
	Department of Farm Machinery and Power Engineering Mahatma Phule Krishi Vidyapeeth Rahuri-413 722, Dist. Ahmednagar (MS)	
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Doctoral Programme in Farm Machinery and Power Engineering

Course Layout

Minimum Credit Requirements

Sr. No.	Subject	Minimum credit(s)
1.	Major	15
2.	Minor	08
3.	Supporting	05
4.	Seminar	02
5.	Research	45
	Total Credits	75
	Compulsory Non Credit Courses	06

Sr. No.	Course Number	Course Title	Credits
A) Major Subjects (Min. 15 credits)			
1	FMPE601*	Advances in Farm Machinery and Power engineering	4(3+1)
2	FMPE602*	Simulation modeling in Farm Machinery and Power Engineering	2(2+0)
3	FMPE603	Energy conservation and Management in Farm Machinery and Power Engineering	2(2+0)
4	FMPE604	Computer Aided Analysis and Design of Farm Machinery	3(2+1)
5	FMPE605	Machinery for natural resource management and precision farming	4(3+1)
6	FMPE606	Advances in Hydraulics and Electro Pneumatic controls	2(2+0)
7	FMPE 607	Advances in Ergonomics	3(2+1)
8	FMPE 693*	Special Problem	1(0+1)
9	FMPE694*	Case Study	1(0+1)
B) Minor Subjects (Min. 08 credits)			
1	FMPE 621	Mechanism Analysis and Synthesis	3(3+0)

2	FMPE 622	Experimental Stress Analysis	3(2+1)
3	AE 503	Applied Instrumentation	3(2+1)
4	STAT 609	Operation Research	3(2+1)
5	RES 622	Design and Analysis of Renewable Energy Conversion System	3(2+1)
6	RES 623	Energy Management and Planning	3(2+1)
7	RES 624	Agro Energy Audit and Management	2(2+0)
C) Supporting Subjects (Min. 05 credits)			
1	AE 502	Similitude in Engineering	3(2+1)
2	MATHS 601	Mathematical Modeling and Software Application	3(1+2)
3	PFE 605	Agricultural Waste and Byproduct Utilization	3(2+1)
4	MATHS 602	Optimization Techniques	2(1+1)
5	STAT 531	Data Analysis using Statistical Packages	3(2+1)
6	AE 605	Project Planning and Implementation	3(2+1)
D) Seminar (02 credits)			
1	FMPE 691	Doctoral seminar I	1(0+1)
2	FMPE 692	Doctoral seminar II	1(0+1)
E) Doctoral Research (45 credits)			
1	FMPE 699	Doctoral research	45 (0+45)
F) Non Credit Compulsory Courses			
1	PGS 501	Library and Information Services	1(0+1)
2	PGS 502	Technical Writing and Communication Skills	1(0+1)
3	PGS 503 (e-course)	Intellectual Property and its Management in Agriculture	1(1+0)
4	PGS 504	Basic Concepts in Laboratory Techniques	1(0+1)
5	PGS 505 (e-course)	Agricultural Research, Research Ethics and Rural Development Programmes	1(1+0)
6	PGS 506 (e-course)	Disaster Management	1(1+0)

Course Contents

A) Major Subjects

FMPE601* Advances in Farm Machinery and Power Engineering	4(3+1)
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Theory

UNIT I

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.

UNIT II

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.

UNIT III

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.

UNIT IV

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.

Suggested readings

Bevan T. 1962. *The Theory of Machines*. Longman.

Close CM, Fredrick DK & Newwell IC. 2001. *Modelling and Analysis of Dynamic System*. John Wiley & Sons.

Franklin GF & Powell JD. 1980. *Digital Control of Dynamic System*. Addison Wesley Publ.

Kepner RA, Bainer R & Berger EL. 1978. *Principles of Farm Machinery*. AVI Publ.

Mabie HH & Ocrirk FW. 1987. *Mechanism and Dynamics of Machinery*. John Wiley & Sons.

