



REVISED COURSE SYLLABUS

OF

M.TECH. IN PROCESSING AND FOOD ENGINEERING

ACCORDING TO ICAR GUIDELINES

WITH EFFECT FROM: SESSION.....

DEPARTMENT OF POST HARVEST ENGINEERING & TECHNOLOGY
FACULTY OF AGRICULTURAL SCIENCES
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Objective:

To acquaint and equip the students with different techniques of measurement of engineering properties and their importance in the design of processing equipments.

Theory**UNIT-I**

Physical characteristics: Importance of the engineering properties of the biological materials, Physical characteristics of different food grains, fruits and vegetables; Shape and size, description of shape and size, volume and density, porosity, surface area and their methods of determinations.

UNIT-II

Rheological properties: concept of Rheology and ASTM standard definitions of terms related to mechanical properties, physical states of a material, classical ideal materials, rheological models and rheological equations, visco-elasticity, creep-stress relaxation, Non-Newtonian fluid and viscometry, rheological properties of solid and liquid food, force, deformation, stress, strain, elastic, plastic behaviour.

UNIT- III

Thermal properties: Specific heat, thermal conductivity, thermal diffusivity, methods of determination, steady state and transient heat flow. Electrical properties; Dielectric loss factor, loss tangent, A.C. conductivity and dielectric constant, method of determination, energy absorption from high frequency electric field.

UNIT-IV

Aerodynamic, Hydrodynamic and Frictional Properties: Drag coefficient, terminal velocity, Relation between Drag coefficient and Reynolds number, terminal velocity from time distance relation, Friction in agricultural materials, rolling resistance, angle of internal friction, angle of repose, Contact stresses between bodies, Hertz problems, firmness and hardness, mechanical damage, dead load and impact damage, vibration damage, friction, effect of load, sliding velocity, temperature, water film and surface roughness.

Application of engineering properties in design and operation of agricultural equipment and structures.

Practicals

1. Determination of physical properties like, length, breadth, thickness, surface area.
2. Determination of bulk density, porosity and true density.
3. Determination of coefficient of friction and angle of repose.

4. Determination of colour for various food grains, fruits, vegetables, spices and processed foods.
5. Determination of thermal properties like thermal conductivity, thermal diffusivity and specific heat of food materials.
6. Determination of rheological properties like firmness and hardness of grain and fruits
7. Determination of aerodynamic properties like terminal velocity, lift and drag force for food grains.

Suggested Readings

1. Mohesenin NN. 1980. *Physical Properties of Plant and Animal Materials*. Gordon & Breach Science Publ.
2. Mohesenin NN. 1980. *Thermal Properties of Foods and Agricultural Materials*. Gordon & Breach Science Publ.
3. Peleg M & Bagelalay EB. 1983. *Physical Properties of Foods*. AVI Publ.
4. Rao MA & Rizvi SSH. (Eds.). 1986. *Engineering Properties of Foods*. Marcel Dekker.
5. Ronal Jowitt, Felix Escher, Bengt Hallsrram, Hans F, Th. Meffert, Walter EC Spices, Gilbert Vox. 1983. *Physical Properties of Foods*. Applied Science Publ.
6. Singhal OP & Samuel DVK. 2003. *Engineering Properties of Biological Materials*. Saroj Prakasan.

Title of the Paper: Unit Operations in Food Process Engineering**Objective(s):**

- I.** To impart knowledge of different unit operations of food industries like size reduction, evaporation, drying, fluid flow and food freezing.
- II.** To introduce the concept of material and energy balance as applied to food engineering systems

Syllabus:**Unit-I**

Review of basic engineering mathematics; units and dimensions; mass and energy balance.

Principles of Fluid Flow - Introduction to stress strain behaviour in materials; properties of fluid viscosity; capillary tube viscometer; power law equation for pseudoplastic; newtonian and dilatant fluids; flow in pipes-friction, laminar and turbulent flow equations, considerations in pumping fluid.

Unit-II

Size Reduction-Principles, types of equipments, applications and energy laws, Screening of solids, size measurement and analysis, standard sieves, Membrane Separation Processes

Mixing: Objectives, equipments for solid, liquid mixing; energy requirements, mixing indices.

Unit-III

Food freezing - Properties of frozen foods; freezing point depression, general introduction to enthalpy change during freezing, Plank's equation for predicting freezing time; food freezing equipment such as air blast freezers; plate freezers and immersion freezers.

Evaporation - Thermodynamics of evaporation; boiling point elevation; heat transfer during evaporation; heat transfer coefficients, design of evaporation system; retention time; single effect and multiple effect system; thermo-compression systems.

Unit-IV

Psychrometry - Principles, air properties; application in drying of foods.

Food dehydration - Basic principles of dehydration; constant rate and falling rate periods of dehydration; equilibrium moisture content; fixed bed dehydration; drum dehydration, and fluidized bed drying; spray drying of liquid foods, different types of dryer and their specific applications in food processing sector.

