

Baba Sahab Dr Bhim Rao Ambedkar College of Agril Engg & Technology
(Chandra Shekhar Azad University of Agriculture & Technology, Kanpur)
Campus-Etawah-206 001 U.P.

M. Tech. (Agricultural Engineering)
(Effective from the session 2017-18)

Name of the Subjects	Course No.	Credits	Semester			
			I	II	III	IV
Core Courses: Total 12 Credits (two course in first semester and one course in second and third semester).						
Unit Operations in Food Process Engineering	AEN 511	3(2+1)	3			
Engineering Properties of Food Materials	AEN 512	3(2+1)	3			
Advanced Food Process Engineering	AEN 521	3(2+1)		3		
Processing of Cereals, Pulses and Oilseeds	AEN 531	3(2+1)			3	
Major Courses : Total 12 credits (two courses in second semester & one course in first & third semester)						
Fruits & Vegetable Process Engineering	AEN 513	3(2+1)	3			
Food Packaging	AEN 514	3(2+1)	3			
Meat Processing	AEN 515	3(2+1)	3			
Drying and Dehydration of Foods	AEN 516	3(2+1)	3			
Transport Phenomena in Food Processing [#]	AEN 522	3(2+1)		3		
Food Processing Equipments Design	AEN 523	3(2+1)		3		
Farm Structures and Environmental Control	AEN 524	3(2+1)		3		
Storage Engineering and Handling of Agricultural Products	AEN 525	3(2+1)		3		
Post Harvest Processing of Grains	AEN 535	3(2+1)			3	
Food Chemistry & Microbiology	AEN 536	3(2+1)			3	
Biochemical & Process Engineering	AEN 537	3(2+1)			3	
Supporting Courses: Total 12 credits (two courses in first semester and one course in second and third semester).						
Higher Mathematics	BSH 515	3(3+0)	3	-	-	
Statistical Methods	BSH 510	3(2+1)	3	-	-	
Advance Programming with 'C++'	CSE 511	3(1+2)	3			
CAD/CAM	MED 518	3(1+2)	3			
Methods of Numerical Analysis	BSH 521	3(2+1)		3		
Energy Management in Food Process Industries	RES 523	3(2+1)		3		
Energy Management in Agriculture	RES 537	3(3+0)			3	-
Renewable energy systems	RES 531	3(2+1)			3	
Energy Lab	RES 536	3(0+3)			3	
Others						
Non credit courses	PGS 501-506	1	1	1	1	
Seminar	AEN 591	1(0+1)			1	
Comprehensive Examination	AEN 533	NC			NC	
Thesis	AEN 599	20(0+20)			5	15
Total credit hours to be offered (For Masters)		57	15	12	15	15

Compulsory course

Non Credit courses: One course of 01 credit each in I, II and III semester

COMPULSORY NON-CREDIT COURSES (Compulsory for Master's programme in all disciplines)

Code	Course Title	Credits
PGS 501	Library and information services	1(0+1)
PGS 502	Technical writing and communications skills	1(0+1)
PCS 503	Intellectual property and its management in agriculture	1(1+0)
PGS 504	Basic concepts in laboratory techniques	1(0+1)
PGS 505	Agricultural research, research ethics & rural development programmes	1(1+0)
PGS 506	Disaster management	1(1+0)

UNIT OPERATIONS IN FOOD PROCESS ENGINEERING

AEN 511

3(2+1)

Objective

To acquaint the students with different unit operations of food industries.

Theory

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 foods 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 food.

Size Reduction: Principles, types of equipments, applications and energy laws, sorting & grading equipments
Mixing: Objectives, equipments for solid, liquid mixing; energy requirements, mixing indices.

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

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

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.

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.

Suggested Readings

- Brennan JG, Butters JR, Cowell ND & Lilly AEI. 1990. Food Engineering Operations. Elsevier.
- Earle RL. 1985. Unit Operations in Food Processing. Pergamon Press.
- Fellows P. 1988. Food Processing Technology: Principle and Practice. VCH Publ.
- McCabe WL & Smith JC. 1999 Unit Operations of Chemical Engineering. McGraw-Hill.
- Sahay KM & Singh KK. 1994. Unit Operation of Agricultural Processing. Vikas Publ. House.
- Singh RP & Heldman DR. 1993. Introduction to Food Engineering. Academic Press.

ENGINEERING PROPERTIES OF FOOD MATERIALS

AEN 512

3(2+1)

Objective

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

Theory

Importance and brief description of mechanical; thermal; electrical and optical properties; Physical characteristics - Shape; size; charted standards; roundness; sphericity; axial dimensions and projected area.; Volume and Density - Platform scale; specific gravity balance; pycnometer method; Porosity and surface areas - Leaf and stalk surface area; fruit surface area; egg surface area and specific surface in porous pack.

Basic concepts of Rheology, Physical states of material; Rheological models and Rheological equations, Maxwell, Kelvin, 4-element model, Generalized Maxwell and Generalized Kelvin models; Viscoelastic characterization of materials - Stress; strain behaviour; creep, stress relaxation and dynamic tests.

Textural and structural mechanics of food materials, effect of age, water content and temperature on texture of foods, introduction to rheological characteristics of Agricultural, Dairy and Food Products.

