Revised Course Syllabus

Of

M.Tech. (Processing and Food Engineering)

According to ICAR Guidelines

With effect from: Session 2018 – 19
(Approved in the BOS held on 03.02.2018)

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.

Course Outcomes:

After the completion of the course the students will be able to:

CO1: Understand the physical, chemical, and mechanical properties of food and their handling and storage.

CO2: Determine the porosity and roundness of fruits and vegetables.

CO3: Apply the knowledge of properties in the designing of food processing equipments.

CO4: Gain practical knowledge of food properties.

CO5: Develop the conceptual knowledge of food properties which can be utilized at industrial level.

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:**

New Syllabus: M.Tech (Processing and Food Engineering)
(Approved in the BOS held on 03.02.2018)


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

Course Outcomes:

After the completion of the course the students will be able to:

CO1: Apply the principles of mass, heat transfer and thermodynamics to analyze and synthesize unit operations in food processing technology.

CO2: Familiarize with principles of fluid flow and basic unit operation principles of several food processing methods.

CO3: Understand basic principles and energy laws related to size reduction

CO4: Ability to make material and energy balances on unit operations and processes

CO5: Understand the concept of humidity and usage of psychometric chart.

CO6: Learn the principles of dehydration and types of dryers employed in food processing sector.

Theory:

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.
New Syllabus: M.Tech (Processing and Food Engineering)
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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.
7. Experiments on cleaning and sorting equipments.
8. Calculation for fruits and vegetables dehydration

Suggested Readings:
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.

Course Outcomes:

After the completion of the course the students will be able to:

CO1: Ability to perform heat, mass and momentum transfer analysis.

CO2: Ability to analyze problems along with appropriate boundary conditions.

CO3: Ability to understand the chemical and physical transport processes and their mechanism.

CO4: Ability to develop steady and time dependent solutions along with their limitations.

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.
New Syllabus: M.Tech (Processing and Food Engineering)
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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.
4. Solving problems on radiation heat transfer.
5. Design of heat exchangers.
6. Experiments on conduction, convection and radiation heat transfer.

Suggested Readings
   Hill.
FEM 1010 Dairy Products Processing 2+1

Objective:
To impart knowledge of principles of processing of milk and milk products.

Course Outcomes:
After the completion of the course the students will be able to:

CO1: Acquire the basic knowledge about constituents, pre-treatment and processing of milk.

CO2: Identify with the different types of milk and their production methods.

CO3: Learn about various milk products as well their manufacturing process.

CO4: Understand the different packaging and cleaning techniques employed in dairy industries.

Unit-I

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 Anantakrishnan and AQ Khan and PN Padmanabhan, Shri Lakshmi Publications, Madras.

2. Milk Products Preparation and Control- CP Anantakrishnan 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
Objective(s):

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 and their properties and packaging systems.

Course Outcomes:

After the completion of the course the students will be able to:

CO1: Understand packaging materials and its importance in Food Industry
CO2: Adapt and utilize packaging materials for right application in Food Industry
CO3: Check barrier properties of packaging materials to avoid cross-contamination
CO4: Standardize testing methods for packaging materials to assure quality
CO5: Confirm packaging laws and regulations as per standards laid down by government agencies.

Theory:

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
New Syllabus: M.Tech (Processing and Food Engineering)
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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.
5. Familiarization of types of packaging materials.

Suggested readings/Text/References:

1. Hand Book of Spices and Packaging with Formulae- Eiri Board, New Delhi,
3. Food Packaging Principles and Practice- Robertson, G.L., CRC Press
New Syllabus: M.Tech (Processing and Food Engineering)
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FEM 1013                       Applied Instrumentation          2+1

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

Course Outcomes:

After the completion of the course the students will be able to:

CO1: Acquaint themselves with the classification of instruments, functional elements of instruments, static and dynamic performance characteristics, errors in measurements, and estimation of uncertainties in measurement systems.

CO2: Acquire an in-depth knowledge of the principles and working of various transducers and their applications in the food industry.

CO3: To possess a deep understanding of the measurement of food processing parameters and the related instruments.

CO4: To be aware of the principles and working of flow transducers, biomedical instruments, and instruments for composition analysis.

Theory:

UNIT-I


UNIT-II

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


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
New Syllabus: M.Tech (Processing and Food Engineering)  
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FEM 1014                      Low Temperature Preservation             2 + 1

Objectives:

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

II  To acquaint with application of refrigeration engineering in food technology.

Course Outcomes:
After the completion of the course the students will be able to:

CO1:  Understand the basic principles of refrigeration and air conditioning.

CO2:  Analyze performance and working principle of air refrigeration systems, vapor compression refrigeration systems, vapour absorption refrigeration systems, and steam jet refrigeration systems.

CO3:  Study the psychometric properties of air and utilize the principles of psychometric in the design of air conditioning equipments.

