

AGRICULTURAL ENGINEERING
(Applicable for batches admitted from 2016-2017)



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA - 533 003, Andhra Pradesh, India

IV Year I Semester

S. No.	Subject	L	T	P	Credits
1	Micro Irrigation Engineering	4	--	--	3
2	Farm Machinery and Equipments – II	4	--	--	3
3	Post Harvest Engineering for Horticulture Produce	4	--	--	3
4	Mechanical Measurements and Instrumentation	4	--	--	3
5	ELECTIVE – I	4	--	--	3
	1. Seed Processing and Storage Engineering				
	2. Green House Technologies				
6	ELECTIVE – II	4	--	--	3
	1. Watershed Management				
	2. Food Packaging Technology				
	3. Minor Irrigation and Command area development				
7	Farm Machinery Lab - 2	--	--	3	2
8	Dairy and Food Engineering Lab	--	--	3	2
Total Credits					22

IV Year II Semester

S. No.	Subject	L	T	P	Credits
1	Design of Agricultural Machinery	4	--	--	3
2	Agricultural Extension Techniques and Business Management	4	--	--	3
3	Agro Industries and Bi-product Utilization	4	--	--	3
4	ELECTIVE – III	4	--	--	3
	1. GIS and Remote Sensing				
	2. Human Engineering and Safety				
	3. Production Technology of Agricultural Machinery				
5	Seminar	--	--	3	2
6	Project Work	--	--	15	10
Total Credits					24

MICRO IRRIGATION ENGINEERING

Objective: To impart knowledge and skills to students to design sprinkler and drip irrigation systems to improve water productivity of different crops and to perform economic analysis and to prepare project proposals and cost estimates of Micro – Irrigation Systems.

Unit – I:

Sprinkler Irrigation Historical development, Scenario in the World, Country and State, adoptability and limitations, Components of the sprinkler system, pump set, (Centrifugal, turbines and Submersible), Main lines, Lateral lines, Sprinkler heads, Debris screens, Desilting basins, booster pumps, Take-off valves, Flow control valves (individual sprinkler).

Unit-II:

Sprinkler heads, fertigation Equipment, Types of sprinkler Irrigation systems: A. Based on mechanism: i) Rotating head system, ii) Perforated pipe system, B. Based on portability: i) Portable systems, ii) Semi-portable systems, iii) Semi-permanent systems, iv) Permanent systems and v) Solid set systems. Precipitation profiles and Moisture distribution patterns, Recommended sprinkler spacings, Effects of wind speed on working of the system, Importance of distribution uniformity, Christiansen Uniformity coefficient,

Unit-III:

Design of Sprinkler system, layout, laterals and mains: i) Inventory of Resources and Conditions, ii) Types of system and Layout, iii) Sprinkler Selection and Spacing, iv) Capacity of Sprinkler Systems, v) Hydraulic Design of Sprinkler Systems, vi) Selection of pump, Operation and maintenance of system, Field evaluation of the system, Cost analysis.

Unit – IV :

Drip Irrigation, Historical development, Scenario in the World, Country and State, Advantages and Limitations, Components of drip irrigation: A. Head Control- Non return valve, Air release & Vacuum breaker, Filter, Fertigation Tank, Throttle valve, Pressure gauge, other fittings, B. Wayer carrier systems- PVC pipeline, Control valve, Flush valve, other fittings, C. Water distribution systems- Drip lateral, Drippers, Emitting pie, Grommet, Start connector, Nipple, End cap, Micro tube, Barbed connector, Drip Hydraulics, Pipe section, Water flow in pipes, Velocity recommended pressure, Pressure and Hydrostatic, Pressure due to gravity, Friction and pressure losses, Coefficient of friction.

Unit –V:

Types of Emitters: A) Based on Floe regime (Reynolds number): i) Laminar Flow, ii) Partially turbulent flow, iii) Fully turbulent flow and B) Based on Lateral connection: i) in-line and ii) on-line, Emitter flow equation, Emitter constants, Pressure variations (%) for different emitter flow variations and x-values, Emission uniformity (EU), Distribution Uniformity and Irrigation efficiency.

Unit-VI:

Planning and design of drip system- Collection of primary data, Layout, crop water requirements, hydraulic design, selection of components, Economic pipe size selection, Pressure variation Along drip Irrigation and design criteria of lateral, sub-main and mail lines, Pai-wu I design charts. Installation, operation and Maintenance of drip irrigation systems, testing and field evaluation of the system, Computer Software programs for design of drip irrigation systems, Automation of drip irrigation systems – i) Volume based, ii) time based and iii) Soil moisture bases systems.

BOOKS:

1. Drip Irrigation & Sprinkler Irrigation, Sivanappan R K Padma Kumari O and Kumar V 1997, Keerthi Publishing House Pvt. Ltd., Coimbatore.

REFERENCES:

1. Micro-Irrigation for Crop Production, Design, Operation and Management, Freddie R. Lamm, James E. Ayars and Francis S, Nakayama, 2006, Elsevier Publications, Singapore.
2. Land and Water Management Principles, R. Suresh, 2008, Standard Publishers Distributors, Delhi.

FARM MACHINERY AND EQUIPMENT – II

Objective: To enable the students to understand the basic principles of cutting mechanisms and to know the various available harvesting machines. To know the working principle and functions of various machine parts of mowers, reapers, windrowers, forage harvesters, threshers, combine harvesters, cotton strippers, cotton pickers, groundnut and potato and sugarcane harvesters. Students can also understand the importance of testing and evaluation of agricultural machines and different standard codes (BIS Codes) available in India for testing of machinery.

Unit – I:

Harvesting – Crop harvesting machinery, history of development, manual harvesting and its classification. Principles and types of cutting mechanisms – principle of cutting mechanism, impact cutting, types of impact cutting, shear cutting Construction and adjustments of shear and impact type cutting mechanisms. Mowers – history and development, tractor mounted mowers, Trail behind tractor mower, integral Rear mounted mowers, side or central mounted tractor mower, semi-mounted mowers, safety precautions in operation and adjustments of mowers, Knife drives, cutter bar and its parts – inside and outside shoes. Cutter Bar – Guards, Ledger plates, wearing plates, knife clips, grass board and various parts of cutter bar assembly, alignment and registration of cutter bar. Windrowing – Methods of windrowing, Self propelled windrows, effects on yields and quality of Reapers, Animal drawn reaper, Tractor mounted Vertical conveyer reaper Repairs & maintenance of Harvesting equipment.

Unit-II:

Power operated vertical conveyer reapers – Reaper binders – Care and maintenance, types Forage harvesting equipment – row forage harvesting equipment, field forage harvesters, types of field forage harvesters. Field chopper harvesters, forage wagons and boxes, field flail forage harvesters, theself propelled forage harvester, silo forage blowers, silo un loaders.

Unit – III:

Threshing – Principal of threshing, threshing methods, threshing by manual, threshing by animals, threshing by machines, oldpad threshers, Power thresher – types of power threshers, hammer mill type, rasp bar, spike tooth, syndicator, Classification threshers based on feeding type, components of power thresher. Cleaning unit- Aspirator, blower, winnower, winnowing fan, cylinder adjustment, wheat thresher, groundnut thresher, and terminology connected with power thresher. Development of the binder and development of the combine.