Practicals

1. Study of fluid flow properties.
2. Study of heat exchangers.
3. Applications of psychrometric chart.
4. Determination of EMC.
5. Experiments on different types of driers and numerical problems.
6. Experiments on size reduction equipments.
7. Experiments on cleaning and sorting equipments.
8. Calculation for fruits and vegetables dehydration

Suggested Readings

1. Berk Z. 2009. Food Process Engineering and Technology. Elsevier.
2. Brennan JG, Butters JR, Cowell ND & Lilly AEI. 1990. Food Engineering Operations. Elsevier.
3. Earle RL. 1985. Unit Operations in Food Processing. Pergamon Press.
4. Fellows P. 1988. Food Processing Technology: Principle and Practice. VCH Publ.
5. Heldmen DR &Hartel RW. 1997. Principles of Food Processing. Springer.
6. McCabe WL & Smith JC. 1999 Unit Operations of Chemical Engineering. McGraw-Hill.
7. Sahay KM & Singh KK. 1994. Unit Operation of Agricultural Processing. Vikas Publ. House.
8. Singh RP &Heldman DR. 1993. Introduction to Food Engineering. Academic Press.
9. Sun Da Wen. 2006. Handbook of Frozen Food Processing and Packaging. Francis and Taylor, CRC press.
10. Toledo RT. 2007. Fundamentals for Food process Engineering. Springer.

Transport Phenomena in Food Processing**Objective(s):**

To impart knowledge on principles of momentum, heat and mass transfer and its application in food processing, fundamental understanding of the laws of mass and energy balance, molecular diffusion and their application to food engineering; practical problems related to convective heat transfer process and its applications in food processing.

Syllabus:**Unit-I**

Introduction to transport (momentum, heat and mass transfer) phenomena and their analogous behaviour, steady and unsteady state heat conduction, analytical and numerical solution of unsteady state heat conduction equations, use of Gurnie-Lurie and Heisler Charts in solving heat conduction problems.

Unit-II

Equation of continuity, equation of motion, velocity distribution in circular pipes and parallel plates, Generalized form of equations and simplifications, expansion and reduction of basic transport equations to specific transport problems.

Unit-III

Convective heat transfer in food processing systems involving laminar and turbulent flow, Convective heat transfer – flow over flat plate - forced & natural convection, flow over cylinder - forced & natural convection; flow over spheres - forced & natural convection, laminar vs. turbulent flow.

Radiation heat transfer and its governing laws, its applications in food processing.

Unit-IV

Molecular diffusion in gases, liquids and solids; molecular diffusion in biological solutions and suspensions molecular diffusion in solids, unsteady state mass transfer and mass transfer coefficients, molecular diffusion with convection and chemical reaction, diffusion of gases in porous solids and capillaries, mass transfer applications in food processing.

Practicals

1. Solving problems on steady and unsteady state momentum, heat and mass transfer
2. Numerical analysis on steady and unsteady state problems.
3. Solving problems in natural and forced convection heat transfer.
4. Solving problems on radiation heat transfer.
5. Design of heat exchangers.
6. Experiments on conduction, convection and radiation heat transfer.

Suggested Readings

1. Earle RL. 1985. Unit Operations in Food Processing. Pergamon Press.
2. Geankoplis J Christie 1999. Transport Process and Unit Operations. Allyn& Bacon.
3. Holman JP. 1992. Heat Transfer. McGraw-Hill.
4. McCabe WL & Smith JC. 1999. Unit Operations of Chemical Engineering. McGraw Hill.
5. Pitts DR& Sisson LE. 1988. Theory and Problems of Heat Transfer. Ms Graw Hill.
6. Yanniotis S. 2007. Solving Problems in Food Engineering. Springer.

Objective:

I. To impart knowledge of principles of processing of milk and milk products.

Unit-I

The milk: definition by PFA, nutritional importance and status of milk production and processing. Milk constituents: their roles and nutritional significance. Properties of milk: chemical and physical. Microorganisms in milk and their roles. Quality testes of milk: platform tests (sensory test, COB test, sedimentation test), alcohol alizarin, resazurine, MBR test, acidity, protein, fat, etc. Handling of milk: milk cleaning, chilling and transportation.

Unit-II

Types of market milks: full cream, standardized milk, toned, double toned milks and their production methods. Processing of fluid milk: pasteurization, sterilization, separation and homogenization.

Unit-III

Technology of milk products: cream, butter, cheese, khova, whey, yoghurt, ice-cream, condensed and dried milk.

Unit-IV

Packaging of fluid milk and dairy products: glass bottles, flexible pouches, aseptic packaging system. Cleaning and sanitization of dairy plant equipments/machineries: types of dairy detergents, methods and procedure of cleaning, basic principle of CIP cleaning.