Shigley JE & Uicker JJ. 1980. *Theory of Machinery and Mechanism*. McGraw Hill.

FMPE 602 Simulation Modelling in Farm Machinery and Power Engineering 2(2+0)

Theory

UNIT I
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.
UNIT II
Experimentation with physical models and their application in farm machinery design. 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.
UNIT III
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.

Suggested readings

Langhaar HL.1954. *Dimensional Analysis and Similitude*. McGraw Hill.
Sedov LI. 1991. *Similarity and Dimensional Methods in Mechanics*. Mir Publ., Moscow.

FMPE 603 Energy Conservation and Management in Farm Power and Machinery 2(2+0)

Theory

UNIT I
Energy requirement of different operations in agricultural production systems viz. crop, livestock and aquaculture.
UNIT II

Energy conservation through proper management and maintenance of farm machinery, planning and management of agricultural production systems for energy conservation and energy returns assessment.
UNIT III
Development of computer program for efficient energy management in a given agricultural production system. Energy use planning and forecasting for a given system.

Suggested readings

Mittal JP, Panesar BS, Singh S, Singh CP & Mannan KD. 1987. *Energy in Production Agriculture and Food Processing*. ISAE and School of Energy Studies, Ludhiana. ISAE Publ. Pimental D. 1980. *Handbook of Energy Utilization in Agriculture*. CRC Press.

FMPE 604 Computer Aided Analysis and Design of Farm Machinery 3(2+1)

Theory

UNIT I
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.
UNIT II
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.
UNIT III
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.

Suggested readings

Chris McMahon & Jimmie Browne. 2000. *CAD /CAM/ Principles, Practice and Manufacturing Management*. Pearson Edu.

Grover Mikell P. 2003. *Automation, Production Systems and Computer Integrated Manufacturing*. Prentice-Hall of India.

Radhakrishnan P, Subramanyan S & Raju V. 2003. *CAD/CAM/CIM*. New Age International.

Rao PN. 2002. *CAD/CAM Principles and Applications*. Tata McGraw Hill.

Zeid Ibrahim.1998. *CAD/CAM Theory and Practice*. Tata McGraw Hill.

FMPE 605 Machinery for Natural Resource Management and Precision Farming 4(3+1)
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Theory

UNIT I
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.
UNIT II
Ag GPS parallel swathing option, data base management, functional systems documentation. Application of relevant software.
UNIT III
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.
UNIT IV
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
UNIT V
Land cleaning and reclamation equipment. Land leveling equipment. Power shovels, drag lines, cam shells. Rubber tire for earth moving machinery. Trenching machineries and wagons. 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

Suggested readings

De Mess M. N. Fundamental of Geographic Information System. John Willy and Sons, New York

Dutta SK. 1987. Soil conservation and land management. International distributors, Dehradun. Kuhar, John. E. 1977. The precision farming guide for agriculturalist. Lori J. Dhabalt, USA. Lille Sand, T and Kaiffer, R. Remote Sensing and Image Interpretation, John Willy and Sons, London.

Nichols HL& Day DH.1998. Moving the earth. The work book of excavation. McGraw Hill. Peurifoy RL 1956. Construction, planning, equipment and methods. McGraw Hill Sabbins, F. Remote Sensing Principle and Interpretation. Freeman, New York

Singh G.1991. Manual of soil and water conservation engineering. Oxford and IBH, Co. Sigma & Jagmohan.1976. Earth moving machinery. Oxford & IBH Wood & Stuart. 1977. Earth moving machinery. Prentice Hall.

FMPE 606 Advances In Hydraulics and Electro Pneumatic Controls	2(2+0)
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Theory

UNIT I

Fluid power, its advantages, properties of hydraulic fluids, viscosity, bulk modulus, density. Concepts of energy of hydraulic systems, laws of fluid flow.

