

Ph.D. Programme in Farm Machinery & Power

<i>Course No.</i>	<i>Course Title</i>	<i>Credits</i>
1st Semester		
FMP-701	Advances in Farm Machinery and Power Engineering	3+1
FMP-702	Soil Dynamics in Tillage & Traction	2+1
FMP-703	Computer Aided Analysis and Design of Farm Machinery	1+2
FMP-704	Design and Analysis of Renewable Energy Conservation Systems	2+1
2nd semester		
FMP-751	Advances in Tractor Design	3+1
FMP-752	Machinery for Natural Resource Management and Precision Farming	2+1
FMP-753	Advances in Human Factor Engineering Farm Machinery	2+1
FMP-754	Simulation Modeling in Farm Machinery & Power Engineering	2+1
FMP-799	Seminar-I	0+1
3rd Semester		
FMP-849	Seminar-II	0+1
4th Semester		
	Nil	
5th Semester		
	Nil	
6th Semester		
FMP-999	Seminar-III	0+1
FMP-1000	Doctoral Research	0+45

FMP-501 Design of Farm Power and Machinery Systems 2+1

Theory

Modern trends, principles, procedures, fundamentals and economic considerations for design and development of farm power and machinery systems. Design considerations, procedure and their

applications in agricultural tractors & typical machines. Reliability criteria in design and its application. Analytical design considerations of linkages/ components in farm machinery and its application. Design of selected farm equipments: – tillage, seeding, planting, interculture, plant protection, harvesting and threshing. Design of rotary, vibrating and oscillating machines. Design and selection of matching power unit. Safety devices for tractors & farm implements.

Practical

Statement and formulation of design problems. Design of farm power systems. Design of mechanisms & prototypes in farm machinery.

FMP-502

Soil Dynamics in Tillage and Traction

2+1

Theory

Dynamic properties of soil and their measurement, stress-strain relationships, theory of soil failure. Mechanics of tillage tools and geometry of soil tool system, design parameters and performance of tillage tools. Introduction of traction devices, tyres-types, function & size, their selection; mechanics of traction devices. Deflection between traction devices and soil, slippage and sinkage of wheels, evaluation and prediction of traction performance, design of traction and transport devices. Soil compaction by agricultural vehicles and machines.

Practical

Relationship of soil parameters to the forces acting on tillage tools, wheel slippage and tyre selection, design and performance of traction devices and soil working tools.

FMP-503

Testing and Evaluation of Tractors and Farm Equipment

2+1

Theory

Types of tests; test procedure, national and international codes. Test equipment; usage and limitations. Power losses in dynamometers and hydraulic test equipment. Prototype feasibility testing and field evaluation. Laboratory and field testing of selected farm equipment. Non-destructive testing techniques. Tractor performance testing, evaluation and interpretation of results. Review and interpretation of test reports. Case studies.

Practical

Laboratory and field testing of selected farm equipment. Interpretation and reporting of test results. Material testing and its chemical composition. Accelerated testing of fast wearing components. Non-destructive testing techniques.

FMP-504

Design and Analysis of Renewable Energy Conversion Systems

2+1

Theory

Energy cycle of the earth; water flow and storage; ocean currents and tides. Energy heat flow and energy storage; photosynthesis and biomass; renewable energy sources. Thermodynamics of energy conversion; conversion of solar energy, wind energy, water flows, heat, biomass, etc.; other conversion processes. Development and use of biogas, alcohols and plant oils, plant oil esters in I.C.engines. Study of various parameters for measuring the performance of the output.

Design of bio-fuel production units: design of gasifiers, gas flow rates, biogas plants. Establishment

of esterification plant, fuel blending.

FMP- 551 Tractor Design

2+1

Theory

Technical specifications of tractors available in India, modern trends in tractor design and development, special design features of tractors in relation to Indian agriculture. Parameters affecting design of tractor engine and their selection. Design of fuel efficient engine components and tractor systems like transmission, steering, front suspension, hydraulic system & hitching, chassis, driver's seat, work-place area and controls. Tire selection Mechanics of tractor. Computer aided design and its application in agricultural tractors.

Practical

Extensive practices on the packages mentioned in the theory.

FMP-552 Operations Research in Farm Power & Machinery Management

2+1

Theory

Nature, methods, impact and scope of operational research; linear programming and integer programming models and applications. Network terminology, shortest route and minimal spanning tree problems, maximal flow problem, project planning and control with PERT and CPM.