Mechanical Damage - Economic importance; causes; detection and evaluation of mechanical damage. Impact damage and its mechanics; vibration damage and stress cracking; Maximum allowable load for Agri. Products.

Aero- and Hydro-dynamic characteristics - Drag coefficient; terminal velocity; separation of foreign materials; pneumatic transport and handling; Effect of moisture on frictional properties. Angle of internal friction; angle of repose. Application of frictional properties in design of handling and processing machines. Screw conveyors, oscillating conveyors; shifting on an oscillating riddle.

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.

Suggested Readings

- Mohesenin NN. 1980. Thermal Properties of Foods and Agricultural Materials. Gordon & Breach Science Publ.
- Mohesenin NN. 1980. Physical Properties of Plant and Animal Materials. Gordon & Breach Science Publ.
- Peleg M & Bagelalay EB. 1983. Physical Properties of Foods. AVI Publ. Co.
- Rao MA & Rizvi SSH. (Eds). 1986. Engineering Properties of Foods. Marcel Dekker.
- Singhal OP & Samuel DVK. 2003. Engineering Properties of Biological Materials. Saroj Prakasan.

FRUITS & VEGETABLES PROCESS ENGINEERING

AEN 513

3(2+1)

Objective

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

Theory

Fruits and vegetables -Washing fruits and vegetables; scalding and blanching; peeling fruits and vegetables for canning; object of grading; effect of variety and maturity; effect of temperature; grading for quality; changes in concentration of syrup after canning; size grading fruits and vegetables; quality control; sugar used in canning and preparation of syrup for canning; syruping machine; brines and brining; object of exhausting; relation of temperature of exhausting to degree of vacuum; measuring vacuum; type of exhaust boxes; filling cans and vapour sealing principles of processing of canned fruits and vegetables; theoretical and practical processing times. Introduction to processing methods and equipment; flow diagram of canning for apples; cherries; grapes; pears; plums; orange; pineapples canned dried fruits and vegetable general comparison of fruits and vegetables; raw products canning; flow charts for green beans; carrots; corn; lime beans; peas tomatoes and spinach/spoilage of canned foods; discoloration corrosion and perforation of the plate; general introduction to micro organisms causing spoilage.

Sun drying - Sun drying of fruits; equipment for sun drying; sun drying of figs; dates and grapes.

Dehydration - Types of dehydration of fruits such as apples; bananas; cherries; dehydration of vegetables.

Pickling -Types of pickles; introduction to flow diagram for production of cucumber, onion; pickles etc.

Freezing - Physical changes during freezing and thawing rates of cooling and freezing; methods of freezing; storage temperature; use of sulphur dioxide in frozen pack fruits; ascorbic and citric acids; brief direction for fruits and vegetables such as apples apricots grapes mangoes; peaches; cherries; pineapple; fruit juices; concentrates; cauliflower; carrot; peas; tomatoes and potato pre cooked frozen foods; home and farm freezers.

References:

- Cruess, W.V.(2000) "Commercial Fruit and Vegetable Products". McGraw Hills Book Company, Inc., New York.

- Girdhari Lal and Tandon, G.L. (1986). Preservation of fruits and vegetables Published by Publications and Information Division, ICAR, New Delhi-12.

PROCESSING OF CEREALS, PULSES AND OILSEEDS

AEN 531

3(2+1)

Objective

To acquaint the students with the post harvest technology of cereals, pulses and oilseeds with special emphasis on their equipments.

Theory

Production and utilization of cereals and pulses, Grain structure, chemical composition, effect of temperature on quality of grains, physical properties, thermal and aerodynamic properties.

Principles of parboiling of paddy and wheat; physicochemical changes during parboiling, effect of parboiling on milling; nutritional and cooking qualities of rice, methods of parboiling of paddy, introduction major process such as crystal rice process, Jadavpur University process; AVORIO Process, RPEC method, sodium chromate method, Kisan parboiling and pressure parboiling, parboiling of wheat principles and process.

General considerations in milling – Cleaning and separation, effectiveness of separation, husking of grain, factors affecting and effectiveness of husking, grinding and effectiveness of grinding machinery used in cereal grinding.

Hydrothermal treatment/conditioning of cereal grains, Rice Milling- Traditional rice milling machine, modern rice milling machinery, general principles of cleaning, open double sieve cleaner and single scraper, drum cleaner, paddy cleaner with stirrer, husking machinery such as impact type paddy husker, rubber roll husker (Japan type), Paddy separator (Japan and European type), whitening of grain, vertical and horizontal whitening machines, friction type whitening machine.

Milling of corn, wheat and pulses - Wet and dry milling of corn, wheat milling and milling of pulses.

Utilization of rice bran and other by products -Principles of storage and utilization of rice bran, methods of utilization Including dry and wet heat treatment, rice bran stabilizer under development in India, extraction of rice bran oil, solvent and batch extraction methods, refining of crude rice bran oil, solvent and batch extraction methods, refining of crude rice bran oil into edible grade oil, uses of bran, bran oil and various constituents.

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.