Unit – IV:

Harvester, advantages and disadvantages of combines, types of combines – Tractor drawn and self propelled combines. Functions performed by a combine, cutting mechanism, threshing mechanism, separating mechanism, cleaning mechanism, attachments for combine. Combine harvesting equipment- types of corn pickers, snappers, picker husker, Picker Sheller, power transmission, gathering and snapping mechanism, conveying and elevating mechanism. Husking mechanism, shelling mechanism, factors affecting performance of corn pickers, safety rules for operating corn pickers - Root crop harvesting equipment – groundnut harvester, groundnut diggers, digger operation and adjustments – groundnut shakers, groundnut threshers and pickers, groundnut combines different units and its operation. Potato harvesters – harvesting methods and equipment, one row harvester, two rowharvester, digging and soil separation, vine removal by harvesters, separation of stones and clods.

Unit-V:

Cotton harvesting equipment – cotton stripper, types of cotton strippers, factors affecting the performance of the cotton strippers, plant characteristics – thickness of plants – conveying system. Cotton pickers – types of pickers, drum type and chain belt spindle arrangements in cotton pickers, methods of mounting spindles, doffing of the cotton, conveying systems, working, factors affecting performance of cotton pickers. Sugar cane harvesters – self propelled sugar cane harvester, cleaning and special sugar cane wagon. Sugar cane harvesters – Self propelled sugar cane harvester, conveying and special sugar cane wagon.

Unit-VI:

Principles of fruit harvesting tools and machines – Harvesting methods – manual harvesters – hold on and twist type – Horticultural tools and gadgets. Testing of farm machine- Introduction, Standardization efforts, Testingprogramme and Procedure, Type of testing systems, national testing, prototype testing, testing for quality marketing.

TEXT BOOKS:

1. Principals of Farm Machinery. Kepner R.A., Bainer R and Barger E.L, 1987. CBS Publishers and Distributors, Delhi.
2. Engineering principles of Agricultural machines, Ajith k Srivatsava, Carrol E. Goering, Roger P. Rohrbach, 1993, ASAE Publishers.
3. Pesticide Application Equipment. Bindra O S and Hari Charansingh 1971. Oxford and IBH Publishing Co. Ltd., New Delhi.

REFERENCE BOOKS:

1. Farm Machinery and Equipment. Smith H.P. 1971. Tata McGraw-Hills Publishing Co., Ltd., New Delhi.
2. Testing and Evaluation of Agricultural Machinery. Mehta M.L., Verma S.R. Misra S.K. and Sharma V.K. Daya Publishing House, New Delhi.

POST HARVEST ENGINEERING AND HORTICULTURAL PRODUCE**Unit – I:**

Factors affecting fruit and vegetable quality, pre-harvest factors, Environmental Factors, Cultural factors, Post Harvest Factors, Engineering properties of Fruits and vegetables, Physical properties, Shape, Size, density, porosity, surface area, colour, serilynamie properties, dry coefficient terminal velocity Rheological properties, screen stain, Mechanical Properties, comprehension strength, tensile strength, shear resistance, Electrical properties, conductive, resistance dielectric properties, Optical properties, dielectric properties-optical properties, light transmittance, light reflectance,

Unit-II:

Handling and transportation of fruits and vegetables. Harvesting indices of different fruits and vegetables, determination of Maturity standards for fruits and Vegetable- Size, shapes, aroma, Fruit ripening, leaf charges, firmness, Juice content, sugar content, skin colour, total soluble solid, modern techniques for determination of harvesting indices/ and grading of fruits, Electrical property, Near Infrared Reflectance (NIR), Radiation, Optical method, Light reflectance, Machine vision. Cleaning of fruits & Vegetables, soaking, rinsing, Cleaning & Washing- by agitator, by spraying water, wet and dry brushing, chemical washing, factors affecting effectiveness of a sprayer, Peeling of fruits and vegetables, Hand peeling, Mechanical peeling, peeling by heat treatment, Lye peeling, Grading of fruits & vegetables, Factors affecting grading, Types of graders, screen grader, roller grader, rope and cable type grader and weight grader.

Unit – III:

Canning of fruits & Vegetables, Grading, washing, peeling, cutting, Blanching, cooling, filling, Syruping or brining, Exhausting, sealing, Heat processing, cooling to room temp, Storage, Labeling, Making of cans for canning, causes of spoilage of canned foods, Hydrogen swell, Flipper, Springer, soft swell, hard swell, Buckling, Principles of preservation of Fruits & Vegetables, Asepsis packaging, preservation by high temperature. Pasteurization, Flash Pasteurization, Sterilization, Chemical preservation with sulphur dioxide, advantages, disadvantages, Preservation with Benzoic acid, Concentration and reverse osmosis technique applied to fruits & vegetables, Drying and dehydration of fruits & vegetables (Flow chart), types of dryers, cabinet dryer, tray dryers, tunnel dryer, Reconstitution test and rehydration, Ratio of Rehydration coefficient, Freeze drying, methods of freezing, slow freezing, quick freezing method, advantages and disadvantages, direct immersion, indirect contact with refrigerant, Air blast freezing, cryogenic freezing, De-hydro freezing, Freeze-Drying (Flow chart).

Unit – IV:

Post harvest management of Fruits and vegetables, procurement centers, Washing & grading, pre-cooling, room cooling, hydro cooling, Transportation by refrigerated trucks, Centralized cold storage centers etc, Controlled atmospheric storage, effects of CA, additional benefits, Limitations, Maintaining CA system, modified atmosphere storage/Packaging, Maintenance of MAP, active modification, passive modification, Requirements of fresh fruits package under CAS or MAS.

Unit-V:

Packaging of fruits and vegetables, packaging of fresh fruits, advantages of fresh packaging, Packaging materials, Cello pave, Poly vinyl chloride, polyethylene, Ethyl vinyl alcohol, Packaging of apples, Oranges, Mangoes, Bananas etc, Preparation of preservation of unfermented fruit beverages, selection of fruit, sorting and washing, Juice extraction, De-aeration, Filtration, Clarification, addition of sugar, fortification, preservation, Baffling, Unfermented beverages, Apple juice, grape juice, Pineapple juice, Citrus juice, Mango juice, with all flow sheets.

Unit – VI:

Fermented beverages, Wine, Flow sheet for processing of grape wine, Selection of fruit, crushing, Addition of sugar, adjustment of PH, addition of preservative addition of wine yeast, Fermentation, Firing & filtration, aging, packaging, Preparation of Vinegar, Alcoholic fermentation, Acetic acid fermentation, quality characteristics of fruits and vegetable for processing, Sensory, Hidden and quantitative characteristics, Oleoresin and essential oil extraction, turmeric oleoresin, extraction of chilli oleoresin, factors responsible, Solvents used for oleoresin extraction, advantages and disadvantages, Extraction of essential oil from spices by steam distillation, flow chart.

TEXT BOOKS:

1. Food Science by Potter, N. CBS Publishers.
2. Fruits and Vegetable Preservation. Principles and practices by srivastava R P & Kumar S International book distributy C.

REFERENCE BOOK:

1. Fruits: Tropical and subtropical by Bose T. K &Mitre, SK Naya Prakash.
2. Fruits and Vegetable processing by Bhatti, S and varma U CBS Publishers.
3. Technology of food preservation by Defroshier and Defrossier CBS Publications.