System approach in farm machinery management and application of programming techniques to the problems of farm power and machinery selection. Maintenance and scheduling of operations. Replacement of old machines, repair and maintenance of agricultural machinery, inventory control of spare parts, work study, productivity, method study. First order Markov chains and their applications in sales forecasting and in problems of inventory control and modeling of workshop processes and quality control. Time and motion study. Man-machine task system in farm operations, planning of work system in agriculture. Computer application in selection of power units and to optimize mechanization system.

Practical

Management problems and case studies.

FMP-553

Ergonomics and Safety in Farm Operations

2+0

Theory

Concept and design criteria for optimum mutual adjustment of man and his work: Importance of ergonomics and its application in agriculture, concept of indirect calorimeter, work physiology in various agricultural tasks. Anthropometric data and measurement techniques, joint movement and method of measurement, analysis and application of anthropometric data, measurement of physical and mental capacities. Human limitations in relation to stresses and demands of working environments. Mechanical environment; noise and vibration and their physiological effects, thermal environment; heat stress, thermal comfort, effect on performance and behavior, field of vision, color discrimination, general guidelines for designing visual display, safety standards at work place during various farm operations and natural hazards on the farm. Farm safety legislation. Man-machine system concept. Human factors in adjustment of man and his work. Design aspects of foot and hand controls on tractors and farm equipment. Design of operator's seat for tractors and agricultural equipment.

Practical

Laboratory experiments on measurement of physical and mental capacities and limitations of human-being in relation to the stress and environment, anthropometric measurements, study of human response to dust, noise and vibrations, case studies on ergonomics.

FMP 554

3+0

Energy Conservation and Management in Farm Power and Machinery

Theory

Energy requirement of different operations in agricultural production systems viz. crop, livestock and aquaculture. Energy conservation through proper management and maintenance of farm machinery, planning and management of agricultural production systems for energy conservation and energy returns assessment.

Development of computer program for efficient energy management in a given agricultural production system. Energy use planning and forecasting for a given system.

FMP-555

Applied Instrumentation in Farm Machinery and Stress Analysis

2+1

Theory

Strain and stress, strain relationship, strain gauges. Mechanical, optical, electrical acoustical and pneumatic etc. and their use. Various methods of determining strain/stresses experimentally. Measuring devices for displacement (linear and rotational), velocity, force, torque and shaft power. Strain gauges: types and their application in two and three dimensional force measurement. Design and analysis of strain gauges. Introduction to functional elements of instruments. Active and passive transducers, Analog and digital modes, Null and deflection methods. Performance characteristics of instruments including static and dynamic characteristics.

Devices for measurement of temperature, relative humidity, pressure, sound, vibration, flow etc. Recording devices and their type. Measuring instruments for calorific value of solid, liquid, and gaseous fuels. Basic signal conditioning devices - data acquisition system – micro computers for measurement and data acquisition. Data storage and their application.

Practical

Calibration of instruments, Experiment on LVDT, strain gauge transducer, inductive and capacitive pickups, speed measurement using optical devices, vibration measurement exercises, making of thermocouples and their testing- basic electronic circuits and application of linear ICs.

FMP-601

Agro-Energy Audit and Management

2+0

Theory

Energy resources on the farm: conventional and non-conventional forms of energy and their use. Heat equivalents and energy coefficients for different agricultural inputs and products. Pattern of energy consumption and their constraints in production of agriculture. Direct and indirect energy. Energy audit of production agriculture, and rural living and scope of conservation.

Identification of energy efficient machinery systems, energy losses and their management. Energy analysis techniques and methods: energy balance, output and input ratio, resource utilization, conservation of energy sources. Energy conservation planning and practices. Energy forecasting, Energy economics, Energy pricing and incentives for energy conservation, factors effecting energy economics. Energy modelling.

FMP-602

Farm Machinery Dynamics, Noise & Vibrations

3+1

Theory

Principles of soil working tools: shares, discs, shovels, sweeps and blades, rota-tillers and puddlers.

Metering of seeds and granular fertilizers with various mechanism, effect of various parameters on distribution of seed and fertilizer in seed cum fertilizer drills and planters, flow of seeds and fertilizers through tubes and boots. Kinematics of transplanter.