Suggested Readings

- Asiedu JJ.1990. Processing Tropical Crops. ELBS/MacMillan.
- Chakraverty A. 1995. Post-harvest Technology of Cereals, Pulses and Oilseeds. Oxford & IBH.
- Morris Lieberman. 1983. Post-harvest Physiology and Crop Preservation. Plenum Press.
- Pandey PH. 1994. Principles of Agricultural Processing. Kalyani.
- Pillaiyar P. 1988. Rice - Post Production Manual. Wiley Eastern.
- Sahay KM & Singh KK. 1994. Unit Operations in Agricultural Processing. Vikas Publ. House.

ADVANCED FOOD PROCESS ENGINEERING

AEN 521

3(2+1)

Objective

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

Theory

Kinetics of biological reactions - Kinetics of reaction occurring in processed foods Reaction velocity constant; order of reaction; quality changes during storage of foods; application of Arrhenius equation to the biological reaction

Thermal processing: Death rate kinetics, thermal process calculations, methods of sterilization and equipments involved, latest trends in thermal processing. Commercial sterility; chilling, pasteurization and sterilization methods based on slowest heating region; determination of the process time based on region of greatest

temperature lag; the process equivalence in terms of minutes at 121.1°C, aseptic canning process hydrostatic sterilizer and aseptic packaging practices.

Mechanical separation process - Filtration, design of filtration system; constant rate filtration, constant pressure filtration, mechanism of filtration, design of filtration sedimentation and centrifugation; basic equations, rate of separation, liquid liquid separation particle gas separation .

Water in foods: Water activity, moisture sorption isotherms, Moisture hysteresis, Raoult's law, Henry law, Moisture sorption models such as BET, GAB, Henderson; methods of developing moisture sorption isotherm, Use of moisture isotherm in storage conditions and shelf life estimation.

Extrusion: Theory of extrusion, types of extruders, advantages of twin screw extruders, Components of extruders, Pressure measurement in extruders.

Practical

Solving problems on Kinetics of reactions, Time estimation in thermal processing, water activity measurement, Moisture Isotherm, Shelf life of foods. Separation processes.

Suggested Readings

- Brennan JG, Butters JR, Cowell ND & Lilly AEI. 1990. Food Engineering Operations. Elsevier.
- Coulson JM & Richardson JF. 1999. Chemical Engineering. Vol. II & IV. The Pergamon Press
- Earle RL. 1985. Unit Operations in Food Processing. Pergamon Press.
- Fellows P. 1988. Food Processing Technology: Principle and Practice. VCH Publ.
- Geankoplis J Christie. 1999. Transport Process and Unit Operations. Allyn & Bacon.
- Henderson S & Perry SM. 1976. Agricultural Process Engineering, 5th Ed. AVI Publ. Co.
- McCabe WL & Smith JC. 1999 Unit Operations of Chemical Engineering. McGraw-Hill.
- Sahay KM & Singh KK. 1994. Unit Operation of Agricultural Processing. Vikas Publ. House.
- Singh RP & Heldman DR. 1993. Introduction to Food Engineering. Academic Press.
- Singh RP. 1991. Fundamentals of Food Process Engineering. AVI Publ.

FOOD PACKAGING

AEN 514

3(2+1)

Objective

To acquaint the students with packaging methods, packaging materials, packaging machineries, modern packaging techniques etc.

Theory

Introduction of packaging: Package, functions and design. Principle in the development of protective packaging. Deteriorative changes in foodstuff and packaging methods of prevention.

Food containers: Rigid containers, glass, wooden boxes, crates, plywood and wire bound boxes, corrugated and fibre board boxes, textile and paper sacks, corrosion of containers (tin plate); Flexible packaging materials and their properties; Aluminium as packaging material; Evaluation of packaging material and package performance.

Packaging equipments: Food packages, bags, types of pouches, wrappers, carton and other traditional package; Retortable pouches;

Shelf life of packaged foodstuff. Methods to extend shelf life; Packaging of perishables and processed foods; Special problems in packaging of food stuff.

Package standards and regulation; Aseptic packaging, CA and MAP, Active packaging; Biodegradable packaging.

Practical

Thickness, substance weight, water absorption capability of flexible packaging materials; Strength properties of packaging materials; Water vapour and gas transmission rate of flexible packaging materials; Identification and chemical resistance of plastic films; Packaging of fruits/vegetables; Estimation of shelf-life of packaged food stuff; Familiarization of types of packaging material.

Suggested Readings

- Crosby NT. 1981. Food Packaging Materials. Applied Science Publ.

- Mahadeviah M & Gowramma RV. 1996. Food Packaging Materials. Tata McGraw-Hill.
- Palling SJ. (Ed). 1980. Developments in Food Packaging. Applied Science Publ.
- Sacharow S & Grittin RC. 1980. Principles of Food Packaging. AVI Publ. Co.

MEAT PROCESSING

AEN 515

3(2+1)

Objective

To acquaint the students with processing of meat and meat products and the design features of the equipments used for their processing.

Theory

Meat and poultry products: Introduction, kinds of meat animals and poultry birds, classification of meat, composition of meat.

Slaughtering: Pre slaughter operations, post slaughter operations, wholesale and retail cuts.

Preservation of poultry: different methods, stuffed products, frozen products, poultry concentrates and flavours, synthetic poultry flavour.