UNIT II

Distribution system, pressure rating of tubing and hoses, couplings. Basics of hydraulic flow and hydraulic circuit analysis – pumps, types and theory of operation. Pressure intensifiers. Fluid power actuators, hydraulic rams, gear motors, piston motors and their performance characteristics, electro hydraulic motors and hydrostatic transmissions, control components.
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UNIT III

Directional pressure safety and servo valves. Hydraulic circuit design. Regenerative pump unloading, pressure intensifier circuits. Speed control of hydraulic motors, mechanical hydraulic servo systems for tractors.

UNIT IV

Pneumatic circuits – properties of air. Compressors, control elements. Design of pneumatic circuits. Electrical control for fluid power circuits. Electronic sensors/ circuits used as controls in modern farm equipment. Maintenance of hydraulic and pneumatic circuits and devices. Trouble shooting.
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Suggested readings

Anthony Esposito. 2003. *Fluid Power with Applications*. Pearsons Edu.

Krutz G.1984. *Design of Agricultural Machines*. John Wiley & Sons.

Merritt HE. 1991. *Hydraulic Control System*. John Wiley & Sons.

Majumdar SR. 2003. *Oil Hydraulic System*. Tata McGraw Hill.

FMPE 607	Advances In Ergonomics	3 (2 +1)
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Theory

UNIT I
Human limit and differences, Sensing, The body and performance
Unit II
Cognitive processing and performance, Perception, problem solving and design making Memory Motivation
Unit III
Basic design and human factor, interface design, human machine interface, human computer interface, supporting human performance, selection criteria,
Unit IV
Performance aids, physical and social environments.

Practical

Anthropometric measurement techniques in design, assessment of physical fatigue, physical stress and work posture, measurement and vibration sound

Suggested readings

Ernest J , Mc Cornik, Mc Graw Hills

Stephen Pheasant, Body space anthropometry, ergonomics and design of work, Taylor
and Francis Ltd, London

E Grandjean, Fitting the tank to the man, Taylors and francis Ltd. London

B) Minor Subjects**FMPE 621 Mechanism Analysis and Synthesis Advances in Ergonomics 3 (3 +0)****Theory****UNIT I**

Introduction to kinematics of mechanisms, kinematic analysis and synthesis, mobility and degree of freedom of a mechanism, systematics of mechanisms deriving other mechanisms from linkages.

UNIT II

Relative motion, instantaneous center method, Kennedy's theorem. Graphical and analytical methods of displacement, velocity and acceleration analysis, Computer – Aided analysis of mechanisms.

UNIT III

Dimensional synthesis of linkages for path generation, function generation and rigid-body guidance problems. Graphical techniques. Relative pole method and method of inversion etc. Analytical kinematics synthesis of linkages, Freudenstein's method, Loop closure equations based on complex variable approach

UNIT IV

Kinematics of gears-Analysis of epicyclic gear trains. Synthesis of gear trains compound and epicyclic. Cam – follower system; standard follower motions and combinations, importance of follower acceleration in cam system dynamics, terms related to cam design- their importance. Cam synthesis – graphical cam profile layout for a desired follower motion. Analytical determination of cam profile co-ordinates for disc cam operating common types of follower.

Suggested readings

George N Sandor & Arthur G Erdman.1984. *Advanced Mechanism Design - Analysis and Synthesis*. Vols. I, II. Prentice Hall.

Norton. 2003. *Design of Machinery - An Introduction to the Synthesis and Analysis of Mechanisms and Machines*. McGraw Hill.

Shigley Vicker. 2007. *Theory of Machines and Mechanisms*. McGraw Hill.

FMPE 622 Experimental Stress Analysis**3 (2+1)****Theory****UNIT I**

Strain and stress, Strain relationship, Strain gauges mechanical, optical, electrical, acoustical and pneumatic etc and their use. Different types of electric strain gauges, Semiconductor gauges.

UNIT II

Rosette analysis, Train gauge circuits, Strain measurements at high temperatures. Two dimensional & three dimensional photo elastic method of strain analysis.
UNIT III
Bifringent coatings and scattered light in photo elasticity, Brittle coating methods, Moire method of strain analysis, Grid Method of strain analysis, Photoelastic strain gauges.