Theory:

UNIT I

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, and experiment on controlled and modified atmosphere storage system.

Suggested readings:
Objective:

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

Course Outcomes:

After the completion of the course the students will be able to:

CO1: Understand the concept of basic unit operations involved in grain processing such as grading, husking, milling, and parboiling and their handling and storage.

CO2: Gain practical knowledge of extraction of edible and non-edible oil, and time estimation in freezing and thermal processing.

CO3: Apply the practical knowledge of food process engineering at industrial level as well as in the designing of food process equipment.

CO4: Design the equipments such as single and multiple effect evaporators, plate and packed towers.

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**


**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**


13. Handbook of Postharvest Technology - Chakraverty, Muzumdar, Raghavan, Ramaswamy (editors), Marcel Dekker Inc.
Objective(s):
To impart knowledge on equilibrium stage separation processes and molecular diffusion.

Course Outcomes:
After the completion of the course the students will be able to:

CO1: Acquaint one with the fundamental concepts of mass transfer principles.
CO2: Understand the general principles of separation processes, extraction and leaching.
CO3: Identify and solve single and multistage mass transfer problems.
CO4: Understand basics of diffusion mass transfer and its application in food processing.

Theory:

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.
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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:

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.

Course Outcomes:

After the completion of the course the students will be able to:

CO1: To identify the principles of keeping animals in liarage and slaughtering of the meat animals in slaughter house.
CO2: To educate the students about the primal cuts of the meat.
CO3: Apply the principles of HACCP for meat production, packaging, freezing during frozen storage.
CO4: To adapt the safe system of meat transportation and distribution.
CO5: To apply principle of SOP during meat product development.

Theory:

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

Unit-III

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.
New Syllabus: M.Tech (Processing and Food Engineering)
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FEM 2022 Food Quality and Safety Engineering  2+1

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.

Course Outcomes:

After the completion of the course the students will be able to:

CO1:  Identify the principles of analysis both (Proximate and Ultimate) to match the food standards.

CO2:  To provide directions to Food industry for Food Quality Standards.

CO3:  To educate the students for handling of the instruments for study of quality characteristics.

CO4:  To educate the students about the Food Regulations of National and International Standards viz. FPO-1945, FSSAT-2006, CAC-1979 etc. to prevent fraudulent practices.

CO5:  To understand the Food Safety and Hygiene.

CO6:  To evaluate sensory quality test with instrument.

Theory:

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 pine apple, 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. (FSSA, 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:


FEM 2023  Statistical Methods and Experimental Design  2+1

Objective: To give fundamental and applied knowledge of experimental designing and statistical application in agriculture.

Course Outcomes:

After the completion of the course the students will be able to:

CO1: Understand the basic concept of statistics in agriculture including frequency curve and its characteristics, Measures of dispersion- standard deviation (SD) and standard error (SE).

CO2: Identify common and important types of experimental designs with respective advantages and disadvantages

CO3: Choose an appropriate design in a given research setting.

CO4: Perform a correct statistical analysis of different types of designs using appropriate software such as MINITAB, R-Analysis, and SPSS.

Theory:

Unit -I

Unit -II
Principles of experimental designs; completely randomized design (CRD), randomized block design (RBD), latin square design (LSD) and split plot design (SPD).

Unit -III

Unit -IV
Application packages of statistical analysis: R-analysis, MINITAB and SPSS.

Suggested Readings/Texts/References
New Syllabus: M.Tech (Processing and Food Engineering)  
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2. Panse V.G. and Sukhatme P.V. 1989. Publication and Information Division Indian Council of Agricultural Research, New Delhi
http://www.R-project.org/.
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.

Course Outcomes:

After the completion of the course the students will be able to:

CO1: Understand the classification, biological functions and nutritional importance of carbohydrates, lipids and proteins during storage and processing of food with emphasis on food industry applications.

CO2: Gain knowledge of vitamins, minerals, pigments and flavors of food and their importance in the food industry.

CO3: Classify enzymes and understand their kinetics, including factors affecting the enzyme catalyzed reaction rate and the role of enzyme inhibitors.

CO4: Comprehend the need and scope of food microbiology and enumerate the important genera of micro-organisms associated with food.

CO5: Develop the conceptual knowledge of culture maintenance and preservation, contamination of foods, microbial spoilage of various food products, and microbiology of water, food infection and food intoxication.

Theory:

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, Mecheles 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:
New Syllabus: M.Tech (Processing and Food Engineering)
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FEM 3006  Fruits and Vegetable Process Engineering  2+1

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

Course Outcomes:
After the completion of the course the students will be able to:

CO1: Analyze the nutritional aspects in fruit and vegetables

CO2: Provide solution for spoilage of fruit and vegetables while handling and storage.

CO3: Set up new processing flow line for new products with quality standards.

CO4: Set quality assurance policy in process flow meeting the standards for effective output.