Different preservation methods of meat: Smoking, curing and freezing, chilling of meat and different methods of chilling, freezing of meat and different methods of freezing of meat, physical and chemical changes during chilling and freezing, packaging of meat and meat products, quality control.

Classification, composition and nutritive value of eggs: Grading of eggs, different quality parameters of eggs, Haugh unit, processing of egg, yolk processing, egg breaking mechanisms, freezing of egg, pasteurization, desugarisation and dehydration of egg, different dehydration methods, quality control and specification of egg products.

Fish: Nutritional quality of fish and fish products, fillet and steaks, different preservation techniques, chilling, freezing, drying, canning, curing and smoking, quality control in fish processing.

Practical

Experiments in slaughtering, dressing, wholesale and retail cutting: Curing, preservation of meat and meat products, estimation of quality of egg, Haugh unit, desugarisation, preparation of whole egg powder, yolk powder, freezing of fish, drying of fish, canning of fish, visit to meat and fish processing units.

Suggested Readings

- Chooksey MK & Basu S. 2003. Practical Manual on Fish Processing and Quality Control. CIFE, Kochi.
- Chooksey MK. 2003. Fish Processing and Product Development. CIFE, Kochi.
- Hall GM. 1997. Fish Processing Technology. Blabie Academic & Professional.
- Lawrie RS. 1985. Developments in Meat Sciences, Vol. III. Applied Science Publ.
- Mead GC. 1989. Processing of Poultry. Elsevier.
- Pearson AM & Tauber FW. 1984. Processed Meats. AVI Publ. Co.
- Stadelman WJ & Cotterill OJ. 1980. Egg Science and Technology. AVI Publ. Co.

DRYING AND DEHYDRATION OF FOODS

AEN 516

3(2+1)

Objective

To acquaint the students with the latest technologies of dehydration of food products and the design features of different dryers.

Theory

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.

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.

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.

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.

Suggested Readings

- Bala BK. 1998. Drying and Storage of Cereal Grains. Oxford & IBH.
- Brooker DB, Bakker Arkema FW & Hall CW. 1974. Drying Cereal Grains. The AVI Publ. Co.
- Chakraverty A & De DS. 1999. Post-harvest Technology of Cereals, Pulses and Oilseeds. Oxford & IBH.
- Hall CW. 1970. Drying of Farm Crops. Lyall Book Depot.
- Tadensz Kudra & Majumdar AS. 2002. Advanced Drying Technologies. Marcel Dekker.
- Wallace B Van Arsdell & Michael J Copley. 1963. Food Dehydration. The AVI Publ. Co.

TRANSPORT PHENOMENA IN FOOD PROCESSING

AEN 522

3(2+1)

Objective

To acquaint the students with the principles of heat and mass transfer and its applications in food processing.

Theory

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.

Convective heat transfer in food processing systems involving laminar and turbulent flow, Convective heat transfer – flat plate forced & natural convection, low over cylinder forced & natural convection; flow through cylinder forced convection; flow over spheres forced & natural convection, laminar vs. turbulent flow
Radiation heat transfer and its governing laws, its applications in food processing.

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.

Suggested Readings

- Earle RL. 1985. Unit Operations in Food Processing. Pergamon Press.
- Geankoplis J Christie 1999. Transport Process and Unit Operations. Allyn & Bacon.
- Holman JP. 1992. Heat Transfer. McGraw-Hill.
- McCabe WL & Smith JC. 1999. Unit Operations of Chemical Engineering. McGraw Hill.

FOOD PROCESSING EQUIPMENT DESIGN

AEN 523

3(2+1)

Objective

To acquaint 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

Material of construction - Choice of materials, physical and economical factors, generalized properties and fields of application of different metals such as ferrous metals and non ferrous metals; Steels and their uses; alloy steels; non ferrous metal and their alloys; generalized properties and field of application of non metals.

Piping - Cast iron and wrought iron pipes and tubing; light wall pipe; tubing, pipe connections and fittings; pipes and tube design data, design of steam piping.

Design of pipe line - Sizing process lines; piping specifications; piping layout and arrangement; pipe insulation and installation.

Design of vessels and storage tanks - Vessel fabrication; welding processes; brazing and soldering; shell plates; heads; theory of pressure vessel design; working formula stress and design considerations.

Design and Selection of Heat Exchangers - Heat exchanger types; heat exchanger design-design procedure; short cut method of design.

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.

References:

- Farall, A.W., Food Engineering Systems. Vol 1. AVI Publishing Company Inc, Ch. 13, 19 and 20.
- Hesse, H.C. and Rushton J.H. (1964) Process Equipment Design. Nostrand Company, N.C., Affiliated East West Press Pvt. Ltd., New Delhi.
- Joshi, M.V. (1981). Process Equipment Design. Macmillan India Ltd., New Delhi
- Rase, H.F. and Barrow, M.H. (1967) Project Engineering of Processing Plants. John Wiley & Sons Inc., New York. Ch. 2, 3, 5, 12, 13, 14, 18, 20 and 21.
- Kern, DQ (1965) Process heat transfer. McGraw Hill Kogakusha Ltd. New Delhi.
- Foust, AS and others (2001) Principle of Unit Operations, John Willey and Sons INC., New York.
- Evans, FL (1974). Equipment design handbook, Vol II, Gulf Publication Houston, Texas.
- Sinnott, R.K. (1983). Chemical Engineering and Introduction to Chemical Engineering Design Vol VI, Pergamon Press, Oxford

FARM STRUCTURES AND ENVIRONMENTAL CONTROL

AEN 524

3(2+1)

Objective

To acquaint the students with the techniques to control temperature, humidity and other composition of air to create favourable environment in the agricultural structures.