Theory of atomization, specific energy for atomization, electrostatic spraying and dusting, spray distribution patterns. Kinematics of reapers/harvesting machines. Theory of mechanical separation of grains from ear heads/pods. Parameters affecting performance of threshers, aerodynamic properties of straw and grain mixture, theory of root crop harvesters, power requirement of various components of field machines. Noise and vibration theory- Definition, units and parameters of measurement and their importance. Types of vibrations- free and forced, in damped and without damped analysis of one, two and multiple degree of freedom systems and their solution using Newton's motion, energy method, longitudinal, transverse and torsional vibrations, Raleigh's methods, Lagrange equation.

Introduction of transient vibration in systems, vibration of continuous media. Balancing of single rotating weight and number of weights in same plane and different planes. Complete balancing of reciprocating parts of engine

Practical

Study of vibration measurement and analysis equipment, Study of different vibration measurement and evaluation, Measurement and analysis of vibration on different components of thresher, combine, reaper, power tiller and tractor. Determination of modulus of elasticity, rigidity, Evaluation of logarithmic decrement and damping factor. Whirling of shaft. Heat motion in two pendulum system.

FMP 603

3+1

Land Development Machinery

Grading of slopy lands, principles of mechanisms of crawler, mounted tractors; dump truck and their mechanisms; load hoisting equipments; earth diggers and ditchers; bull dozers and scrapers; elevating and self powered graders; automation of earth moving and grading machines; boring machines; different methods of boring; cost of operation; selection of suitable earth moving equipment.

Practical

Problems related to soil translocation; study of steering, power transmission, traction aids and devices of crawler tractor, operation of some selected earth moving machines.

FMP-701

Advances in Farm Machinery and Power Engineering

3+1

Theory

Farm machinery system, its characteristics and evaluation. Identification of dynamic characteristics of related components of engine and agricultural machines. Mechanism of dynamic elements and analysis of forces, displacement and their equilibrium in machines. Statement and formulation of design problems. Computer-aided design of mechanical power transmission systems. Half interval search method. Single and double-tie-rod steering systems, development of mathematical models and its computer-aided solutions.

Analysis of forces in tractor implement combinations under two and three dimensional conditions. Vibrations, transmissibility and effect of damping on various agricultural machine systems like engine, cutter-bar, straw walker, threshing cylinder and reaper-binder. Application of various vibration analysis methods. Tractor dynamics; development of the model. Checking, interpretation and statistical analysis of results.

Practical

Development of computer programs for Half interval search method. Single and double-tie-rod steering systems, Development of mathematical models and its computer aided solutions. Design problems using CAD.

FMP-702

Soil Dynamics in Tillage and Traction

2+1

Theory

Dynamic properties of soil and their measurement, stress-strain relationships, theory of soil failure. Mechanics of tillage tools and geometry of soil tool system, design parameters and performance of tillage tools. Introduction of traction devices, tyres-types, function & size, their selection; mechanics of traction devices. Deflection between traction devices and soil, slippage and sinkage of wheels, evaluation and prediction of traction performance, design of traction and transport devices. Soil compaction by agricultural vehicles and machines.

Practical

Relationship of soil parameters to the forces acting on tillage tools, wheel slippage and tyre selection, design and performance of traction devices and soil working tools.

FMP-703

Computer Aided Analysis and Design of Farm Machinery

1+2

Theory

Introduction to CAD – the design process – modelling using CAD – architecture of CAD system. Geometric modelling – requirements – geometric construction methods – representation of curve – desirable modeling facilities. – CAD standards – Graphical Standard system – Exchange of modeling data.

System analysis – Relevance of system approach to biological systems and engineering systems. Role of a system analyst in design of a system and development of computer systems. Characteristics of Agricultural systems. Tools of structured analysis.-The data flow model. Object oriented approach. Feasibility study – Steps in feasibility analysis – cost analysis. System design process – structured design. Application to farm machinery scheduling problem. Application to farm – factory co-ordination – case study. Design of farm machinery with the help of CAD.

Practical

Practical on CAD software, its uses and application in design of farm machinery. Design procedures. Exercise on agricultural engineering system analysis. Description of the machinery scheduling problem in harvesting and transport system. Investigation of existing software models – cases studies.