Practical

Measurement of strain with strain gauge. Photo elastic methods and Moire's apparatus.

Suggested readings

Srinath LS.1984. *Experimental Stress Analysis*. Tata McGraw Hill.

Singh Sadhu. 1982. *Experimental Stress Analysis*. Khanna Publ.

Dally J.W. & W.F. Riley, 1990. *Experimental Stress Analysis*. Tata McGraw Hill.

AE 503	Applied Instrumentation	3 (2+1)
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Theory

UNIT I
Basic instrumentation systems and transducer principles. Displacement Transducers: Potentiometer, LVDT, Piezoelectric and capacitive transducers. Digital Transducers. Velocity transducers – Analog and Digital
UNIT II
Acceleration and absolute motion measurement. Force transducer _ Strain Gauge, Hydraulic load cell, Cantilever type and Probing ring. Method of separation of force – Torque, Power and Energy measuring techniques.
UNIT III
Temperature measurement using Bi-metals, PTRs, Thermistors, Thermocouples, Electronic IC sensors and Pyrometers. Heat flux measurement. Humidity measurement – Dry and Wet bulb, Hair hygrometer and Humister. Soil and Grain moisture transducers, pressure measurement – Manometers, Bourdon Tube, Diaphragm type transducer. High pressure and vacuum sensing techniques.
UNIT IV
Flow transducers, Positive displacement, venturimeter, Rotameter, Drag force, Ultrasonic, Electromagnetic, Hot wire anemometers. Time and frequency measurement.
UNIT V
Level measurement, OD and pH measurement, PCO ₂ and grain quality measurement. Biomedical measurement – BP, ECG etc., Ultrasonic flaw detection, Spectroscopy.

Practical

Study the characteristics of various transducers : Potentiometer, LVDT, Proximity sensors and Photo pickups, Load cell, Thermistor and Thermocouple, LM 335/AD 590se of various Analog interfacing blocks: Attenuators, Amplifiers, A/D converters, Filters, digital interfaces using Wave shapers and level shifters.

Practice of using interfaces and developing suitable software for data acquisition through PC/Microcomputer: Use of Microcomputer kit, Study the use of 8255 I/O IC, Study the use of printer port in a PC. Data acquisition through PC/Kit.

Suggested readings

Doebelin EO.1990. *Measurement Systems Applications and Design*. Tata McGraw Hill.

Nakra BC &Chaudhary KK. 2004. *Instrumentation Measurement and Analysis*. Tata McGraw Hill.

Sawhney AK. 2008. *Electrical & Electronics Measurement and Instrumentation*. Dhanpat Rai & Sons.

STAT 601	Operational Research	3 (2+1)
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Theory

UNIT I
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.
UNIT II
System approach in farm machinery management and application of programming techniques to the problems of farm power and machinery selection.
UNIT III
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.
UNIT IV
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.

Suggested readings

Carville LA. 1980. *Selecting Farm Machinery*. Louisiana Cooperative Extn. Service Publication.

Culpin C & Claude S. 1950. *Farm Mechanization; Costs and Methods*. McGraw Hill.

Culpin C & Claude S. 1968. *Profitable Farm Mechanization*. Crosby Lockwood & Sons.

FAO. 1984. *Agricultural Engineering in Development: Selection of Mechanization Inputs*. Agricultural Service Bulletin.

Hunt D. 1977. *Farm Power and Machinery Management*. Iowa State University Press.

Waters WK. 1980. *Farm Machinery Management Guide*. Pennsylvania Agric. Extn. Service Spl. Circular No. 1992

Stephen J Klin. 1965. *Similitude and Approximation Theory*. McGraw Hill.