Practical

1. Milk Testing - Platform Tests
 - (a) organoleptic evaluation (OE)
 - (b) Clot on boiling test (COP)
 - (c) Alcohol test (AT)
 - (d) Sediment test (ST)
 - (e) Resazurin test (RT)
2. Determination of Activity (Titrable Acidity) of Milk
3. Determine of Specific Gravity of Milk
4. Detection of Addition of Starch in Milk
5. Detection of Addition of Skim Milk, Milk Powder or Partial Removal of Fat from Milk

Suggested readings/text/references:

1. The Technology of Milk Processing- CP Anantkrishnan and AQ Khan and PN

- Padmanabhan, Shri Lakshmi Publications, Madras.
2. Milk Products Preparation and Control- CP Anantkrishnan and AQ Khan and PN Padmanabhan, Shri Lakshmi Publications, Madras
 3. Outline of Dairy Technology- Sukumar De, Oxford University Press
 4. Dairy Plant Engineering and Management- Tufail Ahmad, Kitab Mahal, Allahabad

PFE-515

Packaging and Handling of Foods

Objective(s):

Credits-2

1. To Impart knowledge of the objectives of food packaging and its role in food preservation during storage, transportation and distribution
2. To provide knowledge to the students about the types of packaging materials their properties and packaging systems.

Unit-I

Introduction of Packaging, Importance, definition and functions of food packaging, Packaging materials, suitability and cost factor, Glass (construction of jars and bottles, optical, thermal and mechanical properties of glass), Metal (types of base metal sheets, construction of metal cans, lacquering), Wooden boxes, Crates, Plywood, Corrugated and Fibre board boxes, Textiles and Paper sacks, Plastics- substituted different types of plastics used in food packaging. . Form-Fill-Seal packaging machines

Unit-II

Environmental factors and food stability; Effect of oxygen and light, Light Protection characteristics of packages, permeability to gases and vapours, methods of measuring permeability, permeability to fixed gases, permeability to humidified gases, flow through pin holes, cracks and imperfect seals, permeability of multilayer materials.

Unit-III

Packaging tests; tensile strength, compression, bursting, tear and impact test for packages, integrity testing of packages, cushioning effect on packaged foods, deterioration of packaged foods, shelf life calculation for packaged foods, water activity and sorption isotherms, water activity and food stability

Unit-IV

Packaging systems; Modified Atmosphere and Controlled Atmosphere Packaging, Aseptic packaging including techniques, aseptic systems (Tetrapack, Bag-in-Box), integrity testing of aseptic packages.

Practicals

1. Determination of thickness, substance weight, water absorption capacity of flexible packaging materials.
2. Studies on strength properties of packaging materials.
3. Determination of shelf life of packaged foodstuff.
4. Determination of chemical resistance of plastics.
5. Familiarization of types of packaging materials.

Suggested readings/Text/References:

1. Hand Book of Spices and Packaging with Formulae- Eiri Board, New Delhi,
2. Modern Packaging Technology for Processed Food, Bakery, Snacks Food, Spices- Eiri Board, New Delhi.
3. Food Packaging Principles and Practice- Robertson, G.L., CRC Press
4. Novel Food Packaging Techniques- Raija Ahvenainen, CRC Press

PFE 516 Applied Instrumentation**2+1****Objective:**

To acquaint and equip the students with various types of transducers for study and analysis of various variables.

Theory:**UNIT-I**

Introduction to instrumentation, classification of instruments, functional elements of instruments and their presentation. Static performance characteristics: accuracy, precision, sensitivity, etc. Types of errors in measurements, estimation of uncertainties in measurement systems. Dynamic performance characteristic: Formulation of system equation, frequency response of first and second order instruments for harmonic and step inputs.

UNIT-II

Transducer: Transducer principles, Displacement Transducers: Potentiometer, LVDT, Piezoelectric and capacitive transducers, Digital Transducers. Velocity transducers: Analog and Digital Acceleration and absolute motion measurement. Force transducer – Strain Gauge, Hydraulic load cell, Cantilever type and Probing ring. Method of separation of force – Torque, Power and Energy measuring techniques.

UNIT-III

Measurement of food processing parameters: Temperature measurement using Bi-metals, PTRs, Thermistors, Thermocouples, Electronic IC sensors and Pyrometers. Heat flux measurement. Humidity measurement – Dry and Wet bulb, Hair hygrometer and Humister. Soil and Grain moisture transducers, Pressure measurement: Manometers, Bourdon Tube, Diaphragm type transducer. High pressure and vacuum sensing techniques.

UNIT-IV

Flow Measurement: Flow transducers, Positive displacement, venturimeter, Rotameter, Drag force, Ultrasonic, Electromagnetic, Hot wire anemometers. Time and frequency measurement. Liquid measurement: BOD and pH measurement, PCO₂ and grain quality measurement. Biomedical measurement – BP, ECG etc., Ultrasonic flow detection, Spectroscopy.

Practicals:

1. Study the characteristics of various transducers: Potentiometer, LVDT, Proximity sensors and Photo pickups, Load cell, Thermistor and Thermocouple.
2. Study the characteristics of flow transducers: venturimeter, Rotameter and Orifice meter.