FMP-704

Design and Analysis of Renewable Energy Conversion Systems

2+1

Theory

Energy cycle of the earth; water flow and storage; ocean currents and tides. Energy heat flow and energy storage; photosynthesis and biomass; renewable energy sources. Thermodynamics of energy conversion; conversion of solar energy, wind energy, water flows, heat, biomass, etc.; other conversion processes. Development and use of biogas, alcohols and plant oils, plant oil esters in I.C.engines. Study of various parameters for measuring the performance of the output.

Design of bio-fuel production units: design of gasifiers, gas flow rates, biogas plants. Establishment of esterification plant, fuel blending.

Practical

Solution of design problems from the practical oriented topics covered in theory.

FMP-751 Tractor Design 3+1

Theory

Technical specifications of tractors available in India, modern trends in tractor design and development, special design features of tractors in relation to Indian agriculture. Parameters affecting design of tractor engine and their selection. Design of fuel efficient engine components and tractor systems like transmission, steering, front suspension, hydraulic system & hitching, chassis, driver's seat, work-place area and controls. Tire selection Mechanics of tractor. Computer aided design and its application in agricultural tractors.

Practical

Extensive practices on the packages mentioned in the theory.

FMP-752 Machinery for Natural Resource Management and Precision Farming 2+1

Theory

Functional design, specifications, requirements and working of farm machinery needed for natural resources management like rotavator, Precision sowing and planting machines, laser guided leveller, power sprayer ,straw chopper cum spreader, straw bailer , combine harvester etc. Ag GPS parallel swathing option, data base management, functional systems documentation. Application of relevant software.

An introduction to precision farming. GIS/GPS positioning system for precision farming, Yield monitoring and mapping, soil sampling and analysis. Computers and Geographic information systems. Precision farming- Issues and conditions. Role of electronics in farm machinery for precision farming.

Engineering fundamentals related to earth moving machinery: Swell, shrinkage and compaction measurements. Use of tractors & Crawlers and effects of altitude & temperature on their performance. Grade resistance and gradability. Land cleaning and reclamation equipment. Land leveling equipment. Economic analysis of land development machinery. Application of PERT and CPM to the problems related to land development.

Practical

Introduction to GIS and GPS, study of models vis-à-vis farm machinery usage. Precision farming using GIS and GPS – case study. Study the mechanism of power shovels, drag lines, earth diggers, clamshells etc. earth work estimation, unit cost of operation, work scheduling, machinery maintenance, entrepreneurship

FMP-753**Advance in Human Factor Engineering in Farm Machinery****2+1****Theory**

Concept and design criteria for optimum mutual adjustment of man and his work: Importance of ergonomics and its application in agriculture, concept of indirect calorimeter, work physiology in various agricultural tasks. Anthropometric data and measurement techniques, joint movement and method of measurement, analysis and application of anthropometric data, measurement of physical and mental capacities.

Human limitations in relation to stresses and demands of working environments. Mechanical environment; noise and vibration and their physiological effects, thermal environment; heat stress, thermal comfort, effect on performance and behavior, field of vision, color discrimination, general guidelines for designing visual display, safety standards at work place during various farm operations and natural hazards on the farm.

Farm safety legislation. Man-machine system concept. Human factors in adjustment of man and his work. Design aspects of foot and hand controls on tractors and farm equipment. Design of operator's seat for tractors and agricultural equipment.

Practical

Laboratory experiments on measurement of physical and mental capacities and limitations of human-being in relation to the stress and environment, anthropometric measurements, study of human response to dust, noise and vibrations, case studies on ergonomics.

FMP 754**Simulation Modelling in Farm Machinery and Power Engineering****2+1**

System performance and modelling methodologies – transformation of units of measurement – dimensional homogeneity. Buckingham's Pi Theorem. Simulation for system modelling, Formulations of simulation model, validation and testing of the simulation model.

Sensitivity of models, scale effects, scale factors. Use of models. Complete similarity, kinematics and dynamic similarity. Model laws, empirical methods in model engineering. Principle of similarity in mathematical investigations. Mathematical modelling and its limitations, etc.

Mathematical modelling through ordinary differential equation of first order, second order, partial differential equations. Similarity conditions and abstract parameters determining characteristics of engines. Similitude in tillage tool studies, prediction models for traction devices.

Practical

Problems in simulation models & Buckingham's Pi theorem. Problems in scale effects, scale factors and mathematical modelling. Analysis of modelling behaviour in problems related to tillage, traction and earthmoving equipment.