grading and quality testing; milk processing and packaging; defects in milk- causes and prevention; standardized milk, skim milk; sterilized milk; reconstituted/ rehydrated milk; recombined milk
Unit 4	Butter Introduction, definition, composition; processing and production steps; overrun; continuous butter manufacturing; quality testing of table butter; butter- defects, causes and their prevention; packaging and storage
Unit 5	Ice cream Introduction, definition; composition; types; processing steps and flow diagram; overrun; ice-cream-quality parameters and testing; ice-cream defects causes and prevention; packaging and storage
Unit 6	Cheese Introduction, definition, composition, types; processing steps for cheese manufacturing; process flow diagram for cheddar cheese; cheese-defects, causes and prevention; quality control for cheese
Unit 7	Dried milk Introduction, definition; composition; types of dried milk; processing steps; process flow diagram for dried milk; dried milk- defects, causes and prevention; malted milk and beverages
Unit 8	Traditional Indian Dairy Products Acid coagulated products ; fermented products-dahi, processing conditions, defects etc.; shrikhand; lassi; mattha/Chhas); fat rich products- ghee and its processing; milk based puddings/ desserts- kheer; payasam; gajar-ka-halwa
Practical	Title 1. Platform tests of milk (clot on boiling COB test, alcohol test) 2. Determination of specific gravity and total solids of milk using lactometer. 3. Determination of titrable acidity and pH of milk sample 4. Determination of moisture and fat content of milk powder 5. Determination of fat using gerber method 6. Detection of adulterants in milk like water, urea, neutralizers, preservatives, Sucrose, starch 7. Preparing standardized milk as per requirement. 8. Separation of fat from milk 9. Direct microscopic clump count (DMC) of milk 10. Determination of hygienic quality of sterilization (i.e. MBRT/ Alkaline phosphatase test / rezaurin test) 11. Determination of protein content in milk 12. Determination of moisture content and salt content of butter 13. Preparation of ice-cream and its textural study using texture analyser 14. Preparation of mozzarella cheese/ processed paneer 15. Preparation of Dahi/ Yoghurt 16. Preparation of Lassi/ Chhans related beverage 17. Preparation of paneer/channa

Text books

1. Out lines of dairy technology by Sukumar De. Oxford University Press
2. Dairy Plant System and Layout by Tufail Ahmed, Kitab Mahal, Allahabad

Reference Books

1. Indian dairy products by K S Rangappa Asia Publishing House
2. Engineering for dairy and food products by A W Farrall John Wiley and Sons
3. Cheese and Butter by V. Cheke and A. Sheeprd, Agrobios (India)
4. Dairy chemistry and biochemistry by P F Fox and PLH McSweeney, Blackie Academic and Professional, An Imprint of Chapman & Hall, London.
5. Milk and Milk Products by Eckles and Eckles

PHE 351 3 (2+1)
Storage Structures and Environment Control
(32 lectures + 16 Practical)

Unit 1	Storage Importance of scientific storage systems, post harvest physiology of semi-perishables and perishables, climacteric and non climacteric fruits, respiration, ripening, changes during ripening, ethylene biosynthesis
Unit 2	Damages Direct damages; indirect damages; causes of spoilage in storage (moisture, temperature, humidity, respiration loss, heat of respiration, sprouting), destructive agents (rodents, birds, insects etc), sources of infestation and control.
Unit 3	Storage structures Traditional storage structures (bukhari, morai etc); improved storage structures; modern storage structures, farm silos-horizontal silos, tower silos, pit silos, trench silos, size and capacity of silos
Unit 4	Storage of grains Storage of cereal grains and their products, respiration of grains, moisture and temperature changes in stored grains; conditioning of environment inside storage through ventilation.
Unit 5	Aeration & Stored Grain Management Introduction, purposes of aeration, aeration theory, aeration system design, aeration system operation,
Unit 6	Storage pests and control Damage due to storage insects and pests, its control, seed coating, fumigations, etc. Damage caused by rodents and its control.
Unit 7	Storage of perishables Storage of agricultural perishables, cold storage, controlled and modified atmospheric storage, hypobaric storage, evaporative cooling storage, conditions for storage of perishable products, control of temperature and relative humidity inside storage
Unit 8	Design of storage structures Functional and structural design of grain storage structures, pressure theories, pressure distribution in the bin, grain storage loads, pressure and capacities, warehouse and silos, BIS specifications, functional, structural and thermal design of cold stores
Practical	Title
1	Visits to traditional storage structures
2-3	Layout design, sizing, capacity and drawing of traditional storage structures
4	Visits to FCI godowns
5	Design of FCI godowns for particular capacity and commodity
6	Drawing and layout of FCI godown for particular commodity and capacity
7	Visits to cold storage
8	Design of cold storage for particular capacity and commodity
9	Drawing and layout of cold storage for particular commodity and capacity
10	Visits to CA storage
11	Design of CA storage for particular capacity and commodity
12	Drawing and layout of CA storage for particular commodity and capacity
13	Measurement of respiration of fruits/grains in the laboratory
14	Study on fumigation
15	Visits to evaporative cooling system for storage
16	Storage study in the MAP

Text Books

1. Handbook of Postharvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices, Marcel Dekker, Inc., NY by A. Chakraverty, A. S. Mujumdar, G.S.V. Raghavan, H.S. Ramaswamy.
2. Grain Storage Engineering and Technology, Batra Book Services by Vijayaraghavan, S.

Reference books

1. Storage of Cereal Grains and Their Products, 4th Edition, AACC by David B. Saucer.

2. Post Harvest Technology of Horticultural Crops, New India Publishing *by* Sudheer, K.P. and V.Indira, V Indira.
3. Principles of Agricultural Engineering, Volume – II, Jain Brothers *by* A. M. Michael and T. P. Ojha.
4. Handling and Storage of Food Grains in Tropical and Subtropical Area *by* FAO Pub.
5. Silos, Theory and Practice: Vertical Silos, Horizontal Silos (retaining Walls), 2nd Ed, Lavoisier Pub. *by* André M. Reimbert
6. Fruit and Vegetables: Harvesting, Handling And Storage, 2nd Ed, Iowa State Press *by* Keith Thompson
7. Advanced Data Warehouse Design, Springer *by* Malinowski, Elzbieta, Zimányi, Esteban.