Suggested Readings

1. Doebelin EO.1990. *Measurement Systems Applications and Design*. Tata McGraw Hill.
2. Nakra BC & Chaudhary KK. 2004. *Instrumentation Measurement and Analysis*. Tata McGraw Hill.
3. Sawhney AK. 2008. *Electrical and Electronics Measurement and Instrumentation*. Dhanpat Rai & Sons.
4. Sirohi RS & Radha Krishna HC. *Mechanical Measurements*. New Age International Pvt. Ltd. Publishers, New Delhi
5. Holman J P *Experimental Methods for Engineers*. Tata McGraw- Hill, Publishing Co. Ltd., New

PFE517

2+1

LOW TEMPERATURE PRESERVATION

Objectives:

To acquaint with thermodynamic principles of various types of refrigeration systems.

To acquaint with application of refrigeration engineering in food technology.

Theory:

UNIT I

Introduction to thermodynamics: types of thermodynamic systems, energy interactions. First law of thermodynamics for closed and open systems. Second law of thermodynamics: Kelvin-Planck and Clausius' statements, Carnot cycle, Carnot theorem. Reversed Carnot cycle- ideal heat pump and refrigerator. Reverse Carnot cycle for a gas and vapour as working substances. Properties of pure substances and their representation on various property diagrams-pv, Ts, ph, hs diagrams. Refrigerants -nomenclature and properties.

UNIT II

Vapour-compression refrigeration cycle: definition of terms, simple and actual cycle with liquid refrigerant sub-cooling, vapour refrigerant superheating. Compound compression refrigeration system with inter-cooling, flash gas removal. Multi-evaporator systems.

UNIT III

Vapour absorption refrigeration system: aqua ammonia system, Munters-Platen system. Gas cycle refrigeration: Bell Coleman cycle. Steam-jet refrigeration.

UNIT IV

Psychrometrics: definition of terms, psychrometric chart, psychrometric processes. Cold preservation of foods: freezing techniques- air freezing, contact freezing, immersion freezing.

Practical:

Solving problems on Psychrometry, study of various refrigeration systems, design aspect of cold storage, load estimation, construction, maintenance, static pressure drop, experiment on controlled and modified atmosphere storage system.

Suggested readings:

Engineering Thermodynamics- P K Nag,, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

Refrigeration and Air conditioning- P L Ballaney, Khanna Publishers, New Delhi.

PFE 521

Advanced Food Process Engineering

2+1

Objective:

To acquaint and equip the students with different unit operations of food industries and their design features.

Theory:

UNIT-I

Importance of food processing in value addition, types of processing: primary, secondary and tertiary processing. Basic unit operations in grain processing: separations- cleaning and grading, shelling/husking, milling and material handling equipments. Milling of cereals: various methods of rice milling and associated equipments/plants. Roller milling of wheat, milling of corn, Parboiling of paddy and wheat, technology and equipments/plants for milling of major pulses, pigeon pea (dry and wet milling), Bengal gram, green gram, etc.

UNIT-II

Thermal processing: Death rate kinetics, thermal process calculations, methods of sterilization and equipments involved, Latest trends in thermal processing, Evaporation: Properties of liquids, heat and mass balance in single effect and multiple effect evaporator, aroma recovery, equipments and applications. Drying: Rates, equipments for solid, liquid and semi-solid material and their applications, theories of drying, novel dehydration techniques.

Non-thermal processing: Microwave, irradiation, ohmic heating, pulsed electric field preservation, hydrostatic pressure technique etc.

UNIT-III

Freezing: Freezing curves, thermodynamics, freezing time calculations, equipments, freeze drying, principle & equipments. Separation: Mechanical filtration, membrane separation, centrifugation, principles, equipments and applications, latest developments in separation and novel separation techniques.

UNIT-IV

Sources of edible oils, general unit operations in oil milling, technology and equipments for oil milling: traditional, hydraulic, screw presses, Solvent extraction method of oil milling, principle of refining of edible oils.

Practicals:

1. Solving problems on single and multiple effect evaporator, distillation, crystallisation.
2. Solving problems on extraction, leaching, membrane separation and mixing.
3. Design of plate and packed tower.
4. Solving problems on time estimation in thermal processing
5. Extraction of oil (edible and non edible)