RES 622 Design and Analysis of Renewable Energy Conversion Systems 3 (2+1)

Theory

UNIT I
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.
UNIT II
Thermodynamics of energy conversion; conversion of solar energy, wind energy, water flows, heat, biomass, etc.; other conversion processes
UNIT III
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.
UNIT IV
Design of bio-fuel production units: design of gasifiers, gas flow rates, biogas plants. Establishment of esterification plant, fuel blending.

Practical

Problems related to designing and analysis for conversion of renewable energy systems

Suggested readings

Boyle Godfrey. 1996. *Renewable Energy: Power for Sustainable Future*. Oxford Univ. Press.

Culp AW. 1991. *Principles of Energy Conservation*. Tata McGraw Hill.

Duffie JA & Beckman WA. 1991. *Solar Engineering of Thermal Processes*. John Wiley.

Garg HP & Prakash J. 1997. *Solar Energy - Fundamental and Application*. Tata McGraw Hill.

Grewal NS, Ahluwalia S, Singh S & Singh G. 1997. *Hand Book of Biogas Technology. Solar Energy Fundamentals and Applications*. TMH New Delhi.

Mittal KM. 1985. *Biomass Systems: Principles & Applications*. New Age International.
 Odum HT & Odum EC. 1976. *Energy Basis for Man and Nature*. Tata McGraw Hill.
 Rao SS & Parulekar BB.1999. *Non-conventional, Renewable and Conventional*.
 Khanna Publ. Sukhatme SP.1997. *Solar Energy - Principles of Thermal Collection and Storage*. 2nd Ed. Tata McGraw Hill.

RES 623 Energy Management and Planning

3 (2+1)

Theory

UNIT I

Human, animal, mechanical energy sources, fuel: solid, liquid, gaseous, crop production energy, plantation, rainfed, irrigated, tractor owned, bullock frames, crop rotation and energy needs, agro industries/ processing and energy needs, animal raising, domestic purpose, energy requirements, energy use patterns, different categories of farmers, resource use pattern, input/ output ratio, energy inflow in village ecosystem, self-sufficiency in energy, system planning for energy conservation, Questionnaire and contact procedures for survey, field survey, Yardstick for energy resource analysis and conservation efficiency, reliability and availability, Economics, study on energy needs for household, energy budgeting for crop production, energy in – flow, out flow in a typical village, Energy audit in agro- processing industries like rice mill, oil mill, poultry, dairy etc. Integrated energy system, scope, planning and design of energy, modeling, project preparation strategies, socioeconomic and environmental aspect of energy management. Rural and urban energy planning waste heat recovery. Co-generation with alternate energy system.

Practical

Preparation of energy census schedule visit to sample farm and data collection on energetic. Estimation of energy equivalents for inflow outflow analysis. Integrated energy planning exercise for farm. Visit to oil mill for energy use pattern data collection visit to sugar mill, village Gur Industry for energy pattern data collection in Agro industries, Energy analysis for household sector, Energy planning for village Eco- System. Estimation and energy planning for mixed and integrated farming system, Case study of energy conservation in a typical agro industry.

Suggested Readings

Turner, W.C. (1997). *Energy, management Handbook*. Fairmont Press.
 Brookfield, V.T. (1996), *Energy Environment and the Economy: Asian Perspectives*
 Edward Elgar Publishing
 Grubb, M and Walkar. J.(1992). *Emerging Energy Technologies: Impact and Policy Implication*. Dartmouth Pub.
 Fowler J, H, (1975), *Energy and the Environment*. McGraw, Hill

Capehart, B.L., Turner W.V. Kennedy, W.J.(1997), Guide to Energy Management Fairmont Press.

Sornson. H.A. (1983) Energy conservation System. John Willey.

Goldemberg, J. Johnsson, T.B. Reddy, A.K.N. and Williams. R. H. (1987) .Energy for a sustainable world. World resource Institute, USE.

Mittal, K.M. (1997). Nonconventional energy Systems. Principles, Programmers and Prospects, Sheller Publishing.

Verma S. R. Mittal V.P. & S., Energy Management and conservation in Agricultural Production & Food Processing, USG Publishers, Ludhiana.

