Semester-VII

1. Project (AGE 101) **Credits 0+6**

2. Seminar (AGE 102) **Credits 0+1**

3. ELECTIVES:

3.1: Food Packaging Technology (PFE 114)

	L	P
Credits	**2**	**+ 1**
Contact Hours	**2**	**+ 2**

Theory: Factors affecting shelf life of food material during storage; spoilage mechanism during storage; definition, requirement, importance and scope of packaging of foods; types and classification of packaging system; advantage of modern packaging system. Different types of packaging materials used. Different forms of packaging, metal container, glass container, plastic container, flexible films, shrink packaging, vacuum & gas packaging. Packaging requirement & their selection for the raw & processed foods. Advantages & disadvantages of these packaging materials; effect of these materials on packed commodities, Package testing, Printing, labeling and lamination. Economics of packaging; performance evaluation of different methods of packaging food products; their merits and demerits; scope for improvements; disposal and recycle of packaging waste.

Practical: Identification of different types of packaging materials; determination of tensile strength of given material; Determination of compressive strength of given package; To perform different destructive tests for glass containers; To perform non-destructive tests for glass containers; Vacuum packaging of agricultural produces; Determination of tearing strength of paper board; measurement of thickness of packaging materials; To perform grease-resistance test in plastic pouches; Determination of bursting strength of packaging material; Determination of water-vapour transmission rate; Shrink wrapping of various horticultural produce; Testing of chemical resistance of packaging materials; Determination of drop test of food package; Visit to relevant industries.

3.2: Design and Maintenance of Greenhouse (PFE 115)

	L	P
Credits	**2**	**+ 1**
Contact Hours	**2**	**+ 2**

Theory: History and types of greenhouse; importance, function and features of green house; scope and development of green house technology. Location, Planning and various component of greenhouse; design criteria and calculation; constructional material and methods of construction; covering materials and its characteristics, solar heat transfer, solar fraction for green house, steady state analysis of green house, Greenhouse heating, cooling, shedding and ventilation systems; Carbon Dioxide generation and monitoring and lighting systems, instrumentation & computerized environmental Control Systems. Watering, fertilization, root substrate and its pasteurization, containers and benches, plant nutrition. Alternative cropping systems; plant tissue culture, chemical growth regulation; disease control; integrated pest management; postproduction quality and handling Cost analysis of greenhouse production; Applications of green house & its repair & maintenance.

Practical: Study/visit to a functional green house; planning and layout of green house & associated utilities; Material selection for the construction of green house; Measurement of temp. using thermomseter, thermistor & thermocouples inside the green house; Measurement of humidity & air velocity using various methods; Measurement of solar radiations inside the green house; Application of psychometric charts; estimation of cooling requirements in a green house; estimation of ventilation requirements; Thermal performance of green house; Application of data loggers for simultaneous estimation & control of different parameters like temp., RH, solar radiations etc.; Calculations of environment indices inside a green house; Structural analysis of green house; Economic analysis of green house; Visit to a commercial green house.

3.3: Waste and By-Product Utilization (PFE 116)

	L	P
Credits	**1**	**+ 1**
Contact Hours	**1**	**+ 2**

Theory: Types and formation of byproducts and waste; magnitude of waste generation in different food processing industries; concept scope and maintenance of waste management and effluent treatment, Temperature, pH, Oxygen demands (BOD, COD), fat, oil and grease content, metal content, forms of phosphorous and sulphur in waste waters, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues, Waste utilization in various industries, furnaces and boilers run on agricultural wastes and byproducts, briquetting of biomass as fuel, production of charcoal briquette, generation of electricity using surplus biomass, producer gas generation and utilization, waste treatment and disposal, design, construction, operation and management of institutional community and family size biogas plants, concept of vermi-composting, Pre-treatment of waste: sedimentation, coagulation, flocculation and floatation, Secondary treatments: Biological and chemical oxygen demand for different food plant waste– trickling filters, oxidation ditches, activated sludge process, rotating biological contractors, lagoons, Tertiary treatments: Advanced waste water treatment process-sand, coal and activated carbon filters, phosphorous, sulphur, nitrogen and heavy metals removal, Assessment, treatment and disposal of solid waste; and biogas generation.