MECHANICAL MEASUREMENTS AND INSTRUMENTATION

Objective To enable the students to understand the principles and to acquire the knowledge on measuring systems, different types of instruments used for measuring the parameters like pressure, force, strain, temperature, sound, acceleration and displacement etc. and also to study practically using instruments for carrying out the experiments related to the concerned fields.

Unit- I:

Measurement and its significance, methods of measurement – direct methods and indirect methods and classification of measurements – primary measurements, secondary measurements and tertiary measurements. Instruments and measuring systems, their classification – according to history of instruments, according to mode of measurement and according to the functional requirement and principles of operation. Their principles of operation. Functional elements of a generalized measurement system–basic functional elements – transducer element, signal conditioning element and data precision elements and auxiliary elements. Examples of instruments for identification of basic and auxiliary elements – bourdon tube pressure gauge with out and with electrical read out, spring balance and proving ring etc. Inaccuracy in measurement and its analysis – types of errors or limiting errors – propagation of error or uncertainty.

Unit-II:

Detector transducer elements – introduction, classification and their principles – primary and secondary transducers, mechanical transducer, pressure transducers and active, passive transducers, analogue transducers and digital transducers. Signal conditioning elements and their principles of operation, data presentation elements and types – visual display type, graphical recording type, magnetic type and digital type. Static performance characteristics of instruments: static sensitivity, independent and proportional linearity, hysteresis, threshold, resolution and drift – zero and sensitivity drifts.

Unit- III:

Measurement of pressure: Introduction, types of pressure – atmospheric pressure, gauge pressure and absolute pressure, units of measurement and conversion of units from one system or another system. Types of pressure measuring devices with examples–mechanical devices, electromechanical devices. Manometers – types: simple U tube manometer. Well type manometer and inclined well manometer – ranges and their application – fluids used in manometer – desirable properties of manometric fluids – micro manometer for measuring very low pressures. Low pressure measurement devices – basic methods of measuring low pressures –study of McLeod pressure gauge used for measuring vacuum pressures: principles, construction, range and limitations. Electrical methods of measuring pressure – pressure sensitivity of resistance gauge – study of Bridgman pressure gauge used for measuring very high pressures: construction, principle, range and applications.

Unit- IV:

Measurement of strain – introduction, strain gauge principle, metals used for manufacturing strain gauges – strain gauge theory and gauge factor. Strain gauge circuits – Wheatstone bridge circuit and unbalanced bridge. Measurement of change of resistance. Cross sensitivity and temperature compensation using dummy gauge and more than one active gauge – advantages and applications of strain gauges.

Strain gauge arrangements – measurement of axial force applied to simple beams by the arrangement of one active gauge, using two active gauges and using of active gauges. Measurement of force applied to a cantilever by using four active gauges–simple arrangement method and Poisson arrangement method. Measurement of pressure using strain gauges – diaphragm type strain gauge pressure transducer.

Unit- V:

Measurement of temperature – introduction and classification of temperature measuring gases along with examples – bimetallic thermometer, mercury thermometer and vapor pressure thermometer. Bimetallic thermometers – principles – types: strip type and cantilever type – materials of construction – types based on shape – advantages, ranges of measurement and applications. Liquid in glass thermometers – type of liquids used – desirable properties of liquids used in thermometer – complete immersion type measurement and partial immersion type measurement – ranges – disadvantages. Liquid in metal thermometer. Thermometers based on expansion of gases – vapor pressure thermometer; construction, principles, gases used, range, merits and limitations.

Unit-VI:

Electrical methods of measuring pressure – electrical resistance thermometers – conductor type and semiconductors type – metals used – platinum resistance thermometer. Thermistor – principle – metals used – types based on shape – range of measurement – advantages – limitations. Comparison between thermometer and thermistor. Thermometer – principle – thermocouple laws – base metal type and base metal type thermocouples – thermocouple materials and characteristics. Comparison between resistance thermometer and thermocouple. Thermopile – principle.

Measurement of sound – introduction – noise and loudness, sound pressure level, sound power level, variation of intensity of sound with distance and combination of sounds. Sound measuring system. Microphone – principle, types: capacitor type, carbon granule type, piezo electrical crystal type and electrodynamic type – fields of application. Study of speed measuring instruments-stroboscope and tachometer-principles-construction-range. Study of proving ring for force measurement and study of linear variable differential transformer (LVDT) for displacement measurement-principles and construction.

TEXT BOOKS:

- 1 Mechanical Measurements, Sirohi RS and Radhakrishna HC 1983, Wiley Eastern Ltd., 4835/24 Ansari Road, New Delhi
- 2 Instrumentation, Measurement and Analysis Nakra BC and Choudhary KK 1987. Tata McGraw Hill publishing co Ltd., 12/ 4 Asaf Ali Road, New Delhi
- 3 A course in Mechanical Measurements and Instrumentation, Shawhney A K, 1989, Dhanpat Rai and Sons, 1682, NaiSarak, New Delhi.

REFERENCES:

1. Engineering Measurements and Instrumentation, Adams L F, 1981, The English Language Book Society and Hodder and Stoughton, London.
2. Mechanical Measurements, Thomas G B and Buck N L, 1969, Oxford and IBH Publishing Co. Ltd., 66, Janpath, New Delhi.

**SEED PROCESSING AND STORAGE ENGINEERING
(Elective-I)**

Objective: To enable the students to understand the principles and acquire the knowledge on moisture content determination methods, EMC models, principles and methods of drying and their analysis, study of different driers, dehydration and functional requirements, storage of grains, CAP storage, MAP storage, and study the conveying equipment.

Unit-I:

Moisture contents and methods for determination: Moisture content representation, wet basis, dry basis, direct and indirect methods of moisture content determination, problems. Importance of EMC and methods of its determination: static method, dynamic methods: desorption method and isothermographic method. EMC curve and EMC model: Henderson equation, hysteresis effect, bound moisture, unbound moisture, free moisture. Deep bed drying and their analysis, time of advance of drying front, decreasing rate period – remarks on the deep bed, problems on drying. Critical moisture content, drying models, rate of drying curves for constant drying conditions, calculation methods for falling rate drying period.

Unit-II:

Calculation of drying air temperature and air flow rate, air pressure within the grain bed, Shred's and Hukill's curve. Different methods of drying: convective drying, radiation drying, dielectric drying, chemical drying, sack drying, puff drying, foam mat drying, freeze drying etc. Study of different types of driers: unheated air driers: air distribution systems, heated air driers: flat bed type batch dryers, reciprocating batch drier. Study of LSU dryer, baffle dryer, rotary dryer, performance, energy utilization pattern and efficiency.

Unit – III:

Types and causes of spoilage in storage. Functional requirements of seed storage, control of temperature and relative humidity inside storage. Calculation of refrigeration load, control of its environment, air movement inside the storage. Storage of grains: destructive agents, respiration of grains, moisture and temperature changes in stored grains. Conditioning of environment inside storage through natural ventilation. Conditioning of environment inside storage through mechanical ventilation, artificial drying.

Unit-IV:

Design and control of environment. Storage of cereal grains and their products. Storage of seeds – terminology and treatments. Principles of grain storage – parameters – effecting the grain storage. Changes occurring during storage, nutritive changes, minerals, carbohydrates, proteins and vitamins. Moisture migration, storage insects, pests and their control.

