Syllabus for M.-Tech. in Post Harvest Engineering

Semester-I

PHE 501 UNIT OPERATIONS IN AGRICULTURAL PROCESSING 2+1 (3)

Theory

UNIT I

Review of basic engineering mathematics; Units and dimensions; Mass and energy balance.

UNIT II

Principles of fluid flow, methods of heat transfer, heat exchangers and their designs.

UNIT III

Psychrometry, dehydration:- theory and process, type of dryers, EMC, Thermal processing operations; Evaporation, dehydration/drying, types of dryers, blanching, pasteurization, distillation, steam requirements in food processing.

UNIT IV

Refrigeration principles and Food freezing. Mechanical separation techniques, size separation equipments; Filtration, sieving, centrifugation, sedimentation. Material handling equipment, conveyors and elevators; Size reduction processes and equipment; Grinding and milling. Agitation and mixing of liquid, powder and paste.

Practical

Fluid flow properties, study of heat exchangers problems, application of psychrometric chart, determination of EMC, study of driers, elevating and conveying equipments, size reduction equipments, cleaning and sorting equipments, mixing equipments, sieve analysis, kinetics of fruits and vegetables dehydration, calculation of refrigeration load, food plant design, gas and water transmission rate, solving of numerical problems.

PHE 502 ENGINEERING PROPERTIES OF BIOLOGICAL MATERIALS 2+1 (3)

Theory

UNIT I

Physical characteristics of different food grains, fruits and vegetables; Shape and size, description of shape and size, volume and density, porosity, surface area. Rheology; ASTM standard, terms, physic al states of materials, classical ideal material, rheological models and quations, visco-elasticity,creep-stress relaxation, Non-Newtonian fluid and viscometry, rheological properties, force, deformation, stress, strain, elastic, plastic behaviour.

UNIT II

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. Friction in agricultural materials, rolling resistance, angle of internal friction, angle of repose, flow of bulk granular materials, aero-dynamics of agricultural products, drag coefficients, terminal velocity.

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

Practical
Experiments for the determination of physical properties like, length, breadth, thickness, surface area, bulk density, porosity, true density, coefficient of friction, angle of repose and colour for various food grains, fruits, vegetables, spices and processed foods, aerodynamic properties like terminal velocity, lift and drag force for food grains, thermal properties like thermal conductivity, thermal diffusivity and specific heat, firmness and hardness of grain, fruits and stalk, electrical properties like dielectric constant, dielectric loss factor, loss tangent and A.C. conductivity of various food materials.

PHE 503 TRANSPORT PROCESS IN FOOD ENGINEERING 3+0 (3)

Theory

UNIT I
Introduction to heat and mass transfer 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. Applications in food processing including freezing and thawing of foods.

UNIT II
Convective heat transfer in food processing systems involving laminar and turbulent flow heat transfer in boiling liquids, heat transfer between fluids and solid foods. Functional design of heat exchangers: Shell and tube, plate and scraped surface heat exchangers, Jacketed vessels.

UNIT III
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.

Practical
Solving problems on steady and unsteady state conduction with or without generation; numerical analysis; problems in natural and forced convection; radiation; design of heat exchangers; performing experiments on heat conduction, convection and radiation heat transfer.

PHE 504 POST HARVEST ENGINEERING OF CEREALS, PULSES AND OILSEEDS 2+1 (3)

Theory

UNIT I
Production and utilization of cereals and pulses, grain structure of major cereals, pulses and oilseeds and their milling fractions; grain quality standards and physico-chemical methods for evaluation of quality of flours.

UNIT II
Pre-milling treatments and their effects on milling quality; parboiling and drying, conventional, modern and integrated rice milling operations; wheat roller flour milling; processes for milling of corn, oats, barley, gram, pulses, paddy and flour milling equipments.

UNIT III
Dal mills, handling and storage of by-products and their utilization. Storage of milled products, Expeller and solvent extraction processing, assessment of processed product quality.

UNIT IV
Oilseed processing, Extraction and refining of oil from coconut, soyabean, sunflower and rice bran. Packaging of processed products, design characteristics of milling equipments; selection, installation and their performance, BIS standards for various processed products.

Practical
Physical properties of cereals and pulses, raw and milled products quality evaluations; parboiling and drying; terminal velocities of grains and their fractions; study of paddy, wheat, pulses and oilseeds milling equipments; planning and layout of various milling plants, visit to related agro-processing industry.

Semester-II

PHE 551 STORAGE AND HANDLING OF CROPS 2+1 (3)

Theory

UNIT I
Storage of grains, biochemical changes during storage, production, distribution and storage capacity estimate models, storage capacity models, ecology, storage factors affecting losses, storage requirements.

UNIT II
Bag and bulk storage, godowns, bins and silos, rat proof godowns and rodent control, method of stacking, preventive method, bio-engineering properties of stored products, function, structural and thermal design of structures, aeration system.