Kenny W.F., Energy Conservation in Process Industries, Academic Press, Inc. New York. Renzo. D. J. Cogeneration Technologies and Economics of Process Industries, Noyes Data Corporation, Park ridges. New Jersey.

RES 624 Agro-Energy Audit and Management 2 (2+0)

Theory

UNIT I
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 indirectenergy.
UNIT II
Energy audit of production agriculture, and rural living and scope of conservation.
UNIT III
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.
UNIT IV
Energy conservation planning and practices. Energy forecasting, Energy economics, Energy pricing and incentives for energy conservation, factors effecting energy economics. Energy modelling.

Suggested readings

Kennedy WJ Jr. & Wayne C Turner.1984. *Energy Management*. Prentice Hall.
Pimental D. 1980. *Handbook of Energy Utilization in Agriculture*. CRC Fluck RC & Baird CD.1984. *Agricultural Energetics*. AVI Publ. Rai GD. 1998. *Non-conventional Sources of Energy*. Khanna Publ.

Twindal JW & Anthony D Wier 1986. *Renewable Energy Sources*. E & F.N. Spon Ltd.

Verma SR, Mittal JP & Surendra Singh 1994. *Energy Management andConservation inAgricultural Production and Food Processing*. USG Publ. & Distr., Ludhiana.

C) Supporting Subjects

AE 502 Similitude in Engineering 3 (2+1)

Theory

UNIT I
Dimensions and units.
UNIT II
Dimensional and similarity analysis. Theory of models.
UNIT III
True, distorted and dissimilar models.
UNIT IV
Application to different systems with special reference to Structural and fluid flow systems, Analogues.

Practical

Equations for the period of simple pendulum. Uniform rectangular cantilever beam.
Spring mass level system. Investigation of extrapolation.
Deflection of a cantilever beam. Prediction of the deflection of a beam using a model. Analogue model experiments

Suggested readings

Green Murphy.1950. *Similitude in Engineering*. Ronald Press.
Huntley HE. 1974. *Dimensional Analysis*. Dover Publ.

MATHS 601 Mathematical Modeling and Software Application 3 (1+2)

Theory

UNIT I
Introduction, stages in mathematical modeling, importance of mathematical modeling
UNIT II
Classification of mathematical models. Continuous and discrete models, linear models and its applications, quadratic models and its applications, exponential models and its applications, empirical models and its applications.
UNIT III
Introduction to MAT LAB, Desktop tools
UNIT IV
MAT LAB basics: variables and arrays, initialization variables, matrix manipulation, linear algebra, roots of polynomials, data analysis and statistics. Solution of the mathematical problems using MAT LAB tools. Graph plotting: 2- D, 3-D, contour.
UNIT V
Simulation of mathematical models using MAT LAB programming.

Practical

Hands on for UNIT III, IV and V.

Suggested Books

Dym, Clive L. Principles of Mathematical modeling.

Chapman, Stephen J. MAT LAB programming for Engineers.

PFE 605 Agricultural Waste and By-Products Utilization 3 (2+1)

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

Practical

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

Suggested readings

ASAE Standards. 1984. *Manure Production and Characteristics*.

Bor S Luh (Ed.). 1980. *Rice: Production and Utilization*. AVI Publ.

Chahal DS. 1991. *Food, Feed and Fuel from Biomass*. Oxford & IBH.

Chakraverty A. 1989. *Biotechnology and other Alternative Technologies for Utilisation of Biomass/ Agricultural Wastes*. Oxford & IBH.

David C Wilson. 1981. *Waste Management - Planning, Evaluation, Technologies*. Oxford. Donald L Klass & Emert H George 1981. *Fuels from Biomass and Wastes*. Ann. Arbor. Science Publ.

Srivastava PK, Maheswari RC & Ohja TP. 1995. *Biomass Briquetting and Utilization*. Jain Bros.

USDA 1992. *Agricultural Waste Management Field Handbook*. USDA.