Unit-V:

Grain storage structures – bag storage of grains: different types of storage, classification planning for a bag storage complex, constructional features and basic specifications of typical bag storage structures, design aspects of bag storage structures. Bulk storage of grains: advantages of bulk handling system, types of bulk storage traditional storage structures, moral, bhukari, kothari type storage structures. Bulk storage of grains, pusa bin, brick and cement bin, bunker storage, vertical silos.

Unit-VI:

Grain handling equipment-bucket elevator: types of bucket elevators, components of bucket elevators, head section, boot section, elevator legs, elevator belt, buckets, drive mechanism and power requirement problems. Belt conveyors: Salient features, design considerations, belt tension, power, design problems. Screw Conveyors: Salient features, Conveyor elements, selection of screw conveyors and power requirements–problems. Pneumatic conveyor, essential components, description of typical plant, limitations of pneumatic conveyor. Hermetically sealed and air cooled storage. Controlled Atmosphere storage of grains. Modified Atmosphere storage of grains. Tutorial problems on drying.

TEXT BOOKS:

1. Unit Operations of Agricultural Processing Sahay K M and Singh K K 1994 Vikas Publishing House Pvt. Ltd., New Delhi.
2. Grain Storage Engineering and Technology, Vijaya Raghavan, S. 1993. Batre Bale Service New Delhi.
3. Drying and Storage of Grains and Oilseeds CBS Publishers & distributions, New Delhi.

REFERENCES:

1. Transport Processes and Unit Operations, Geankoplis C J 1978. Aliyn and Bacon Inc., Newton, Massachusetts.
2. Unit operations in Food Processing, Earle R L 1983. Pergamon Press, New York.
3. Post Harvest Technology of Cereals, Pulses and Oil seeds, Chakravarthy A. 1988 Oxford and IBH Publishing Co. Ltd., Calcutta.
4. Unit Operations of Chemical Engineering, McCabe W L and Smith J C 1993 McGraw Hill Book Co., New Delhi.

**GREEN HOUSE TECHNOLOGY
(Elective-I)**

Objective: Constructional and operational details of greenhouses will lead the students to grow crops with profits and also to use the greenhouses for offseason usage and also to manage them commercially.

Unit - I:

Greenhouses – Introduction, history, definition, greenhouse effect, advantages of greenhouses. Classification of greenhouses – Greenhouse types based on shape, utility, construction and covering material. Plant response to greenhouse environment – light, temperature, relative humidity, ventilation and carbon dioxide.

Unit- II:

Environmental requirement for crops – Temperature requirement of horticultural crops, light requirement of crops and lighting control methods, Greenhouse shading methods, Greenhouse supplemental lighting systems. Environmental control inside greenhouse – Manual controlling, thermostats, microprocessors and computerized control systems.

Unit- III:

Natural and forced ventilation summer and winter cooling systems, carbon dioxide enrichment method. Planning of greenhouse facility – Site selection and orientation, structural design, covering materials. Materials used for construction of greenhouses – Wood, Galvanized iron pipe and glass.

Unit- IV:

Greenhouse covering materials – Polyethylene film, PVC, Polyester, Tefzel T2 film, Polyvinyl chloride rigid panel, fiber glass reinforced plastic rigid panel, Acrylic and polycarbonate rigid panel. Design criteria and construction details of glass and pipe framed greenhouses – Material requirement and procedure for erection.

Unit-V:

Greenhouse heating and energy storage – Type of heat loss, heating systems, heat distribution systems, water and rock storage, heat conservation practice. Greenhouse irrigation systems – Rules of watering, Hand Watering, perimeter watering, overhead sprinklers, Boom watering, Drip irrigation.

Unit-VI:

Greenhouse utilization in off season – Drying of agricultural produce. Protected Agriculture Techniques – row covers. Economics of greenhouse production – Capital requirements. Economics of production and conditions influencing returns.

TEXT BOOKS:

1. Greenhouse technology and Application, Vilas M. Salone and Ajay K. Sharma Agrotech Publishers, New Delhi, 2012
2. Greenhouse Technology for controlled Environment, Tiwari, G.N. Narsoa Publishing house Pvt. Ltd.
3. Greenhouse Technology- Management, Operation and Maintenance, N.N Patil, Universal Prakashan Publisher.

REFERENCES:

1. Greenhouse technology and management, Radha Manohar, K and Igathinathane. C. 2nd Edition, BS Publication.
2. Advances in protected cultivation, Singh Brahma and Balraj Singh, New India Publishing Company, 2014.
3. Greenhouse Management of Horticulture crops, S. Prasad and U. Kumar, second edition, Agrobios New Delhi, 2012.
4. Greenhouse: Advanced Technology for Protected Horticulture, J. Hanan, CRC Press, LLC, Florida, 1998.

**FOOD PROCESSING PLANT DESIGN AND LAYOUT
(Elective-I)**

Objective: Students will be trained in organization of food and agricultural processing plant machinery as per process flow. Also, site selection, layout procedures, project design concepts, etc. Will be explained for bringing the talent to establish an engineering industry.

Unit –I:

Plant layout – Definition, meaning, objectives, principles. Plant layout – Factors in planning layouts. Methods of layout planning – Unit areas concept, two – dimensional layouts, scale models. Principles of plant layout – Storage layout, equipment layout, safety, plant expansion, floor space, utilities servicing, building, materials handling equipment, rail roads and roads.

Unit-II:

Types of plant layout – fruit processing plant. Salient features of rice processing plant. Salient features of maize processing plant. Salient features of pulses – processing plants. Salient features of oilseeds processing plants. Salient features of horticulture processing plants. Salient features of processing plants of vegetable crops.

Unit-III:

Salient features of processing of poultry plants. Salient features of processing of fish processing plant. Salient features of processing of meat processing plant. Salient features of milk and milk products processing plants. Salient features of milk and milk products processing plants.

Location selection criteria – Plant location, factors in selecting a plant, selection of the plant site, preparation of the layout. Selection of processes – Comparison of different processes, batch versus continuous operation. Plant capacity – Equipment design and specifications, scale – up in design, safety factors, specifications, materials of construction.

Unit-IV:

Project design – Process design development, general overall design considerations, cost estimation, factors affecting profitability of investments, optimum design (economic and operation). Project design – Practical considerations in design, approach. Project design – Types of designs, feasibility survey, process development, design, construction and operation, design information from the literature.

Unit –V:

Flow diagrams-Qualitative and quantitative flow diagrams. Selection of equipments - Preliminary design, problem statement, literature survey, material and energy balance, equipment design and selection, problems, economics. Process and controls-Control systems, instrumentation control, maintenance, computer aided design. Handling equipments - Selection, factors, pumps, piping, fittings, solid feeders, plant layout. Plant elevation - Requirement of plant building and its components, foundation for equipment and dynamic loading, flooring, walls, roof, illumination, air-conditioning. Labor requirement for processing plant - Labor costs, maintenance and repairs, common denominator, Plant installation, Power and power transmission - Systems.

Unit –VI:

Food plant sanitation-Environmental protection, regulations, pollution control, air pollution abatement, particulate removal, noxious gas removal, thermal pollution control, recycling, CIP. Cost analysis - Cash flow for industrial operations, factors affecting investment and production costs, capital investment, and estimation of capital investment. Cost analysis - Cost indexes, cost factors in capital investment, estimation of total product cost. Preparation of feasibility report -Types of reports, organization of reports, organization of a design report, preparing the report, rhetoric, checklist for the final report.

TEXT BOOK:

Dairy and Food Engineering, Farall F W 1992. John Wiley & Sons, New York.