UNIT III

Grain markets, cold storage, controlled and modified atmosphere storage, effects of nitrogen, oxygen, and carbon dioxide on storage of durable and perishable commodities, irradiation, storage of dehydrated products, food spoilage and preservation, BIS standards.

UNIT IV
Physical factors influencing flow characteristics, mechanics of bulk solids, flow through hoppers, openings and ducts; design of belt, chain, screw, roller, pneumatic conveyors and bucket elevators; principles of fluidization; recent advances in handling of food materials.

Practical
Quality evaluation of stored products, design of storage structures, cold storage, load estimation, construction, maintenance, static pressure drop, experiment on controlled and modified atmosphere storage system, estimation of storage loss, and quality of stored products.

PHE 552 AGRICULTURAL WASTE AND BY-PRODUCTS UTILIZATION 2+1 (3)

Theory

UNIT I
Generation of by-products, agricultural and agro industrial byproducts/ wastes, properties, on site handling, storage and processing.

UNIT II
Collection of wastes, utilization pattern as fuel, agricultural waste fired furnaces: Mechanism, construction and efficiency, suitability of wastes as fuel, fuel briquettes, briquetting process, equipment, factors affecting briquetting.

UNIT III
Utilization of wastes for paper production, production of particle board, utilization, by-products from rice mill, rice husk, rice bran, utilisation.

UNIT IV
Thermo-chemical conversions, densification, combustion and gasification, extraction, biological conversions, anaerobic digestion, biochemical digestion process, digestion systems, energy from anaerobic digestion, cellulose degradation, fermentation process.

Practical
Exercises on stepped grate and fixed grate rice husk furnaces, waste fired furnace, briquette machine, production of alcohol from waste materials, production and testing of paperboards and particleboards from agricultural wastes.

PHE 553 PROCESS EQUIPMENT DESIGN 2+1 (3)

Theory

UNIT I
Design considerations of processing agricultural and food products.

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

UNIT III
Human factors in design, selection of materials of construction and standard component, design standards and testing standards. Plant design concepts and general design considerations: plant location, location factors and their interaction with plant location, location theory models, computer aided selection of the location.

UNIT IV
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, computer aided development of flow charts.

Practical
Detailed design and drawing of mechanical dryers, milling equipment, separators, evaporators, mixers and separators. 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.

PFE 554 ADVANCES IN DRYING OF FOOD MATERIALS 2+1 (3)

Theory

UNIT I
Importance of drying, principles of drying, moisture determination, equilibrium moisture content, determination of EMC, methods and isotherm models, psychrometry, psychrometric terms, construction and use of psychrometric charts.

UNIT II
Air flow and resistance, principles and equipments for air movement and heating, drying methods and theory of drying, driers, classification and other allied equipment, thin layer drying of cereal grains, deep bed and continuous flow drying, drying models.

UNIT III
Heat requirements and thermal efficiency of drying system, aeration, tempering and dehydration, operation of driers and their controls, selection of driers, performance testing of grain driers, drying characteristics of cereals, pulses and oilseeds, microwave drying, radio frequency drying and tunnel drying, principles and equipment.

UNIT IV
Drying of liquid foods, spray drying, drum drying, freeze drying, foam mat drying, heat pump drying, osmotic dehydration; Principles, methods, construction and adjustments, selection of dryers, heat utilization factor and thermal efficiency.

Practical Experiments on batch type thin layer drier, fluidized bed drier, continuous flow mixing type drier, continuous flow non mixing type drier, sand medium drier (conduction type drying), agricultural waste fired furnace drier, spray dryer, drum dryer, foam mat drying and osmotic dehydration, to evaluate the thermal efficiency and heat utilization factor.

Semester-III

PHE-601 COMPUTER APPLICATION IN NUMERICAL ANALYSIS 3+1 (4)

Review of algorithm and methods of successive bisection, Newton-Rapson iterative method. Solution of simultaneous algebraic equations: Gauss elimination method, refinement of its solution, Gauss Seidel iterative method, Algorithn to implement the Gauss-Seidel method. Linear regression algorithm for linear regression, polynomial regression, fitting exponential and trigonometric functions. Formulae for mumerical differentiations, numerical integration, Simpson's numerical solution to differential equation. Raunge-Kutta method, Raunge-Kutta 4^{th} order formulae, Higher order differential equations.

Practical

Practice on developing programs for solutions of higher order algebraic equations, Simultaneous equations, Interpolation, Least square approximation, differentiation, integration and numerical solution t differential equation and testing them on computer.

FE	MINOR-I	3+1 (4)
FE	MINOR-II	2+1 (3)
STAT	SUPPORTING COURSE	3+0 (3)
PHE 649	SEMINAR-I	0+1 (1)

Semester-IV

PHE 699	SEMINAR-II	0+1 (1)
PHE 649	PROJECT WORK	0+20(20)