Wilfred A Cote. 1983. *Biomass Utilization*. Plenum Press.

MATH 602 Optimization Techniques 2 (1+1)**Theory**

UNIT I
Single-variable optimization algorithms; Optimal problem formulation, Optimization algorithms. Optimality criteria, Bracketing methods, Region-elimination methods, Point-estimation method, Gradient based methods, Root finding using optimization techniques.
UNIT II
Multi-variable optimization algorithms: Unidirectional search, Direct search methods, Gradientbased methods.
UNIT III
Constrained optimization algorithms: Knhn-Tucker conditions, Transformation methods.
UNIT IV
Sensitivity analysis, Direct search for constrained minimization, Kinearized search, techniques, feasible direction method, Generalized reduced gradient method, Gradient projection method.
UNIT V
Specialized algorithms: Integer programming, Geometric programming.
UNIT VI
Non-traditional optimization algorithms: Generic algorithms,simulatedannealing,Globaloptimization.

Practical

Hands on for UNIT I to IV

Suggested Book

Deb K; Optimization for engineering design, Algorithms and examples, Prentice Hall of India, New Delhi 1996.

STAT 531 Data Analysis using Statistical Packages 3 (2+1)**Theory**

UNIT I
Use of software packages for: summarization and tabulation of data; Descriptive statistics: Graphical representation of data, Exploratory data analysis.
UNIT II
Fitting and testing the goodness of fit of discrete and continuous probability distributions; Testing of hypothesis based on large sample test statistics; Testing of hypothesis using chi-square, t and f statistics.
UNIT III

Concept of analysis of variance and covariance of data for single factor, multi-factor; one way and multi-classified experiments, contrast analysis, multiple comparisons
UNIT IV
Analysis of mixed models; Estimation of variance components; Testing the significance of contrast; correlation and regression including multiple regression.
UNIT V
Discriminate function; Factor analysis; Principal component analysis; of time series data, fitting of non-linear models; Time series data; Spatial analysis; Neural networks

Practical

Use of software packages for summarization and tabulation of data, obtaining descriptive statistics, graphical representation of data;
Fitting and testing the goodness of fit of probability distributions;
Testing the hypotheses for one sample t-test, two sample t-test, paired t-test, test for large sample-chi-squares test, F-test, one way analysis of variance, contrast and its testing, fixed effect models-analysis of unbalance data sets, testing and significance of contrasts, Estimation of variance components in unbalanced data sets- maximum likelihood, ANOVA, REML, and partial correlation, dissimilarity measures, similarity measures;
Linear regression, Multiple regression, Regression plots, Variable selection, Fitting of growth models curve estimation models, Factor analysis.
Principal component analysis-obtaining principal component, spectral composition;
Analysis of time series data- fitting of ARIMA models, working out moving averages, Spatial analysis; Neural networks

Suggested Book:

Atkinson AC. 1985 Plots Transformation and Regression. Oxford University Press.

Chambers JM, Cleveland WS, kleiner B & Tukey PA. 1993. Graphical Methods for Data Analysis. Wadsworth, Belmont, California.

Chatfield C. 1983. Statistics for Technology. 3 Ed. Chapman & Hall.

Chatfield C 1995 Problem solving: A statistician's Guide. Chapman & Hall

Cleveland WS. 1985. The Elements of Graphing Data. Wadsworth, Belmont, California.

Erickson BH & Nosanchuk TA. 1992 Understanding Data 2nd Ed. Open University Press, Milton Keynes.

Snell EJ & Simpson HR. 1991. Applied statistics; A Handbook of GENSTAT Analyses Chapman & Hall.

Sprent P. 1993. Applied Non-parametric Statistical Methods. 2nd Ed. Chapman & Hall.

Tufte ER. 1983. The Visual Display of Quantitative information. Graphics Press, Cheshire, Conn.

Velleman PF & Hoaglin DC. 1981. Application, Basics and computing of Exploratory Data Analysis. Duxbury Press.