Suggested Readings

1. Brennan JG, Butters JR, Cowell ND & Lilly AEI. 1990. *Food Engineering Operations*. Elsevier.
2. Coulson JM & Richardson JF. 1999. *Chemical Engineering*. Vols. II, IV. The Pergamon Press.
3. Earle RL. 1985. *Unit Operations in Food Processing*. Pergamon Press.
4. Fellows P. 1988. *Food Processing Technology: Principle and Practice*. VCH Publ.
5. Geankopolis J Christie. 1999. *Transport Process and Unit Operations*. Allyn & Bacon.
6. Henderson S & Perry SM. 1976. *Agricultural Process Engineering*. 5 AVI Publ.
7. McCabe WL & Smith JC. 1999. *Unit Operations of Chemical Engineering*. McGraw Hill.
8. Sahay KM & Singh KK. 1994. *Unit Operation of Agricultural Processing*. Vikas Publ. House.
9. Singh RP & Heldman DR. 1993. *Introduction to Food Engineering*. Academic Press.
10. Singh RP. 1991. *Fundamentals of Food Process Engineering*. AVI Publ.
11. Postharvest Technologies of Cereal, Pulses and Oilseeds- Chakraverty, A., Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
12. Principles and Practices of Post Harvest Technology- P H Pandey, Kalyani Publishers, Ludhiana
13. Handbook of Postharvest Technology- Chakraverty, Muzumdar, Raghavan, Ramaswamy (editors), Marcel Dekker Inc.

Mass Transfer Operations

Objective(s):

I To impart knowledge on equilibrium stage separation processes and molecular diffusion.

Syllabus

Unit- I

Vapour-liquid separation processes: Vapour liquid equilibrium relations, relative volatility, flash & batch distillation, steam distillation, vacuum distillation, distillation with reflux single, stage and multistage equilibrium contact for vapour-liquid separation processes.

Unit- II

Extraction: Liquid-liquid extraction, liquid-liquid extraction equipment, single and multistage extraction, Leaching: Introduction, leaching equipment, Principles of single and multistage continuous-counter current leaching.

Unit- III

Stage and continuous gas-liquids separation processes: types of separation processes and methods, equilibrium relations between phases, single and multiple absorption in plate and packed towers.

Unit-IV

Principles of mass transfer, introduction to mass transfer and diffusion, molecular diffusion in fluids, molecular diffusion in biological solutions, molecular diffusion in solids, diffusivity of fluids, mass transfer co-efficient in laminar flow of effective diffusivity.

Practicals

1. Solving problems on vapour-liquid separation processes
2. Solving problems on liquid-liquid extraction
3. Solving problems on solid-liquid extraction
4. Solving problems on absorption
5. Experiments on steam distillation
6. Experiments on solid liquid extraction

Suggested readings/Text/References:

1. Unit operation of Chemical Engineering- McCabe W.L., Smith J.C. and Harriott P., McGraw Hill.
2. Transport Processes and Separation Process Principles- Geankoplis C.J. Prentice-Hall of India.
3. Introduction to Food Engineering- Singh R. Paul & Heldmann Dennis R, Academic Press, London, UK.

Objective(s):

- I. To explain the status of meat, poultry and fish production.
- II. To impart knowledge of processing and preservation techniques of meat, poultry and fish products.

Credits-2**Unit-I**

Status of meat industries, export oriented and integrated plants, municipal slaughter houses vs. modern slaughter house Meat composition, its nutritive aspect, meat production, animal and poultry slaughtering, post-mortem changes, physicochemical changes, post rigor condition of meat, PSE and DFD conditions of meat, whole sale cuts of carcass, Meat refrigeration, freezing, thawing and frozen storage.

Unit-II

Meat Processing: Cured meats-curing ingredients and their roles, methods of curing. Smoked meats composition of smoke, production of smoke, advantages of liquid smoke, Canned meat, Meat cooking- dry and moist cooking methods, its effect on quality, Sectioned and formed meat production method, tumbling and massaging Meat sausages- classification, ingredients and production technology of sausages.

Unit-III

Meat Analysis and quality control, bacteriological tests, Rapid methods of analysis for fat, protein and moisture. Egg-composition, egg candling, storage and dehydration. Egg products processing, Fish preservation by icing, smoking, canning freezing, causes of fish spoilage. By products of meat, poultry and fish processing industry, Surimi production process.

Unit-IV

Fish Processing: Types of fish, composition and nutritive value, factors affecting the quality of fish. Drying, Curing, salting, Smoking, Freezing and Canning of fishes, By-products of meat, fish, and poultry industry and their uses.

Practicals:

1. Curing of Meat
2. Meat Smoking
3. Primal cuts of meat
4. Meat Sausage preparation
5. Meat Kabab
6. Meat balls

Suggested readings/Text/References:

1. Processed Meats- Pearson, A.M. and Gillett, T.A, ASPEN Publication
2. Food Technology and Applications- Bowers, J.
3. Fisheries Processing: Biotechnological Applications- A. M. Martin, Springer London, Ltd.

Objective(s):

- I. To acquaint with principle and procedure of different techniques used in quality evaluation.
- II. To impart knowledge of food regulations and standards.