REFERENCES:

1. Plant Layout and Design, James M Moor, Macmillan, New York.
2. Milk Plant Layout, Hall H S and Y. Rosen, FAO publications, Rome.
3. Principles of Food Sanitation, Marriott N G 1985. Van Nostrand Reinhold Company, New York.
4. Food Technology Processing and Aylward F 2001. Allied Scientific Publishers, Bikaner. Laboratory Control.

WATERSHED MANAGEMENT
(Elective-II)

UNIT-I

INTRODUCTION: Concept of watershed development, objectives of watershed development, need for watershed development in India, Integrated and multidisciplinary approach for watershed management.

UNIT-II

Characteristics of Watershed. size, shape, physiography, slope, climate, drainage, land use, vegetation, geology and soils, hydrology and hydrogeology, socio-economic characteristics, basic data on watersheds. Watershed delineation – Runoff Computations from a watershed – Flood Frequency Analysis – Gumbell, Log Pearson and Weibull Methods of Analysis.

UNIT-III

PRINCIPLES OF EROSION: Types of erosion, factors affecting erosion, effects of erosion on land fertility and land capability, estimation of soil loss due to erosion, Universal soil loss equation.

MEASURES TO CONTROL EROSION: Contour techniques, ploughing, furrowing, trenching, bunding, terracing, gully control, rockfill dams, brushwood dam, Gabion.

UNIT-IV

WATER HARVESTING: Rainwater Harvesting, catchment harvesting, harvesting structures, soil moisture conservation, check dams, artificial recharge, farm ponds, percolation tanks.

UNIT-V

FOREST AND GRASS LAND MANAGEMENT: Interpretation of Satellite Imageries-Land use and Land Cover. Land capability classification, management of forest, agricultural, grassland and wild land. Reclamation of saline and alkaline soils.

UNIT-VI

ECOSYSTEM MANAGEMENT: Role of Ecosystem, crop husbandry, soil enrichment, inter, mixed and strip cropping, cropping pattern, sustainable agriculture, bio-mass management, dry land agriculture, Silvi pasture, horticulture, social forestry and afforestation. Planning of watershed management activities, peoples participation, preparation of action plan, administrative requirements- Reservoir Routing..

TEXT BOOKS:

1. Watershed Management by JVS Murthy, - New Age International Publishers.
2. Water Resource Engineering by R.Awurbs and WP James, - Prentice Hall Publishers.

REFERENCE:

1. Land and Water Management by VVN Murthy, - Kalyani Publications.
2. Irrigation and Water Management by D.K.Majumdar, Prentice Hall of India.

FOOD PACKAGING TECHNOLOGY
(Elective-II)**UNIT I**

Introduction to Food Packaging – Packaging situation in World and in India – Developments in Indian packaging - Definition of Packaging - Package, Packaging, Packing - Need of Packaging food – Logistics – Merchandising Outlets – Handling – Transportation – Packaging machinery – Technology up gradation – Public Distribution – Cost effective packaging - Levels of packaging – Functions of packaging –Packaging environments – Functions/ Environment grid - Shelf life of processed foods – Factors influencing shelf life – Product – package – Environment - Hazards of distribution – mechanical hazards – climatic hazards – other hazards.

UNIT II

Factors influencing shelf Life of fruits and vegetables –Respiratory Metabolism - Controlled Atmosphere Packaging Technology (CAP) – Modified Atmosphere - Packaging Technology (MAP) – Advantages and disadvantages of MAP – Gases - used in MAP - Packaging laws and Regulations – SWMA Rules – PFA Rules – FPO Rules – MFPO Rules – Edible oil packaging order - AGMARK Rules - National Standards on Packaging code for foodstuffs and Perishables – Classification of food stuffs according to the BIS code – Packaging of milk and milk products - Packaging of fruits and vegetables – Meat, fish and poultry – Bakery and confectionary products – Protein rich foods - Packaging of Edible starches and starch products – Oils and Fats – Food grains - and food grain products – Sugar and Honey - stimulant foods – Alcoholic drinks and carbonated beverages –Spices and Condiments.

UNIT III

Packaging materials – Classification of packages – Paper as packaging material – Paper manufacture – pulp – Mechanical pulp – Chemical pulping – Alkaline process – Soda process- Sulfate process – sulphate process – semi chemical - pulping – Digestion - Bleaching - Beating and Refining - Paper making - Converting - Calendering – Strength additives - Sizing agents - Types of paper - Kraft paper - Bleached paper - Grease proof paper – Glassine - paper - Vegetable parchment Waxed paper - Paper Boards - Paper board grades - Folding Cartons - Kinds of carton boxes – Beverage Cartons - Molded Pulp containers - Printing and varnishing - Die cutting and creasing - Gluing and sealing.

UNIT IV

Glass as Package material - Composition of Glass - Parts of Glass container - Closures - Parts of Closures - Types of Closures - Properties of glass – Internal pressure resistance - Vertical load Strength- Resistance to impact - Resistance to Scratches and Abrasions Glass manufacture - Press and Blow (P&B) - Narrow Neck Press and Blow (NNPB) - Shape of glass Container Improvements in glass manufacturing - Hot and Cold end treatment of surface – Inspection of Glass Bottles - Advantages and Disadvantages Metal as Packaging material - Introduction - Manufacture of Tin Plate - Tin plating Manufacture of ECCS- Manufacture of Aluminium - Advantages and Disadvantages.

UNIT V

Container Making Processes - End Manufacture - Three Piece Can Manufacture - Welded Side seams -Soldered Side seams - Double Seaming - Two Piece Can Manufacture D&I Cans - DRD Cans - Protective and Decorative coatings - Aluminium foils and Containers - Tube - Retort Pouch Plastic Consumption in India and World - Plastic packaging material - Classification of Plastics – Advantages and disadvantages Polyethylene - Low Density Polyethylene - Linear Low Density Polyethylene - High Density Polyethylene - Polypropylene - Polystyrene - Polycarbonate – Polyvinyl Chloride – Polyvinylidene Chloride – Ethylvinyl Alcohol- Polyethylene terephthalate Coating - Laminating - Coating process – Laminating Processes.

UNIT VI

Aseptic Packaging –Introduction – Specific fields of application – Reasons for use of Aseptic Packaging – Historical development – Principles of sterilization – Sterilization processes Aseptic packaging system – Carton, Can, Bottle, Sachet and Pouch, Cup systems Horizontal form fill sealing machine Machineries used in Food Packaging –Twist wrapping – Bread wrapping- Horizontal form fill sealing machine - Sequence of operations of a basic twin web machine - Sequence of operations of a basic single web machine - Packaging of Biscuits, , Milk Powder, Coffee - Carbonated soft drink- Fried Snack Foods Package Testing - Thickness – Paper density - Basis weight – Grammage - Burst Strength - Tear Resistance - Tensile Strength - Grease Resistance – Gas Transmission Rate (GTR) - Water Vapour Transmission Rate (WVTR).

TEXT BOOKS:

1. Food Packing Technology by Richard Coles and Mark J. Kirwan, Wiley Blackwell Publishing. 2nd Edition. 2011
2. In – Pack Processed Food by P. Richardson, Woolhead Publishing, 1st Edition, 2008.
3. Food Packaging Principles and Practices by Gordon L. Robertson, CRC Press, 3rd Edition, 2013.