Practical: Waste characterization: (a) temperature (b) pH (c) solids content (d) turbidity (e) BOD (f) COD; Determination of ash content of agril. wastes; Determination of unburnt carbon in ash of paddy straw; To study about briquetting of agricultural residues; Estimation of excess air for better combustion of briquettes; To study about extraction of oil from rice bran; To study about waste treatment plant in food industry; To study about utilization of whey; To study about recovery of peel oil; To study about recovery of germ and germ oil from by-product of cereals; Practical on bioconversion of agro-wastes; Practical on recycling of agro-wastes and by-products; Visits to various industries using waste and food byproducts.

3.4: Development of Processed Products & Equipments (PFE 117)

	L	P
Credits	**2**	**+ 1**
Contact Hours	**2**	**+ 2**

Theory: Applications of unit operations to the food industry, analytical processing concepts with regards to mass and energy balances, equipment involved in the commercially important food processing methods and unit operations; value addition to cereals like rice, wheat etc. Parboiling of rice, quality of processed products of rice & wheat. Processing of pulses, spices and condiments; extruded food product, fermented food product, frozen and dried product, technology of meat, fish and poultry products, technology of milk and milk products. Technology of oilseeds and fat products, snack foods, Fruits and vegetables product: candy, nutraceuticals, food product development trends, food additives and labeling. Process equipment for thermal processing-evaporation, dehydration, drying, blenching, pasteurization, distillation; mechanical separation-filtration, sieving, centrifugation, sedimentation; mechanical handling-conveying and elevation; size reduction and classification-mixing; kneading, blending.

Practical: Working principle and operation of Engleberg huller; study of different cleaners and graders used in agro processing industries; working principle, operation and maintenance of paddy destoner-cum-cleaner, rubber roll sheller, paddy separator and vertical cone whitener; familiaraization with operation and performance of machinery and equipments of Satake rice milling unit of 500 kg/hr; planning and layout of roller wheat flour milling & rice milling; visit to milk plant; visit to roller flour mill; visit to markfed canneries; visit to fruit/vegetable processing plants; flow process diagram and study of various models of the machines used in a sugar mill.

3.5: Food Processing Plant Design & Layout (PFE 118)

	L	P
Credits	**1**	**+ 1**
Contact Hours	**1**	**+ 2**

Theory: Meaning and definition of plant layout. Objectives and principles of layout. Types of layout. Salient features of processing plants for cereals, pulses oilseeds, horticultural and vegetable crops, poultry, fish and meat products, milk and milk products. Location selection criteria, selection of processes, plant capacity, project design, flow diagrams, selection of equipments, process and controls, handling equipments, plant layout, Plant elevation, requirement of plant building and its components, labour requirement, plant installation, power and power transmission, sanitation. Cost analysis, preparation of feasibility report.

Practical: Planning, visit and layout of flour milling plant; Planning, visit and layout of rice milling plant; Planning, visit and layout of milk plant; Planning, visit and layout of bakery plant; Planning, visit and layout of fruits and vegetable dehydration plant; Planning, visit and layout of beverages industry; Planning, visit and layout of edible of extraction plant; Planning, visit and layout of ice-cream plant; Planning, visit and layout of sugar mill plant; Planning, visit and layout of honey/turmeric/chillies processing plant.

3.6: Micro Irrigation Systems Design (SWE 113)

	L	P
Credits	**2**	**+ 1**
Contact Hours	**2**	**+ 2**

Theory: Past, present and future need of micro-irrigation systems, Role of Govt. for the promotion of micro-irrigation in India, Merits and demerits of micro-irrigation system, Types and components of micro-irrigation system, Micro-irrigation system- design, design synthesis, installation, and maintenance. Sprinkler irrigation - types, planning factors, uniformity and efficiency, laying pipeline, hydraulic lateral, sub-mains and main line design, pump and power unit selection. Drip irrigation – potential, automation, crops suitability. Fertigation – Fertilizer application criteria, suitability of fertilizer compounds, fertilizer mixing, injection duration, rate and frequency, capacity of fertilizer tank. Quality control in micro-irrigation components, design and maintenance of polyhouse; prospects, waste land development – hills, semi-arid, coastal areas, water scarce areas, Benefit and Cost analysis.