Unit-I

Proximate constituents and their evaluation/analysis; Estimation of moisture content, ash content, protein, fat and sugar content. Ultimate constituents; vitamins and pigments analysis

Unit - II

Examination of canned food products, FAO/WHO Codex Alimentarius Commission standard of canned pineapple, particulars of specifications, essential composition, allowances and defects, standards and analysis of water,

Unit-III

Sensory evaluation- methods, Difference, Rating Sensitivity tests, and interpretation of results, requirements for sensory evaluation e.g. Laboratory set up, Panel selection etc., measurement of colour and consistency, (CIE system, working principles of Hunter colour difference meter, Disc colorimeter, Lovibond Tintometer, Spectrophotometer), Primary and secondary texture characteristics-consistency (Bostwick and Adams consistometer), viscosity (Efflux tube viscometer, Brooke field viscometer), texture measurement, texture measuring instruments, texture profile analysis

Unit-IV

FPO regulations, FDA standards and procedure, Quality Control criteria for different foods. Microbiological examination of food products, Food adulteration and its detection, HACCP and ISO 9000-22000 in food industry. (FSSAI, PFA, BIS, AGMARK).

Practicals: Analysis of food constituents

1. Proximate analysis of fruits and vegetables
 - a) Estimation of moisture content
 - b) Estimation of ash content
 - c) Estimation of protein
 - d) Estimation of fat
 - e) Estimation of sugar content
2. Estimation of Vitamin C
3. Estimation of lycopene and chlorophyll
4. Estimation of pectin of Guava
5. Microbial examination of food
6. HACCP principle and control chart

Suggested readings/Text/References:

1. Processing Foods : Quality Optimization and Process Assessment - Oliveira F.A.R. & Oiveria, CRC Press
2. Analysis and Quality control for Fruit and vegetable products- Ranganna, S., Tata McGraw- Hill, India.

Food Chemistry and Microbiology

Credit-2+1

Objective(s):

- I. To acquaint with the basic knowledge of chemistry microbiology of foods.
- II. To impart knowledge which would be useful to the students after they complete the program and go to practical field.

Unit-I

Classification, biological functions and nutritional importance of carbohydrate, Structures of mono, di and polysaccharides, optical isomerism in sugars, role of storage and structural polysaccharide in nutrition, properties of polysaccharides and their hydrolysis, Classification, biological functions and nutritional importance of proteins and lipids, physical and chemical properties of fats and oils,

Unit-II

Vitamins and minerals, their sources and importance in human health, Enzymes classification, kinetics of enzyme catalyzed reaction, Factors affecting the enzyme catalyzed reaction rate, Michaelis Menton equation and its derivation, enzyme inhibitors, Food pigments and Food flavour.

Unit-III

Introduction to microbiology: Cell theory, difference between prokaryotic and eukaryotic cells, Haeckel's Kingdom protista, Whittaker five kingdom classification, Germ theory and Koch's postulates, Structures and types of microbial cells (bacteria, molds and yeasts). Growth curve and its different phases, Factors affecting microbial growth.

Unit-IV

Microbial Growth: Culture maintenance and preservation. Contamination of foods, Microbial spoilage of dairy products, meat, fish, poultry & egg products, fruits & vegetable products, Cereal grains, bakery and confectionery products, fermented and canned foods. Microbiology of water, Food infection and food intoxication.

Practicals

1. Identification of bacteria by Gram staining
2. Study on morphology of molds
3. Identification of yeast & mold in a given food
4. Estimation of total plate count
5. Estimation of total yeast & mold count
6. Estimation of peroxide value of fat samples
7. Estimation of TBA number

Suggested readings/Text/References:

1. Food Chemistry- Meyer, L.H., AVI, New York.
2. Food Microbiology- M. R. Adams, M. O. Moss, RSC Publishing.
3. Modern Food Microbiology- James M. Jay, Martin J. Loessner, David A. Golden, Food Science Text series, Springer.

Objective

To acquaint and equip the students with processing of fruits and vegetables and the design features of the equipments used for their processing.

Theory**UNIT I**

Importance of post harvest technology of fruits and vegetables. Structure, cellular components, composition and nutritive value of fruits and vegetables, fruit ripening, spoilage of fruits and vegetables. Physiological disorders and mineral deficiency related disorders and their preventions.

UNIT II

Harvesting and washing, pre-cooling, preservation of fruits and vegetables, blanching, commercial canning of fruits and vegetables, minimal processing of fruits and vegetables. Radiation preservation of fruits and vegetables, irradiation sources.

UNIT III

High pressure processing of fruits and vegetables and its applications. Cold storage of fruits and vegetables, controlled atmosphere packaging of fruits and vegetables, gas composition, quality of storage.

UNIT IV

Dehydration of fruits and vegetables: osmotic dehydration, foam mat drying, freeze drying. Intermediate moisture foods, Sensory evaluation of fruit and vegetable products, packaging technology for fruits and vegetables, general principles of quality standards and control, FPO, quality attributes.