REFERENCES:

1. Recent Innovation in Barrier Technology for Plastic packaging , A review by Jacob L. Packaging Technology and Sciences, 2003.
2. New Concept in Dairy Packaging by Varghes S. and Goyal G.K , Beverages and Food world.

Minor Irrigation and Command area Development

Unit 1

Introduction to Irrigation Projects: Major, medium and minor irrigation projects – their comparative performance; development and utilization of water resources through different minor irrigation schemes.

Unit II:

Introduction to Command area: Basic concepts of command area – definition, need, scope, and development approaches: historical perspective, command area development authorities;

Unit III

Farm Development Activities: Interaction/collaboration of irrigation water use efficiency and agricultural production. Planning and execution of on farm development activities within the scope of command area development;

Unit IV

Definition, Scope and progress of minor irrigation works in Andhra Pradesh.; Geological formation for ground water supply; Ground water development; Methods for ground water exploration.

Unit V

Remote Sensing Techniques: Use of remote sensing techniques for command area development; case studies of some selected commands

Unit VI

Farmer's Participation: Farmer's participation in command area development. Case studies in related areas.

TEXT BOOKS:

1. Michael, A. M. (1990). Irrigation Theory and Practice. Vani Educational Books
2. Modi, P. N. (1995). Irrigation Water Resources and Water Power Engineering. Std Book House, New Delhi.

REFERENCES:

1. Murthy, C.S. (1990). Design of Minor irrigation and canal structures. Wileyeastern Limited, New Delhi.
2. Murthy, V.V.N. (1998). Land and Water Management. Kalyani Publishing, New Delhi.
3. Proc. of seminar on water Management. (1992). Vol 1 & II. Water Management Forum, Gandhinagar.
4. Punmia, B.C and Pande, B.B. (1999). Irrigation and Water Power Engg. Standard Publishers and Distributors, New Delhi.

FARM MACHINERY LAB II

Practical

1. To study the various types of mowers, constructional details, materials and working.
2. To practice the alignment and registration of mower.
3. To study the various types of reaper, constructional details, materials used, working and performance
4. To measure the different losses in thresher and threshing efficiency of a thresher.
5. To study about the various types of chaff cutters and their capacity.
6. To study about constructional details, materials used and working of potato harvesters.
7. To study about constructional details, materials used and working of groundnut harvesters
8. To study the various types of cotton strippers, constructional details, materials used and working
9. To study about safety rules for operating the harvesters, threshers and combiners based on IS standards.
10. To study about different horticultural tools.
11. To visit the machinery production industry and ICAR SAU'S Research Station.

REFERENCE BOOKS:

1. Farm Machinery, Stone A A 1958. John wiley and sons, NewYork.
2. Farm Machinery and Equipment. Smith H.P. 1971. TataMcGraw-HillsPublishing Co., Ltd., NewDelhi.
3. Testing and Evaluation of Agricultural Machinery. Mehta M.L., Verma S.R.MisraS.K. and Sharma V.K. Daya Publishing House, New Delhi.
4. Farm Machinery and Equipment, Smith H P 1971. Tata McGraw HillPublishing Co. Ltd., New Delhi

DAIRY AND FOOD ENGINEERING LAB

Practical

1. To study composite pilot milk processing plant & equipments
2. To study various parts of Pasteurizer and its working
3. To study various parts of Sterilizer and its working
4. To study various parts of Homogenizer and its working
5. To study various parts of Cream Separator and its working
6. To study various parts of Butter Churner and its working
7. To study various parts of Evaporator and its working
8. To study various parts of milk drier and its working
9. To study various parts of freezer and its working
10. Design and layout of dairy plant
11. To determine various physical properties of Food Products
12. To estimate steam requirement for various operations in dairy plant
13. Visit to food industry/ dairy plant.

REFERENCES:

1. Food Engineering and Dairy Technology, Kessler H G 1981. Verlag A. Kessler, Freising
2. Outlines of Dairy Technology, Sukumar De 2005. Oxford University Press, New Delhi
3. Principles of Food Science, Fennema O R 2006. The Bangalore Printing & Publishing Co., Ltd., Bangalore

DESIGN OF AGRICULTURAL MACHINERY

Objective: To enable the students to understand the general procedure for designing any machine parts. To know the design of cotter and knuckle joints, levers, springs, various types of shafts, couplings bearings and various IC engine parts.

Unit-I:

Machine Design – Definition, Classification of machine design, General considerations in machine design, General procedure in machine design. Fundamental units, Mass and Weight, inertia, laws of motion, force, moment of force, couple mass density, torque, work, power and energy. Simple stress in machine parts – Introduction, load, stress, strain, tensile stress and strain, compressive stress and strain, Young's modulus, shear stress and strain, shear modulus, bearing stress.

Unit-II:

Stress strain diagram, working stress, Factor of safety and selection, stresses in composite bars, thermal stress, linear and lateral strain, Poisson's ratio, volumetric strain, bulk modulus and relations, impact stress, resilience. Principal stresses and principal planes – Theories of failure under static load, Rankine's theory, Guest's theory, maximum distortion theory, stress concentration, notch sensitivity - Important terms used in Limit System, fits, types of cotter joints, design of socket and spigot cotter joint. Knuckle joint, Dimensions of various parts of knuckles joint, methods of failure of knuckle joint, design procedure of knuckle joint.

Unit-III:

Levers – Introduction, application of levers in engineering practice, design of lever hand levers, foot lever, cranked lever. Springs – Introduction, types of springs, material for helical springs, spring wire, terminology, springs in series and parallel, flat spiral springs, leaf springs, construction of leaf springs.

Unit-IV:

Shafts – Material used for shafts, types and sizes of shafts, stresses in shafts, maximum working stresses. Design of shafts, for twisting moment, bending moments, fluctuating loads, axial load in addition to combined twisting and bending loads, design of shafts on the basis of rigidity. Keys and coupling – Introduction, types of keys, sunk keys, saddle keys, tangent keys, round keys, splines, forces acting on sunk keys, strength of sunk key. Effect of key ways, shaft couplings, types of shaft couplings, muff coupling, design of flange coupling.

Unit-V:

Design of Machinery: Design of Tillage equipment –a. Cultivator (Manually Drawn and Power Operated); b. Rotavator (Power Operated); c. M.B Plough (Manually Drawn and Power Operated). Design of Sowing Machinery – Tractor Operated seed cum Fertilize drill

Unit-VI:

Design of harvesting equipment: a. Reaper, b. Mower. Design of Thresher: Power operated thresher (Spike tooth and Raspbar), Design of spraying equipment – Tractor mounted Boom sprayer.

TEXT BOOK:

1. Machine Design – Khurmi R.S. and Gupta J.K. 1996, Eurasia Publishing House Pvt. Ltd., New Delhi.

REFERENCES:

1. Machine Design – Jain R.K. 1991. Khanna Publishers, New Delhi.

AGRICULTURAL EXTENSION TECHNIQUES AND BUSINESS MANAGEMENT**Unit-I:**

Describe the meaning of communication, explain models of communication process along with elements and their characteristics. Classify the methods and explain the meaning, objectives, procedure involved in carrying out various individual, group and mass contact methods and describe the factors influencing selection of extension methods.

Discuss about the various information tools and sources like internet, cyber cafes, kiosks, video and teleconferencing, Parishkaram (Farmers call Center) in A.P. and kisan call centers and agri-clinics including agricultural journalism.