Practical: Study of different types of micro-irrigation systems and components; Field visit of micro-irrigation system; Study of water filtration unit; Discharge measurement study of different micro-irrigation systems; Study of water distribution and uniformity coefficient; Study of wetted front and moisture distribution under various sources of micro-irrigation system; Design of micro-irrigation system for an orchard; Design of micro-irrigation system for row crops design of spray type micro-irrigation system; Design of micro-irrigation system for hilly terraced land; Study of automation in micro-irrigation system; Study of micro climate inside a Polyhouse; Study of maintenance and cleaning of different components of various systems; Design of sprinkler irrigation system; Design of landscape irrigation system

3.7: Watershed Planning and Management (SWE 114)

	L	P
Credits	**2**	**+ 1**
Contact Hours	**2**	**+ 2**

Theory: Watershed management - problems and prospects; watershed based land use planning, watershed characteristics – physical and geomorphologic, factors affecting watershed management, hydrologic data for watershed planning, watershed delineation, delineation of priority watershed, water yield assessment and measurement from a watershed; hydrologic and hydraulic design of earthen embankments and diversion structures; sediment yield estimation and measurement from a watershed and sediment yield models; rainwater conservation technologies - in-situ and storage, design of water harvesting tanks and ponds; water budgeting in a watershed; effect of cropping system, land management and cultural practices on watershed hydrology; evaluation and monitoring of watershed programmes; people's participation in watershed management programmes; planning and formulation of project proposal; cost benefits analysis of watershed programmes; optimal land use models; case studies.

Practical: Study of watershed characteristic; analysis of hydrologic data for watershed management; Delineation of watershed and measurement of area under different vegetative and topographic conditions; Measurement of water and sediment yield from watershed; Study of different watershed management structures; Study of various water budget parameters; Study of watershed management technologies; Preparation of a techno-economically effective project proposal.

3.8: Minor Irrigation and Command Area Development (SWE 115)

	L	P
Credits	**2**	**+ 1**
Contact Hours	**2**	**+ 2**

Theory: Major, medium and minor irrigation projects – their comparative performance; development and utilization of water resources through different minor irrigation schemes. Basic concepts of command area – definition, need, scope, and development approaches: historical perspective, command area development authorities; Interaction/collaboration of irrigation water use efficiency and agricultural production. Planning and execution of on farm development activities with in the scope of command area development; Use of remote sensing techniques for command area development; case studies of some selected commands; Farmers participation in command area development.

Practical: Topographic survey and preparation of contour map; preparation of command area development layout plan; land leveling design for a field; earthwork and cost estimation; irrigation water requirement of crops; preparation of irrigation schedules; planning and layout of water conveyance system; design of Irrigation systems; conjunctive water use planning; application of remote sensing for command area development; technical Feasibility and economic viability of a command area project. Study tour to minor irrigation and command area development projects.

3.9: Environmental Engineering (SWE 116)

	L	P
Credits	**2**	**+ 1**
Contact Hours	**2**	**+ 2**

Theory: Importance of safe water supply system. Domestic water requirements for urban and rural areas. Sources of Water supply. Intakes and transportation of water. Drinking water quality. Indian Standards of drinking water. Introduction to water treatment. Importance of sanitation. Domestic waste water: quantity, characteristics, disposal in urban and rural areas. Sewer: types, design discharge and hydraulic design. Introduction to domestic wastewater treatment. Design of septic tank. Solid waste: quantity, characteristics and disposal for urban and rural areas. Introduction to air pollution. Types of pollutants properties and their effects on living beings. ISI standards for pollutants in air and their abetments.

Practical: Determination of turbidity; pH of solution; Suspended solids; Dissolved solids; Total solids; Temporary hardness; Permanent hardness; Fluorides; Chlorides, dissolved oxygen; BOD; Collection of air samples and their analysis; Numerical problems related to theory; Visit to treatment plant.

3.10: Gulley and Ravine Control Structures (SWE 117)

	L	P
Credits	**2**	**+ 1**
Contact Hours	**2**	**+ 2**

Theory: Introduction; floods - causes of occurrence, flood classification - probable maximum flood, standard project flood, design flood, flood estimation - methods of estimation; estimation of flood peak - Rational method, empirical methods, Unit hydrograph method; Statistics in hydrology, flood frequency methods - Log normal, Gumbel's extreme value, Log-Pearson type-III distribution; depth-area-duration analysis; flood forecasting, flood routing – channel routing, Muskingum method, reservoir routing, modified Pul's method; flood control - history of flood control, structural and non-structural methods of flood control measures, storage and detention reservoirs, levees, channel improvement; Gulley erosion and its control; soil erosion and sediment control measures; river training works, planning of flood control projects and their economics.