CO5: Set up Fruits and Vegetables processing flow line with quality standards

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

New Syllabus: M.Tech (Processing and Food Engineering)
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FEM 3007        Mathematical Models in Food Processing    3+0

Objective(s):

To provide the basic concepts of various mathematical modelling techniques, applications of mathematical modelling in food processing and microbial destructions.

Course Outcomes:

After the completion of the course the students will be able to:

CO1: Assess the use of mathematical models in food industry in terms of mathematical techniques knowledge.

CO2: Develop model equations for the given system and demonstrate the model solving ability for various processes/unit operations.

CO3: Formulate and qualitatively analyze mathematical models of a wide range of systems and processes.

Theory:

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.
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Unit-IV

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

Suggested Readings


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.

Course Outcomes:

After the completion of the course the students will be able to:

CO1: Understand the overall plant design concept including plant layout, plant location, factors affecting the plant location, design and testing standard etc.

CO2: Determine the requirement of plant utilities for any food processing plant design.

CO3: Analyze various facts of food plant design such as estimation of break-even and economic plant size, estimation of capital investment, analysis of plant costs and profitability’s.

CO4: Gain the practical knowledge of designing of machineries used at different stages of food processing, such as for drying, milling, grinding, evaporation, etc.

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


FEM 3022 Industrial Fermentation 2+1

Objective:

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

Course Outcomes:

After the completion of the course the students will be able to:

CO1: Identify the principles of enzymology and the effect of fermentation on nutritional value of the processed food.

CO2: Apply the principles of fermentation in the development of Food products of commercial value.

CO3: Apply industrial fermentation for development of non-food products like Penicillin and beer.

CO4: Identify the commercial products like produced by alcoholic fermentation and application of commercial enzymes.

CO5: Exploit the activity of Microorganism for commercial production of enzymes.

Theory:

Unit-I

Introduction and definition of fermentation and terms related to fermentation, nutritional value of fermented food, requirement’s of fermentation, various substrate used in fermentation different types of fomenters

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)
Objective:

- Get an opportunity to read, and understand published research articles relating to food process engineering and allied fields.
- To critically evaluate and analyze published scientific and technical literature.
- Acquire good oral and written communication skills.

Course Outcomes:

After the completion of the course the students will be able to:

CO1: Read and understand technical papers in agriculture and food process engineering.

CO2: To identify and formulate broadly defined chemical engineering problems by critically evaluating the published literature.

CO3: To communicate effectively and professionally.

CO4: To employ state of the art research tools and methods for solving contemporary chemical engineering problems.

Course Syllabus:

The student will be required to search scientific/technical literature in the emerging areas of food process engineering and allied fields in Journals and periodicals (both hard copies and e-journals) and select two research papers of his/her interest. He/she shall comprehend the paper and present the same orally to the gathering of staff and students using ICT tools. Seminar presentation guidelines shall be provided to the students. The seminars shall be evaluated by the associated faculty based on the understanding, presentation, content, and quality of the PPT.
New Syllabus: M.Tech (Processing and Food Engineering)  
(Approved in the BOS held on 03.02.2018)

FEM 3074 Industry/Institute Training 0+1 (NC)

Objective:

To expose the students to the Industry/Institute.

Course Outcomes:

After the completion of the course the students will be able to:

CO1: To write and deliver technical talks.

CO2: Understand professional and ethical responsibility.

CO3: Communicate effectively in English.

CO4: Recognize the need and an ability to engage themselves in life-long learning.

CO5: Adopt themselves in working environment.

CO6: Gain the practical and fundamental knowledge of unit operation and process, principle of management and economics involved in industries.

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.
FEM 4071            Masters Research       20

Objective:

To develop research and project writing skills in students.

Course Outcomes:

After the completion of the course the students will be able to:

CO1: Study and understand technical papers related to his research work in the area of agriculture and food process engineering.

CO2: Apply the concepts and principles involved in the courses related to mathematical analysis, heat and mass transfer, unit operation, and statistical analysis.

CO3: Employ state of the art research tools and methods for solving the selected problem.

CO4: Present his research work effectively and professionally.

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.
COMPULSORY NON-CREDIT COURSES

FEM 1072 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.
FEM 1073  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


New Syllabus: M.Tech (Processing and Food Engineering)
(Approved in the BOS held on 03.02.2018)


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


New Syllabus: M.Tech (Processing and Food Engineering)
(Approved in the BOS held on 03.02.2018)


7. The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000;
8. Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout
New Syllabus: M.Tech (Processing and Food Engineering)
(Approved in the BOS held on 03.02.2018)

FEM 2073 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;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, 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
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, Cooperatives, Voluntary Agencies/Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings:
New Syllabus: M.Tech (Processing and Food Engineering)
(Approved in the BOS held on 03.02.2018)


FEM 3073  Disaster Management  1+0

Objective
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