Unit-II:

Discuss about the adoption and diffusion process and explain the models of adoption process and innovation-decision process, classify adopter categories and enlist the characteristics and explain the factors affecting adoption process. Describe the importance of capacity building of extension personnel and farmers and explain the meaning of training and discuss different types of training to farmers and enumerate the objectives of Farmer's Training Centre (FTC), mandate of Krishi Vignan Kendra (KVK) and objectives of District Agricultural Advisory and Transfer of Technology Centres (DAATTC).

Unit-III:

Management – Definition, decision management, importance of management, concepts, functions of management. Management – Management cycle, planning, organization, direction, control, co – ordination, communication. Agri – business management – Meaning, definition, concept, distinctive features of agribusiness management, application of management principles in agri – business.

Unit-IV:

Agro – based industries – Importance, need, procedure to be followed to setup agro – based industries, constraints in establishing agro – based industries. Project analysis – Project meaning, project cycle, identification, formulation, appraisal, Implementation, monitoring and evaluation. Project appraisal techniques – Undiscounted techniques, pay back method, rate of return/return on investment, etc. Discounted techniques – NPV, BCR, IRR, sensitivity analysis.

Unit-V:

International trade – Definition, comparison between international trade and interregional trade, free trade vs. protectionism, methods of protectionism. India's contribution to international trade in food and agricultural commodities, share of agricultural products in total imports/exports of India, export – import policy. General agreement on trade and tariff (GATT), WTO, objectives, functions and structure of WTO, why WTO, ten benefits of WTO.

Unit-VI:

Principles of WTO trading systems, MFN, national treatment, predictability, promoting fair competition, encouraging development and economic reform. WTO agreements – Provisions relate to agreements in agricultural and food commodities. Agreements on agriculture (AOA) – Domestic supply, market access, export subsidies agreements on sanitary and phyto – sanitary (SPS) measures, Trade related intellectual property rights (TRIPS).

References:

1. Education and Communication for Development, Dahama O.P. and Bhatnagar O.P 1980 –Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Reaching the Unreached – Basics of Extension Education, Ganesh R., Mohammad Iqbal I. and Anandaraja N., Associated Publishing Company, New Delhi.
3. Essentials of Management, Joseph L Massie 1995. Prentice – Hall of India, New Delhi.
4. Agricultural Economics and Agri-business, Omri Rawlins N 1980. Prentice – Hall Inc., New Jersey

AGRO INDUSTRIES AND BI-PRODUCT UTILIZATION

Objective: Processes to convert low value byproducts from agricultural and food processing industries will be explained in detail to produce economically viable value added products. Knowledge on treatment techniques of waste water from agricultural/food industry and animal sheds for safe disposal will be imparted to the students.

Unit –I

Agro-industries-Definition, classification, factors responsible for establishment. By-products utilization-Rice husk-Introduction, characteristics, uses, production of pure silica and silicon, uses of amorphous silica, grades of silicon, structure of rice husk silica. Burning of rice husk for production of white ash, production of high purity silicon (calcium reduction process). Ceramic materials from rice husk – Classification of ceramics, advantages of rice husk white ash, raw materials for ceramics, production process, merits of process. Rice husk combustion – Furnace design calculation, efficiency of furnace, problems on rice husk combustion, design of inclined grate furnace.

Unit-II:

Rice husk – Alcoholic fermentation – Introduction, processes for manufacture of alcohol, production of ethyl alcohol by SSF process. Rice husk – Furfural – Chemistry, products properties of furfural, synthesis, production of furfural and xylose from corn cobs, furfural through RRL process. Rice bran – Oil extraction, food and chemical products processing. Coconut coir and shell utilization – Introduction. Commercial products – Edible copra, milling copra, oil milling, quality of copra and oil.

Unit –III:

Fresh kernel based products and product diversification – Desiccated coconut, canned coconut cream, coconut water. Coconut toddy production. Coir – Brown fiber milling, manufacture of white fiber. Coconut shell products. Mango stone and peel utilization – Mango vinegar, mango leather, mango flour-Cashew nut-Harvesting, processing. Cashew products – Nuts, testa, apple, cashew nut shell liquid, extraction of CNSL. Banana pseudo stem – Pseudo stem, banana stem candy, banana starch from pseudo stem, banana cheese from peel, banana pectin from peel, banana vinegar from pulp and peel, banana peel as cattle feed.

Unit-IV:

Sugarcane bagasse – Molasses, bagasse, filter mud, sugarcane wax. Paper making from agricultural wastes – paper processing – Manufacture of pulp and paper. Raw materials for paper production, paper board production from agricultural wastes. Feed processing plants – Introduction, feedstuffs from cereals, classification of feeds, specialized feeding requirements, feed manufacturing processes, forms of feed. Equipment for unit operations in feed processing – Liquid feed blenders, flaking, milling, mixing, pelleting and extruding. Formulating feeds, layout of feed mills for commercial production.

Unit-V:

Agricultural waste management – Planning waste management systems – System selection, system principles, waste utilization opportunities, waste management alternative systems. Properties of agricultural waste – characteristics of solid and liquid wastes, parameter importance, determination of DO, COD, total organic carbon, BOD. BOD analysis of industrial waste waters, determination of BOD with seed material, problems on BOD. Waste collection, storage and handling – Collection, components of waste collection systems, storage of manures and slurries, factors affecting choice of storage facility. Waste handling and transport, pumping liquid manure, sumps and mixing, mixing and agitation. Industrial waste treatment – Physical treatment of waste – Solid-liquid separation – Settling, problems on solid-liquid separation, screening, drying, incineration, and pyrolysis.

Unit –VI:

Biological treatment – Introduction. Anaerobic decomposition, lagoon systems, anaerobic lagoons, advantages and disadvantages of anaerobic lagoons. Design of anaerobic lagoons, problems on design of anaerobic lagoons, anaerobic lagoon sludge. Aerobic treatment – Introduction, reactions and processes for anaerobic treatment, advantages and disadvantages of anaerobic treatment. Types of aeration systems - Natural aeration - Introduction, planning and design, Mechanical aeration – Film reactors – Tricking filters, rotating biological contactors, problems on tricking filters. Floc reactors – Mechanically aerated lagoons, diffused air systems, Waste for reuse. Briquetting – Introduction, principle, briquetting machines. Processing – Direct compaction, carbonization and extrusion. Establishment of agro processing industries in rural areas, factors affecting for establishing of agro processing plants, cost benefit ratio for agro processing industries, employment generation.

Text Books:

1. Modern Abattoir Practices and Animal by Products, Sharma, B.D, Jaypee Brothers medical Publishers.
2. Food from Wastes, Ervan, international Publishers, Delhi.

Reference Books:

1. Food Agricultural Waste Manual, Vandersholm D H, New Zealand.
2. Agricultural Waste Management Field Hand Book, USDA: New York, USA.
3. Manure Production and Characteristics. Standards, ASAE: Am. Soc. of Agricultural Engineers, New York.

**GIS AND REMOTE SENSING
(Elective-III)**

Objective: To equip the students with the knowledge on techniques of Remote Sensing and GIS applications for land and water resources management with projections on yield response to irrigation water, mapping of salt affected and waterlogged lands and techniques of image processing for various applications in efficient natural resources management.