Theory

Thermodynamic properties of moist air, psychrometric chart and computer programmes for thermodynamic properties.

Farm structures and their design. Constructional details and design of low cost structures, Heating, ventilating and exhaust systems, air distribution and air cleaning,

Drying and dehumidification system, air-water contact operations and evaporation, process and product air conditioning.

Instruments and measurements; codes and standards.

Scope, importance and need for environmental control, environmental control systems and their design, control of temperature, humidity and other air constituents by ventilation and other methods.

Practical

Measurements of environmental parameters calculation of heating and cooling load; design calculation of moisture condensation in agricultural buildings; study of moisture migration behaviour in storage bins; design aspect of cold storage.

Suggested Readings

- Albright LD. 1990. Environmental Control for Animals and Plants. ASAE Textbooks.
- Esmay ML & Dixon JE. 1986. Environmental Control for Agricultural Buildings. The AVI Corp.
- Gaudy AF & Gaudy ET. 1988. Elements of Bioenvironmental Engineering. Engineering Press.
- Moore FF. 1994. Environmental Control Systems: Heating, Cooling, Lighting. Chapman & Hall.
- Threlkeld JL. 1970. Thermal Environmental Engineering. Prentice Hall.

STORAGE ENGINEERING AND HANDLING OF AGRICULTURAL PRODUCTS

AEN 525

3(2+1)

Objective

To acquaint the students with the safe storage of food materials, design of storage structures and the design of different material handling equipments used in the industries.

Theory

Storage of grains, biochemical changes during storage, production, storage factors affecting losses, storage requirements. Storage of Grain - Destructive agents to the stored grains; living and nonliving environment in grain ecosystem; consumers like insects and rodents and decomposers like bacteria and fungi in the stored grains and their control, respiration of grain, Indices of quality or conditioning of grain; functional requirement and conditioning of moist grains.

Temperature and moisture in grain storage - Effect of temperature and moisture content on the deterioration of stored grains; temperature in grain bin and its measurements; moisture migration.

Bag and bulk storage, rat proof godowns and rodent control, method of stacking, preventive method, bio-engineering properties of stored products, function, structural and aeration system. Rankine and Jansen's solution, side wall load, approx. Lateral pressure, increased pressure due to moisture, design of circular bins, rectangular bins, construction details; ventilation in the storage bin, aeration and cooling, air pressure and horse power.

Principles of crop and food preservation and storage - Economic and health aspects, deterioration of food stuff; micro organisms and enzymes, behaviour of food stuff in storage; physiological diseases; preservation methods.

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

Physical factors influencing material handling, material handling equipments for grain handling, design criteria for belt conveyors, types of bucket elevators, pneumatic conveying systems, importance of rural transport systems, recent advances in handling of food materials. 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.

Suggested Readings

- FAO. 1984. Design and Operation of Cold Stores in Developing Countries. FAO.
- Hall CW. 1970. Handling and Storage of Food Grains in Tropical and Sub-tropical Areas. FAO Publication. Oxford & IBH.

- Henderson S & Perry SM. 1976. Agricultural Process Engineering, 5th Ed. AVI Publ. Co.
- McFarlane Ian. 1983. Automatic Control of Food Manufacturing Processes. Applied Science Publ.
- Multon JL. (Ed). 1989. Preservation and Storage of Grains, Seeds and their By-products. CBS.
- Ripp BE. 1984. Controlled Atmosphere and Fumigation in Grain Storage. Elsevier.
- Shefelt RL & Prussi SE. 1992. Post Harvest Handling – A System Approach. Academic Press.
- Shejbal J. (Ed). 1980. Controlled Atmosphere Storage of Grains. Elsevier.
- Vijayaraghavan S. 1993. Grain Storage Engineering and Technology. Batra Book Service.

RENEWABLE ENERGY SYSTEM

RES 531

3(2+1)

Introduction: Energy and Development; Energy demand and availability; Energy crisis; Conventional and Nonconventional energy; Renewable and Non-renewable energy resources; Environmental impacts of conventional energy usage; Basic concepts of heat and fluid flow useful for energy systems.

Solar Energy Systems: Solar radiations data; Solar energy collection, Storage and utilization; Solar water heating; air heating; Power generation; Refrigeration and Air-conditioning; Solar Energy system Economics.

Micro and Small Hydro Energy Systems: Resource assessment of micro and small hydro power; Micro, mini and small hydro power systems; Economics; Pump and turbine; Special engines for low heads; Velocity head turbines; Hydrams; Water mill; Tidal power.

Bio mass Energy Systems: Availability of bio mass-agro, forest, animal, municipal and other residues; Bio mass conversion technologies; Cooking fuels; Biogas; producer gas; Power alcohol from biomass; Power generation; Internal engine modifications and performance; system economics.