Practical: Determination of flood stage-discharge relationship in a watershed; determination of flood peak-area relationships. Determination of frequency distribution functions for extreme flood values using Gumbel's method; Determination of frequency distribution functions for extreme flood values using log-Pearson Type-III distribution; Determination of confidence limits of the flood peak estimates for Gumbel's extreme value distribution; Determination of probable maximum flood; Standard project flood and spillway design flood; Design of levees for flood control; Design of jetties; Study of vegetative and structural measures for Gulley stabilization; Designing and planning of a flood control project; Cost and benefit analysis of a flood control project.

3.11: Remote Sensing and GIS Application (SWE 118)

	L P
Credits	**2 + 1**
Contact Hours	**2 + 2**

Theory: Remote Sensing: Definition, stage in remote sensing, modern remote sensing technology versus conventional aerial photography; 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, digital image processing, digital image; remote sensing in agriculture progress and prospects, microwave radiometry for monitoring agriculture crops and hydrologic forecasting; aerial photo interpretation for water resources development and soil conservation survey.

GIS: History of development of GIS definition, basic components, and standard GIS packages; data-entry, storage and maintenance; data types-spatial-non-spatial (attribute data), 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.

Practical: Familiarization with remote sensing and GIS hardware; use of instruments for aerial photo interpretation; interpretation of aerial photographs and satellite imagery; basic GIS operations such as image display; study the various features of GIS software package; scanning and digitization of maps; data base query and map algebra; GIS supported case studies in water resources management.

3.12: Reservoir and Farm Pond Design (SWE 119)

	L	P
Credits	**2**	**+ 1**
Contact Hours	**2**	**+ 2**

Theory: Earthen embankments - functions, advantages and disadvantages, classification – hydraulic fill and rolled fill dams - homogeneous, zoned and diaphragm type; foundation requirements, grouting, seepage through dams - estimation of seepage discharge, location of seepage/phreatic line by graphical and analytical methods, flow-net and its properties, seepage pressure, seepage line in composite earth embankments, drainage filters, piping and its causes; design and construction of earthen dam, stability of earthen embankments against failure by tension, overturning, sliding etc; stability of slopes - analysis of failure by slice method; types of reservoirs and farm ponds, design and estimation of earth work; cost analysis.

Practical: Study of different types and materials of earthen dams; Determination of the position of phreatic line in earth dams for various conditions; Stability analysis of earthen dams against head water pressure; Stability analysis of earthen dams against foundation shear; Stability analysis of earth dams against sudden draw down condition; Stability of slopes of earth dams by friction circle method / different methods; construction of flow net for isotropic and anisotropic medium; Computation of seepage by different methods; determination of settlement of earth dam; Input-output-storage relationships by reservoir routing; design of farm ponds; cost estimation of farm ponds and other structures.

3.13: Tractor Design and Testing (FPM 114)

	L	P
Credits	**2**	**+ 1**
Contact Hours	**2**	**+ 2**

Theory: Procedure for design and development of agricultural tractor, Study of parameters for balanced design of tractor for stability & weight distribution, hydraulic lift and hitch system design. Design of mechanical power transmission in agricultural tractors. Design of Ackerman Steering and tractor hydraulic systems. Study of special design features of tractor engines and their selection. Design of seat and controls of an agricultural tractor. Tractor Testing.

Practical: Design problem of tractor clutch – (Single/ Multiple disc clutch); Design problem on spur gears; Design problem of bevel gears; Design problem of helical gears; Design of gear box(synchromesh/constant mesh); Design of variable speed constant mesh drive; Selection of tractor tires – Problem solving; Problem on design of governer; Problem related to selection of hydraulic pump; Engine testing as per BIS code – various test; Drawbar performance in the lab; PTO test and measure the tractor power in the lab/field; Determining the turning space, turning radius and brake test, hydraulic pump performance test and air cleaner and noise measurement test; Visit to tractor testing centre/industry.