UNIT-I

Remote sensing: Introduction to Remote Sensing, stages of remote sensing, Data acquisition and analysis, Sensors- Remote sensing types and applications, important features of Indian Remote Sensing Satellites,

Electromagnetic spectrum: Different bands, Resolution, Spectral response Pattern-multi spectral data use, modern remote sensing technology versus conventional aerial photography.

UNIT – II

Visual image interpretation: Image interpretation, Basic principles of image interpretation, Factors governing the quality of an image, Factors governing interpretability, visibility of objects, Elements of image interpretation, Techniques of image interpretation,

Unit III

Digital image processing- Digital image, pixel, resolution, Image processing overview; Image restoration- Radiometric correction-DN (Digital Number value) – Noise removal and correction, Atmospheric error and correction, Geometric Error and correction.

Unit-IV

Image enhancement -Contrast manipulation-gray level thresholding-level slicing-contrast stretching, Digital image processing-spatial Feature Manipulation-spatial filtering- convolution edge enhancement.

Vegetation Indices: Digital image processing, vegetation components, supervised and unsupervised image classification and output stage data merging,

Unit – V

Remote sensing in agriculture: Progress and prospects of yield assessment, remote sensing application in water resources development, remote sensing in soil conservation, aerial photo interpretation for water resources development and soil conservation survey. Remote sensing in geology and soil mapping.

Unit – VI

Geographical Information System: History of development of GIS: Definition, Basic components and standard GIS packages. Data entry, storage and maintenance, Data types – spatial, non-spatial (attribute-date), Data structure, data format, point line vector-raster polygon, Object structural model, files, files organization, Data base management, systems (DBMS), Entering data in computer-digitizer-scanner data compression.

TEXT BOOKS:

1. Remote sensing and Geographical information system, BS publications, Sultan Bazaar, Hyderabad – 3
2. Introduction to Remote sensing, James B and Compell, Published by Taylor & Francis Limited.

REFERENCES:

1. Basics of remote Sensing and GIS, University Science Persons.
2. Remote Sensing and GIS by Basudeb Bhatta, Oxford University Persons, New Delhi.

**HUMAN ENGINEERING AND SAFETY
(Elective-III)**

Objective: To enable the students to study of human relation with environmental factors, study of anthropometry study of safety gadgets for spraying, chaff cutting and tractor & trailer operator.

UNIT-I

Introduction to Human Engineering and Safety: Human factors, Machine factors, environmental factors, relationship between the three; study of human machine model, human performance, effectors and senses, importance of FMJ (Fitting Man Job) and FJM (Fitting Job Man).

Study of Anthropometrics in Designs: Workspace design for standing and seated workers, Tasks requirements – visual requirements and postural requirements.

UNIT – II

Functions of the Skeletal and Muscular Systems: Conditions for the static equilibrium for the human body, the muscle function and types of muscle fatigue and discomfort; Factors influencing the work posture.

Unit- III

Design of Hand Tools: Biometrics and energy for muscle contraction, oxygen dependent and oxygen independent system. CO₂ consumption, importance of cardio muscular system and respiratory system in physical work handling; difference between static and dynamic works.

UNIT – IV

Physical Work Capacity: Factors affecting the work capacity - introduction, work capacity- Personal factors- age and sex. Environmental factors: light and climate. Indirect measures of energy expenditure, calculation of rest periods in manual work.

Safety: Different machines and measures taken for the protection, vision- importance of vision, measures taken for the protection of the vision, guidelines for using colour combinations.

UNIT-V

Noise and Vibration- Measurement of sound, the nature of sound, damages due to noise, preventive measures, Displacer, types of displace, visual displace, audio signals, communication, noise communication, audio warning cues.

UNIT – VI

Advance Effects of Air Pollution: Safety regulation acts during field operations, safety measures. Rehabilitation and compensation to accident victims, human information processing, skill and performance, general model of human information processing, memory storage, short term and long term storages, feedback information, design of hand tools for agricultural operations.

Text Books:

1. Work study and Ergonomics, Dalela S and Saurabh 1995, Standard Publishers and Distributors, NewDelhi.
2. New Horizons I Human Factor Design, Huckingson 1992. McGraw-Hill Book Co., New Delhi.
3. Human Factors Engineering, McCormick E J 1992. McGraw-Hill Book Co., NewDelhi.

Reference books:

1. Human Factors in Engineering and Design, Sanders M S and McCormick E J 1992. McGraw-Hill Book Co., NewDelhi.
2. Anthropometric Methods: Designing to Fit the Human Body by John A. Roebuck Jr. 1996. HFES.Publications.
3. Anthropometric Sourcebook (1978). NASA Reference Publication No. 1024, Houston TX: NASA (NTIS, Springfield, VA 22161, Order No. 79 11734).

**PRODUCTION TECHNOLOGY OF AGRICULTURAL MACHINERY
(ELECTIVE-III)**

Objective: To enable the students to understand the different processes and machinery involved in manufacturing the agricultural machines and to acquire knowledge on CNC tooling, turning tools, milling tools, drilling tools, finishing tools. To know the industrial lay out, planning, organization, administration and management.

Unit-I:

Critical appraisal in production of agricultural machinery-Stresses in machine elements working stresses-stress analysis of machine parts by using standard software.

Unit-II:

Cutting tools including CNC tools and finishing tools-High speed steel cutting tools, cemented carbides, coated carbides, ceramics, drilling tools, types of drill bits, milling cutters.

Unit-III:

CNC tooling-turning tools, milling tools, drilling tools, finishing tools associated with tool turrets, different types of tools used in CNC machining centers – vertical axis machining centers – twin turret turning centre. CNC Turning centers – Multiple spindle turning centers – integrated material handling.

Unit-IV:

Powder metallurgy-introduction, powder metallurgy process, preparation of metal powders. Characteristics of metal powders – mixing compacting – sintering – hot pressing – applications of powder metallurgy. Limits, fits & tolerances – limits and fits compound tolerances – conditions for the success of any system of limits & fits, Terms & definitions.

Unit-V:

Jigs & fixtures – Jigs, fixtures, differences between jigs & fixtures – advantages of jigs & fixtures – essential features of jigs & fixtures. General rules for designing jigs & fixtures – Different types of jigs – Types of fixtures. Controllers – CNC controlling for machine tools – motion control systems – Point to point control system – continuous path control system. CNC controlling for machine tools absolute incremental control system – open loop and closed loop system.

Unit-VI:

Machine control unit – introduction – configuration of machine control unit. Distributed numerical control – introduction and configuration. CNC part programming – Part programming fundamentals – manual part programming methods. CNC part programming – interpretation of G-codes, computer Assisted part programming types- quality of good industrial management. Advantages of good organization – economic order quantity – site selection of a factory – general location of a factory – plant lay out. Selection of stander and critical components for manufacturing agricultural machines. Case studies of manufacturing of agricultural machinery.

Reference:

1. CAD/CAM : Principles and Applications, Rao P.N, 2004, McGraw Hill Education India, New Delhi.
2. Engineering Metrology, Jain R.K., Khanna Publishers, New Delhi.
3. Industrial Organization and Engineering, Banga T.R. and SharamS.C., 2004, Khanna Publishers, New Delhi.
4. Mechanisms and Machine Theory, Rao J.S. and Dukkippatti R.V., 1990, Wiley Astern Ltd., New Delhi.
5. Theory of Mechanisms and Machines, Jagdish La, 191, Metropolitan Book Co. Pvt. Ltd., New Delhi.

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