Wind Energy Systems: Wind data; Horizontal and vertical axis wind mills; Wind farms; Economics of wind energy.

Integrated Energy Systems: Concept of integration of conventional and non-conventional energy resources and systems; Integrated energy system design and economics.

Practical

Study of different renewable energy systems, solar, hydrothermal, biomass, wind and integrated energy systems. study of Bio mass conversion technologies, Comparative study of economics of different systems.

Books:

1. Energy Efficient Buildings in India Mili Majumdar Tata Energy Research Institute
2. Understanding Renewable Energy Systems Volker Quaschnig -
3. Renewable Energy Systems Simmoes Marcelo Godoy CRC Press
4. Renewable Energy Resources John Twidell Taylor and Francis
5. Renewable Energy Sources and Their Environmental Impact Abbasi & Abbasi Prentice Hall of India

AEN 535 POST HARVEST PROCESSING OF GRAINS

3(2+1)

Objective

To acquaint the students with processing of seeds and the design features of the equipments used for their processing.

Theory

Processing of different seeds and their engineering properties, principles and importance of seed processing.

Performance characteristics of different unit operations such as pre-cleaning, grading, conveying, elevating, drying, treating, blending, packaging and storage, seed processing machines like scalper, debreader, huller, velvet separator, spiral separator, cleaner-cum-grader, specific gravity separator, indent cylinder, disc separator, and colour sorter, seed treater, weighing and bagging machines, their operation and maintenance, installation and determination of their capacity, seed quality maintenance during processing, plant design and layout, economy and safety consideration in plant design.

Seed drying principles and methods, theory of seed drying, introduction to different types of heated air dryers, significance of moisture equilibrium, method of maintaining safe seed moisture, thumb rule and its relevance, importance of scientific seed storage, types of storage structures to reduce temperature and humidity; management and operation/cleanliness of seed stores, packaging-principles, practices, materials and hermetic packaging, seed treatment methods and machines used, method of stacking and their impact, design features of medium and long term seed storage building.

Practical

Study of various seed processing equipments such as precleaners, scalpers, air screen cleaners, graders, spiral and pneumatic separators, seed treating equipment, bag closures, scale etc. and their performance evaluation, design and layout of seed processing plant and its economics, analysis of cost of operation and unit cost of processed product, effect of drying temperature and duration of seed germination and storability.

Suggested Readings

- Gregg et al. 1970. Seed Processing. NSC.
- Henderson S & Perry SM. 1976. Agricultural Process Engineering, 5th Ed. AVI Publ. Co.
- Sahay KM & Singh KK. 1994. Unit Operation of Agricultural Processing, Vikas Publ. House.

FOOD CHEMISTRY AND MICROBIOLOGY

AEN 536

3(2+1)

Moisture in foods, fats and other lipids their occurrence in foods and composition, edible fats and oils, fatty acids; physical and chemical properties; rancidity and test for rancidity; technology of edible fats and oils; carbohydrates changes in carbohydrates on cooking. Protein in foods and their properties and determination procedures.

Introduction to micro organisms related to food and their general characteristics contamination of foods by micro organisms; principles of food preservation; spoilage and preservation of different kinds of foods; microbiology in food plant sanitation.

Practicals:

1. Chemical analysis of foods with regard to Moisture, Fat, Protein, Crude fibre, Minerals.
2. Estimation of rancidity in foods.
3. Estimation of carbohydrates in foods.
4. Preparations of Agar medium and related growth of micro-organisms.
5. Preservation methods of foods.
6. Food plant sanitation process.

References:

- Frazier, W.C., and Westhoff, D.C. (1983). Food Microbiology, Tata McGraw Hill Publishing Company Ltd., New Delhi.
- Meyer, LH. 91960). Food Chemistry, Reinhold Publishing Corporation, New York.

BIOCHEMICAL AND PROCESS ENGINEERING

AEN 537

3(2+1)

Objective

To acquaint and equip the students with the basic principles of biochemical and process engineering.

Theory

Applications of engineering principles; mass and energy balance, fluid flow principles, unit operations of process engineering.

Fundamentals of growth kinetics, maintenance energy and yield concepts, principles of media sterilization, media formulations of industrial fermentation.

Aerobic and agitated rheology of fermentative fluids, design and scale-up of bioreactors, enzyme reactors.

Principles of recovery of fermented products in bio-processing, instrumentation, transport phenomenon.

Practicals:

Kinetics of one substitute reactions, kinetics of growth in batch cultures, design consideration for bioreactors, media preparation and sterilization, microprocessor based monitoring of bioprocess parameters.

Suggested Readings

- Coulson JM & Richardson JF. 1999. *Chemical Engineering*. Vols. II, IV. The Pergamon Press.
- Treybal RE. 1981. *Mass Transfer Operations*. 3rd Ed. Harper & Row.
- Brennan JG, Butters JR, Cavell ND & Lilly AEI. 1990. *Food Engineering Operations*. Elsevier.
- Geanoplis J Christie. 1999. *Transport Process and Unit Operation*. Allyn & Bacon.