3.14: Hydraulic Drives and Controls (FPM 115)

	L	P
Credits	**2**	**+ 1**
Contact Hours	**2**	**+ 2**

Theory: Hydraulic Basics: Pascal's Law, Flow, Energy, Work, and Power. Hydraulic Systems, Color Coding, Reservoirs, Strainers and Filters, Filtering Material and Elements. Accumulators, Pressure Gauges and Volume Meters, Hydraulic Circuit, Fittings and Connectors. Pumps, Pump Classifications, Performance, Displacement, Designs, Gear Pumps, Vane Pumps, Piston Pumps, Pump Operation. Hydraulic Actuators, Cylinders, Construction and Applications, Maintenance, Hydraulic Motors. Valves, Pressure-Control Valves, Directional-Control Valves, Flow-Control Valves, Valve. Installation, Valve Failures and Remedies, Valve Assembly, Troubleshooting Valves Hydraulic Circuit Diagrams and Troubleshooting, United States of American Standards Institute USASI Graphical Symbols Tractor hydraulics, nudging system, ADDC. Pneumatics: Air services, logic units, Fail safe and safety systems Robotics: Use of Hydraulics and Pneumatics drives in agricultural systems, PLCs (Programmable Logic Controls).

Practical: Introduction to Hydraulic Systems; Study of Hydraulic Pumps; Study of Hydraulic Actuators; Study of Hydraulic Motors; Study of Hydraulic Valves; Hydraulic codes and circuits; Building simple Hydraulic Circuits; Hydraulics in Tractors; Introduction to Pneumatics; Pneumatics Devices; Pneumatics in Agriculture; Use of Hydraulics and Pneumatics for Robotics.

3.15: Farm Power & Machinery Management (FPM 116)

	L	P
Credits	**2**	**+ 1**
Contact Hours	**2**	**+ 2**

Theory: The role of mechanization and its relationship to productivity, employment, social and technological change; performance and power analysis; cost analysis of machinery: fixed cost and variable costs, effect of inflation on cost; selection of optimum machinery and replacement criteria; Break-even analysis, reliability and cash flow problems; mechanization planning; case studies of agricultural mechanization in India.

Practical: Solving problems related to Various capacities, pattern efficiency, system limitation, power requirement and other operational parameters; Solving of Problems related to cost analysis and inflation; Solving problem related to selection of equipment, replacement, break-even analysis, time value of money etc.; Presentation of seminar on topic assigned related to farm machinery management; Design of farm mechanization plan for different farm size and cropping pattern.

3.16: Renewable Energy Technologies (FPM 117)

	L P
Credits	**2 + 1**
Contact Hours	**2 + 2**

Theory: Design and operational parameters, performance evaluation and maintenance aspects of different renewable technologies like gasifiers, biogas plants, solar passive heating devices, photovoltaic cells and arrays, briquetting machines and balers; bio-diesel utilization in CI engines.

Practical: Performance evaluation of solar water heater; performance evaluation of solar cooker; Characteristics of solar photovoltaic panel; evaluation of solar air heater/dryer; Performance evaluation of a rice husk throatless gasifier engine system; Performance evaluation of down draft gasifier with throat for thermal application; Performance evaluation of a fixed dome type biogas plant; Performance evaluation of floating drum type biogas plant; Estimation of calorific value of producer gas; Testing of diesel engine operation using biodiesel; Evaluation of briquetting machine using biomass material; evaluation of rice straw briquette.

3.17: Human Engineering and Safety (FPM 118)

	L	P
Credits	**1**	**+ 1**
Contact Hours	**1**	**+ 2**

Theory: Human factors in system development – concept of systems; basic processes in system development, performance reliability, human performance. Information input process, visual displays, major types and use of displays, auditory and factual displays. Speech communications. Biomechanics of motion, types of movements, Range of movements, strength and endurance, speed and accuracy, human control of systems. Human motor activities, controls, tools and related devices. Anthropometry: arrangement and utilization of work space, atmospheric conditions, heat exchange process and performance, air pollution. Dangerous machine (Regulation) act, Rehabilitation and compensation to accident victims, Safety gadgets for spraying, threshing, Chaff cutting and tractor & trailer operation etc.

Practical: Calibration of the subject in the laboratory using bi-cycle Ergometer as loading device, versus different physiological parameters; Calibration of the subject in the laboratory using mechanical treadmill as loading device versus different physiological parameters; Study of Respiration gas meter and its use in selected farm operation and their comparison from energy point of view; Calibration of the subject using Heart Rate Monitor and farm operation as a loading device; Study of general fatigue of the subject using Blink ratio method; Study on the use of electromyograph equipment; Anthropometric measurements of a selected group of farm workers and its statistical analysis; Study of optimum work space layout and locations of controls of different factors; Familiarization of the noise and vibration equipment.