Practical

1. Determination of size, shape, density, area-volume-mass relationship of fruits and vegetables,
2. Sugar-acid ratio of fruits,
3. Evaluation of washer, grader and packaging methods,

4. Experiments on drying of fruits and vegetables,
5. Controlled atmosphere storage and quality evaluation.

Suggested Readings

1. Cruesss WV. 2000. *Commercial Fruit and Vegetable Products*. Agrobios.
2. Mircea Enachesca Danthy. 1997. *Fruit and Vegetable Processing*. International Book Publ.
3. Srivastava RP & Sanjeev Kumar. 1994. *Fruit and Vegetable Preservation. Principles and Practices*. International Book Distr.
4. Sumanbhatti & Uma Varma. 1995. *Fruit and Vegetable Processing*. CBS.
5. Thompson AK. 1996. *Post Harvest Technology of Fruits and Vegetables*. Blackwell.
6. Verma LR & Joshi VK. 2000. *Post Harvest Technology of Fruits and Vegetables*. Vols. I-II. Indus Publ.

PFE 532

3(3+0)

Mathematical Models in Food Processing

Objective(s):

- I** To provide the basic concepts of various mathematical modeling techniques, applications of mathematical modeling in food processing and microbial destructions.

Syllabus

Unit-I

An overview of the modeling process. Introduction to mathematical, correlative and explanatory models, need of models and their classification. Formulation, idealization and simplification of the problems.

Unit-II

Probability models, series and linear mathematical approximation, dynamic and interacting dynamic processes.

Unit-III

Applications of mathematical modelling techniques to food processing equipment/operations like mixing, evaporation, parboiling, separation processes, convective drying, dehydration, shelf-life prediction, moisture diffusion, deep fat drying, microwave processing, infrared heating and ohmic heating. Stochastic finite element analysis of thermal food processes. Neural networks approach to modelling food processing operations.

Unit-IV

Microbial growth dynamics models, thermal death rate kinetics of micro-organisms, thermal process time for sterilization, models of pasteurization/sterilization.

Suggested Readings

1. Fischer M, Scholten HJ & Unwin D. 1996. Spatial Analytical Perspectives on GIS. Taylor & Francis.
2. Fish NM & Fox RI. 1989. Computer Application in Fermentation Technology: Modelling and Control of Biotechnological Processes. Elsevier.
3. Getz WM. 1979. Mathematical Modeling in Biology Processes. Elsevier.
4. Hunt DR. 1986. Engineering Models for Agricultural Production. The AVI Publ.
5. Jun S & Irudayaraj JM. 2006. Food Processing Operations Modeling – Design and analysis. Francis and Taylor, CRC press.
6. Kapur JN. 1989. Mathematical Modeling. Wiley Eastern.
7. Meyer JW. 2004. Concepts of Mathematical Modeling. McGraw Hill.
8. Peart RM & Curry RB. 1998. Agricultural Systems, Modelling and Simulation. Marcel Dekker.
9. Tijms HC. 1984. Modelling & Analysis. A Congrtational Approach. Wiley Publ.

PFE 533

Food Processing Equipment and Plant Design

2+1

Objective:

To acquaint and equip the students with the design features of different food processing equipments being used in the industries and with the layout, planning of different food and processing plants.

Theory:

UNIT-I

Design considerations of processing agricultural and food products. Plant design concepts and general design considerations: Plant layout, plant location, location factors and their interaction with plant location, location theory models, and computer aided selection of the location. Human factors in design, selection of materials of construction and standard component, design standards and testing standards.

UNIT-II

Feasibility analysis and preparation of feasibility report: plant size, factors affecting plant size and their interactions, estimation of break-even and economic plant size; Product and process design, process selection, process flow charts, Plant utilities, electricity, water, steam, air, raw material requirements and computer aided development of flow charts.

UNIT- III

Hygienic design aspects and worker's safety, functional design of plant building and selection of building materials, estimation of capital investment, analysis of plant costs and profitability's,

management techniques in plant design including applications of network analysis, preparation of project report and its appraisal.

UNIT-IV

Design of machinery for drying, milling, separation, grinding, mixing, evaporation, condensation, membrane separation.

Practicals:

1. Detailed design and drawing of mechanical dryers, milling equipment, separators, evaporators, and mixers.
2. Each individual student will be asked to select a food processing plant system and develop a plant design report which shall include product identification and selection, site selection, estimation of plant size, process and equipment selection, process flow-sheeting, plant layout, and its evaluation and profitability analysis.
3. Design of Pressure vessels, storage tank, and shell and tube heat exchanger