Higher Mathematics

BSH 515

3(3+0)

- I. Complex variables – Complex functions, Analytic functions, Harmonic function and application to potential problems conformal mapping, simple and bilinear transformations, Schwartz Christoffal transformation, complex integration, Taylor's and Laurent series, Integration by the method of residues.
- II. Special Functions – Error function, Fresnel integrals, sine and cosine integrals, Legendre equation and Legendre polynomials, Bessel's equation and function. Orthogonality relations, Generating functions. Rodrigues formula, Hypergeometric functions.
- III. Integral transform, related theorems, Inversion, L.T. of Unit step function. Impulse function and periodic function. Fourier integral. Sine and Cosine transforms, Inversion formulae, solution of partial differential equations (with special Suggested Readings to Laplace, wave and heat conduction equations/by separation of variable methods.) Application of L.T. and Fourier transform to boundary value/problems.

Suggested Readings

1. C. Prasad; Mathematics for Engineers and Advance Mathematics for Engineers,
2. E. Kreyszig; Advanced Mathematics

Statistical Methods

BSH 510

3(2+1)

Basic concepts, simple problems and applications of the following topics.

Probability – Sample spaces, simple and compound events, mutually exclusive, equally likely and independent events, definition of probability, classical, statistical and axiomatic approach, addition and multiplication laws of probability, conditions probability.

Random variables, discrete and continuous, probability density function (pdf), cumulative distribution function (cdf), mathematical expectation, mean and variance of a random variable, joint pdf., cdf., marginal and conditional densities, independence of random variables.

Binomial, Poisson, hypergeometric, geometric, multinomial distributions, their means and variances, normal distribution its properties and sample problems, lognormal exponential and weibull distributions. Definitions and applications of t, F and χ^2 chi square distributions.

Statistical Inference – Estimation confidence intervals. Testing of hypothesis regarding means, variance, proportions. Regression and Correlation – Linear and curvilinear regression with one independent variable linear correlation, the test of significance of regression coefficient and correlation coefficient.

Applications- Applications to quality assurance, control charts X, RP and C charts, tolerance limits, acceptance sampling.

Applications to reliability and life testing; exponential and weibull distribution models.

Practicals:

1. Inferences concerning means, One mean or two means cases, tests of significance.
2. Inferences concerning variances, one variance or two variances, significance.
3. Inference concerning. One or two population proportions.
4. Testing of hypothesis in 2x2, 2r or rxc contingency tables.
5. Fitting of Binomial and Normal distributions and testing the goodness of fit.
6. Regression Analysis.

Suggested Readings

1. Agarwal, B.L. Basic Statistics, Wiley Eastern Ltd., New Delhi, 2nd ed. 1991.
2. Miller Irwin and J.W. Frannd- Probability and Statistics for Engineers (2nd edition, 1997), Prentice Hall of Indian Pvt. Ltd., New Delhi.

3. Statistics in Research (India Ed. 1986)- Bernard ostle, Oxford and IBH Publication Co., New Delhi.
4. Statistics and Experimental Design: In Engineering and Physical Sciences Vol. I, Johnson, N.L. and Leone, F.C. John Wiley and Sons, New York, 1964.

CAD/CAM

MED 518

3(2+1)

Introduction to computer-aided design, Geometric modeling and interactive graphics, Computer-aided analysis and synthesis of common mechanical components. Application of numerical methods and optimal techniques design problems. Computer-aided selection of standard mechanical components. Introduction of FEM.

Practicals:

Preparation of engineering drawings of machine/implement components, design of plough share/fumow openers/plough discs, and other components of farm machinery, preparation of bill of materials and costing.

Suggested Readings:

1. Ramamurty, T. (2001). Computer Aided Mechanical Design and Analysis. Tata Megraw-Hill, New Delhi.
2. Mukhopadhyay, M. (2000). Matrix, Finite Element, Computer and Structural Analysis Oxford and IBH Publishing Co. Pvt. Ltd.
3. Krishnamoorth, G. (2001). Finite Elements Analysis: Theory and programme. Tata Megraw-Hill, New Delhi.
4. Kundra. C.V. (2000). Numerical Control and Computer Aided Manufacturing. Tata Megraw-Hill, New Delhi.
5. Zeid, K. (2000). CAD/CAM Theory and Practice. Tata Megraw-Hill.

Advance Programming with 'C++'

CSE-511

3(1+2)

Unit 1 . Introduction C++, C++ Programming constructs: Keywords, Built-in Types and Enumerations, Operators, Selection, (if else, nested if), Loops (while, do-while, for).

Unit 2. Aggregation (Array, Structure and Classes), Pointer, Functions, member functions, Declarations, Memory Allocation, Scope and Namespaces, Exceptions.

Unit 3. Object-orientated programming primitives, Classes, Class member privacy Friend classes and functions. A complete example Derived classes. Static members Const members, Static const members, Overriding behaviour, Templates.

Unit 4. Virtual members, Abstract Classes, operators, A class definition example. Redefining [], Redefining [], Redefining>, Input/output: Simple I/O, Formatting Stream Iterators, Output of User-Defined types, Input of User-Defined types.

Practicals :

Program for signe in heritage using c++, function overloading in c++, friend function, function templates to find the largest number, swap data using function templates. stack overflow in c++, base and derived class, bases and derived class, pass by value pointer to pointer.