3.18: Biomass Management for Fodder and Energy (FPM 119)

	L	P
Credits	**1**	**+ 1**
Contact Hours	**1**	**+ 2**

Theory: Introduction to biomass management, biomass resource assessment management techniques/supply chains, Processing of paddy straw, densification- Extrusion process, pellets, mills and cubers, Bailing-classification, uses; residue management for surface mulch and soil incorporation, Paddy Straw choppers and spreaders as an attachment to combine Harvester, Mulch seeder, Paddy Straw Chopper-cum-Loader, Balar for collection of straw; Processing of straw/ fodder for animal use; Agricultural and horticultural use, Cushioning material for fruits and vegetables, Mulching and Composting, Paper and cardboard manufacturing, Straw as a fuel.

Practical: Familiarization with different straw management techniques; on-farm and off-farm uses of straw; collection, loading and transport equipments for unbruised loose straw; briquetting machine and preparation of briquettes; straw baler and making of bales in the field; straw/ fodder chopping machines; straw/ mulching & incorporating machinery; machinery requirement for baling forage crops for silage.

3.19: Production Technology of Agricultural Machinery (FPM 120)

	L	P
Credits	**2**	**+ 1**
Contact Hours	**2**	**+ 2**

Theory: Critical appraisal in production of Agricultural Machinery; Modelling and stress analysis of Machinery parts by using standard software; Advances in material used for tractor & Agril. Machinery. Cutting tools including CNC tools and finishing tools. Advanced manufacturing techniques like powder metallurgy, EDM (Electro-Discharge Machining), Heat Treatment of steels including pack carburizing, shot pining process, chemical vapor deposition (CVD) etc. Limits, Fits & Tolerances, Jigs & Fixtures, Microstructure Analysis. Industrial lay-out planning, Quality management,. Economics of process selection. Techno-economic feasibility of Project Report. Selection of Standard/ critical components. Case studies of manufacturing of agril. machinery. Servo motors, drives & controllers, CNC controllers for machine tools. CNC programming. Assembly and plant automation. Storage and transportation.

Practical: To draw an exhaustive design plan for a machine & describe its kinematics; Part modelling of agril. machinery by using standard software; Problem on design of cultivator and drill parts; Problem on design of sprayer parts and fluid flow; Problem on design of harvesting and threshing machinery parts; Visit to Central Tool Room/ Industry with Advanced manufacturing techniques; Jigs and Fixtures – study in relation to Agril Machinery; Design problems on fits, tolerances and limits; Layout planning of a small scale industry; Problem on Economics of process selection; Preparation of a project report; Case study for manufacturing of weeder/ thresher through industry visit; Study of different CNC controllers/ servo motors; CNC programming; Case studies for manufacturing of tractor through industry visit

3.20: Mechanics of Tillage and Traction (FPM 121)

	L	P
Credits	**2**	**+ 1**
Contact Hours	**2**	**+ 2**

Theory: Introduction to mechanics of tillage tools, engineering properties of soil, principles and concepts, stress strain relationship, design of tillage tools principles of soil cutting, design equation, force analysis, application of dimensional analysis in soil dynamics performance of tillage tools. Introduction to traction and mechanics, off road traction and mobility, traction model, traction improvement, traction prediction, tyre size, tyre lug geometry and their effects, tyre testing, soil compaction and plant growth, variability and geo statistic, application of GIS in soil dynamics.

Practical: Measurement of static and dynamic soil parameters related to tillage; Measurement of soil parameters related to puddling and floatation; Measurement of draft for passive rotary and oscillating tools; Measurement of slip and sinkage under dry and wet soil conditions; Measurement of load and fuel consumption for different farm operations; Economics of weight transfer and tractor loading including placement and traction aids; Studies on tyres, tracks and treads under different conditions; Studies on compaction and number of operations.

3.21: Systems Engineering (FPM 122)

	L P
Credits	**2 + 1**
Contact Hours	**2 + 2**

Theory: System concepts. Requirements for a Linear programming problems. Mathematical formulation of Linear Programming problems and its Graphical solution. Response of systems. Computer as a tool in system analysis. Simplex method. Degeneracy and Duality in linear programming. Artificial variable techniques, Big M method and two phase methods. Mathematical models of physical systems. Modelling of Agricultural Systems and operations. Cost analysis. Transportation problems. Assignment problems. Waiting line problems. Project management by PERT/CPM. Resource scheduling.