Suggested Readings

1. Ahmed T. 1997. *Dairy Plant Engineering and Management*. 4th Ed. Kitab Mahal.
2. Chakraverty A & De DS. 1981. *Post-harvest Technology of Cereals, Pulses and Oilseeds*. Oxford & IBH.
3. Gary Krutz, Lester Thompson & Paul Clear. 1984. *Design of Agricultural Machinery*. John Wiley & Sons.
4. Hall CW & Davis DC. 1979. *Processing Equipment for Agricultural Products*. AVI Publ.
5. Henderson S & Perry SM. 1976. *Agricultural Process Engineering*. 5th Ed. AVI Publ.
6. Johnson AJ. 1986. *Process Control Instrumentation Technology*. 2th Ed. Wiley International & ELBS.
7. Rao T. 1986. *Optimization: Theory and Applications*. 2nd Ed. Wiley Eastern.
8. Richey CB. (Ed.). 1961. *Agricultural Engineers' Hand Book*. McGraw Hill.
9. Romeo T Toledo. 1997. *Fundamentals of Food Process Engineering*. CBS.
10. Slade FH. 1967. *Food Processing Plant*. Vol. I. Leonard Hill Books.
11. Joshi MV. 1981. *Process Equipment Design*. Macmillan India Ltd., New Delhi
12. Foust AS & others 2001. *Principle of Unit Operations*, John Willey and Sons INC., New York.

Objective(s):

I. To acquaint with principle and techniques of fermentation and its application to processing and preservation of all types of food.

Unit-I

Introduction and definition of fermentation and terms related to fermentation, nutritional value of fermented food, requirements of fermentation, various substrates used in fermentation different types of fermenters

Unit-II

Traditional fermented foods: Sauerkraut, oriental fermented foods like soy sauce, miso, tempeh, sofu etc, dairy fermented products, cultured milk, yoghurt, cheese production,

Unit-III

production technology of baker's yeast, citric acid production, uses of citric acid in food and other industries, Antibiotics production and Vinegar production,

Unit-IV

Alcoholic fermentation, Importance, sources, cultivation, purification, separation and isolation of microbial enzyme, conversion to storage form and immobilization of enzymes, industrial application of enzymes.

Practicals

1. Fermentation of cabbage for preparation of sauerkraut
2. Fermentation of mixed-vegetables to make pickle
3. Fermentation of can juice to produce vinegar

Suggested readings/Text/References:

1. Industrial microbiology- Prescott & Dunns, Agrobios (India)
2. Microbial Technology- Pepler, H.J., Academic Press

PFE 595

Industry/Institute Training

0+1 (NC)

Objective:

To expose the students to the Industry/Institute.

Theory:

In-plant training in the relevant food industry during processing operation of the plant to study the actual working of the equipment and various unit operations. The evaluation will be based on the written report of the student and the comments of the factory managers. The duration of training shall be three weeks. The student shall be required to do training in the institute other than the institute in which he/she is enrolled.

PFE 599

Masters Research

20

Objective:

To develop research and project writing skills in students.

Theory:

A research project will be allotted to each student after the III semester. They will be required to complete the data collection, analysis and writing of dissertation so as to submit it at the end of IV Semester and to present it at seminar.

COMPULSORYNON-CREDIT COURSES

PGS 501 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.

PGS 502 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. *Chicago Manual of Style*. 14th Ed. 1996. Prentice Hall of India. *Collins' Cobuild English Dictionary*. 1995. Harper Collins.
2. Gordon HM & Walter JA. 1970. *Technical Writing*. 3rd Ed. Holt, Rinehart & Winston.
3. Hornby AS. 2000. *Comp. Oxford Advanced Learner's Dictionary of Current English*. 6th Ed. Oxford University Press.
4. James HS. 1994. *Handbook for Technical Writing*. NTC Business Books.
5. Joseph G. 2000. *MLA Handbook for Writers of Research Papers*. 5th Ed. Affiliated East-West Press.
6. Mohan K. 2005. *Speaking English Effectively*. MacMillan India.
7. Richard WS. 1969. *Technical Writing*. Barnes & Noble.
8. Robert C. (Ed.). 2005. *Spoken English: Flourish Your Language*. Abhishek.
9. Sethi J & Dhamija PV. 2004. *Course in Phonetics and Spoken English*. 2nd Ed. Prentice Hall of India.
10. Wren PC & Martin H. 2006. *High School English Grammar and Composition*. S. Chand & Co

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

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 & 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 & 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 & 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.
7. *The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000;*
8. *Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout*
9. *Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National*

PGS 504 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 vascupets; ashing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; Electric wiring and earthing. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy.

Suggested Readings

1. Furr AK. 2000. *CRC Hand Book of Laboratory Safety*. CRC Press.
2. Gabb MH & Latchem WE. 1968. *A Handbook of Laboratory Solutions*. Chemical Publ. Co.

PGS 505 Agricultural Research, Research Ethics and Rural Development 1+0
Programmes

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 & 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.

PGS 506
Objective

DISASTER MANAGEMENT

1+0

To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and capacity building.

Theory

UNIT I

Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches

UNIT II

Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.

UNIT III

Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media. Central, State, District and local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.

Suggested Readings

1. Gupta HK. 2003. *Disaster Management*. Indian National Science Academy. Orient Blackswan.
2. Hodgkinson PE & Stewart M. 1991. *Coping with Catastrophe: A Handbook of Disaster Management*. Routledge.
3. Sharma VK. 2001. *Disaster Management*. National Centre for Disaster Management, India.