Suggested Readings:

1. Rumbaugh, James Michael Blaha William Premerlani, Frederick, Eddy and William Lorensen, " Object Oriented Modelling and Design", Prentiece Hall India, 1993.
2. Programming : Principles and Practice Using C++ by Bjarne Stroustrup, 1985.
3. Dillon T and Ten, Poh Lee " Object oriented Conceptual Modelling, Prentice Hall 1933.

Energy Management in Food Process Industries

RES 523

3(2+1)

Objective

To acquaint and equip the students with different energy management techniques including energy auditing of food industries.

Theory

Unit I

Energy form and units, energy perspective, norms and scenario; energy auditing, data collection and analysis for energy conservation in food processing industries.

Unit II

Sources of energy, its audit and management in various operation units of the agro-processing units; passive heating, passive cooling, sun drying and use of solar energy, biomass energy and other non-conventional energy sources in agro-processing industries.

Unit III

Reuse and calculation of used steam, hot water, chimney gases and cascading of energy sources. Energy accounting methods, measurement of energy, design of computer-based energy management systems, economics of energy use.

Practical

Study of energy use pattern in various processing units i.e., rice mills, sugar mills, dal mills, oil mills, cotton-ginning units, milk plants, food industries etc. Energy audit study and management strategies in food processing plants. Identification of energy efficient processing machines. Assessment of overall energy consumption, production and its cost in food processing plants, visit to related food processing industry.

Suggested Readings

- Pimental D. 1980. *Handbook of Energy Utilization in Agriculture*. CRC Press.
- Rai GD. 1998. *Non-conventional Sources of Energy*. Khanna Publ.
- Twindal JW & Anthony D Wier 1986. *Renewable Energy Sources*. E & F.N. Spon Ltd.
- Verma SR, Mittal JP & Surendra Singh. 1994. *Energy Management and Conservation in Agricultural Production and Food Processing*. USG Publ. & Distr., Ludhiana.

ENERGY LAB

3(0+3)

RES 536

Objective

To acquaint and equip the students with different energy lab equipment/apparatus.

Practical

Solar energy systems, solar water heater, solar still, solar energy light, solar dryer, solar energy battery and other solar power system. Micro, mini and small hydro power systems, water mill, biogas, producer gas, biomass, wind mill, hydro thermal energy and economics of various systems.

Books

1. Renewable energy systems, Simmoes Marcelo Goday CRC Press.
2. Renewable energy sources and their environmental impact/Abbasi Prentice Hall of India.

COMPULSORY NON-CREDIT COURSES

(Compulsory for Master's programme in all disciplines; Optional for Ph.D. scholars)

LIBRARY AND INFORMATION SERVICES

PGS 501

1(0+1)

Objective

To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.

Practical

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information-Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; e-resources access methods.

TECHNICAL WRITING AND COMMUNICATIONS SKILLS

PGS 502

1(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

- Chicago Manual of Style. 14, h Ed. 1996. Prentice Hall of India.
- Collins' Cobuild English Dictionary. 1995. Harper Collins.
- Gordon HM & Walter J A. 1970. Technical Writing. 3 rd Ed. Holt, Rinehart & Winston.
- Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 61 Ed. Oxford University Press.
- James HS. 1994. Handbook for Technical Writing. NTC Business Books.
- Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.
- Mohan K. 2005. Speaking English Effectively. MacMillan India.
- Richard WS. 1969. Technical Writing. Barnes & Noble.
- Robert C. (Ed.). 2005. Spoken English: Flourish Your Language. Abhishek.
- Sethi J & Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India.
- Wren PC & Martin H. 2006. High School English Grammar and Composition. S. Chand & Co.

INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE

PGS 503

1

(1+0)

Objective

The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy. Theory Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPs Agreement; Intellectual Property and intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and bio-

diversity 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

- Erbis FH & Maredia K..1998. *Intellectual Property Rights in Agricultural technology*. CABI.
- Ganguli P. 2001. *Intellectual Property Rights: Unleashing Knowledge Economy*. McGraw-Hill.
- *Intellectual Property Rights: Key to New Wealth Generation. 2001*. NRDC & Aesthetic Technologies.
- Ministry of Agriculture, Government of India. 2004. *State of Indian Farmer.Vol.V. Technology Generation and IPR Issues*. Academic Foundation.
- Rothschild M & Scott N. (Ed.). 2003. *Intellectual Property Rights in Animal Breeding and Genetics*. CABI.
- Saha R. (Ed.). 2006. *Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies*. Daya Publ.
- House. *The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003*.

BASIC CONCEPTS IN LABORATORY TECHNIQUES

PGS 504

1(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; washing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, 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

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

AGRICULTURAL RESEARCH, RESEARCH ETHICS & RURAL DEVELOPMENT PROGRAMMES

PGS 505

1 (1+0)

Objective

To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

Theory

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.

Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

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.

DISASTER MANAGEMENT

PGS 506

1(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

Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming. Sea Level rise. Ozone Depletion

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.

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

- Gupta HK. 2003. *Disaster Management*. Indian National Scienc Academy. Orient Blackswan.
- Hodgkinson PE & Stewart M. 1991. *Coping with Catastrophe: A Hani/hook of Disaster Management*. Routledge.
- Sharma VK. 2001. *Disaster Management*. National Centre for Disaster Management, India