AE 605 Project Planning and Implementation 3 (2+1)

Theory

UNIT I

An introduction to project management: An overview of project management. The differences between Project and Program management, Industrial, R& D and social security projects.

UNIT II

Successful initialization and Project Planning; Defining the project scope. Establishing the project scope and defining project deliverables. Defining and Sequencing of Project Deliverables. Project scheduling techniques, Market research and forecasting. GMP and HACCP

UNIT III

Resource planning: Determining resource requirements and acquiring those resources, Source of finance, Debt-equity ratio, Debt service coverage ratio, ROI, RONW, Process of soliciting and selecting vendors for material and services for the project. Cost Management. Establishing the project budget and analyzing budget variances, techno-economic feasibility analysis

UNIT IV

Execution of the project plan and Evaluation Project Progress; Execution of the project plan and activities required to create the project team, monitor progress against the plan, and keep the project on track. Capacity utilization, Break even point

UNIT V

Risk Identification and Analysis: Identify risky events, measure the element of risk, and develop responses to high-risk events. Establishing the project Management Team Identifying project team members, and structuring a successful project team. Keeping the Project on Track The quality process, Project's quality standards and how performance to those standards will be measured. Managing Project change Handling formal and informal change, how to identify and evaluate change, and incorporate change into the project plan

Practical

Preparation of model detailed project report for a small scale food processing unit and its power point presentation, case studies of various food products, projections planning for sales target achievements, Risk analysis for financial and technical feasibilities of the projects, project appraisal methods as applied to selected projects

Suggested Books

Pavlyak MM. 200. System Survival Guide, Ruby Moon Press.

Thomsett TC. 1990. the Little Book of Project Management. American Management Association.

C) Non-Credit Compulsory Courses

PGS 501 Library and Information Services 1 (0+1)

Practical

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

PGS 502 Technical Writing and Communications Skills 1(0+1)

Practical

Technical Writing - Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article. Communication Skills - Grammar (Tenses, parts of speech, clauses, punctuation marks); Erroranalysis (Common errors); Concord; Collocation; Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers.

Suggested readings

Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.
Collins' Cobuild English Dictionary. 1995. Harper Collins.
Gordon HM & Walter JA. 1970. *Technical Writing*. 3rd Ed. Holt, Rinehart & Winston.
Hornby AS. 2000. *Comp. Oxford Advanced Learner's Dictionary of Current English*. 6th Ed. Oxford University Press.
James HS. 1994. *Handbook for Technical Writing*. NTC Business Books.
Joseph G. 2000. *MLA Handbook for Writers of Research Papers*. 5th Ed. Affiliated East-West Press.
Mohan K. 2005. *Speaking English Effectively*. MacMillan India.
Richard WS. 1969. *Technical Writing*. Barnes & Noble.
Robert C. (Ed.). 2005. *Spoken English: Flourish Your Language*. Abhishek.
Sethi J & Dhamija PV. 2004. *Course in Phonetics and Spoken English*. 2nd Ed. Prentice Hall of India.

Wren PC & Martin H. 2006. *High School English Grammar and Composition*. S. Chand & Co.

PGS 503Intellectual Property and its Management in Agriculture 1 (1+0)

(e-Course)

Theory

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested readings

Erbisch FH & Maredia K.1998. *Intellectual Property Rights in Agricultural Biotechnology*. CABI.

Ganguli P. 2001. *Intellectual Property Rights: Unleashing Knowledge Economy*. McGraw-Hill. *Intellectual Property Rights: Key to New Wealth Generation*. 2001. NRDC & AestheticTechnologies.

Ministry of Agriculture, Government of India. 2004. *State of Indian Farmer.Vol.V.Technology Generation and IPR Issues*. Academic Foundation.

Rothschild M & Scott N. (Ed.). 2003. *Intellectual Property Rights in Animal Breeding andGenetics*. CABI.

Saha R. (Ed.). 2006. *Intellectual Property Rights in NAM and Other Developing Countries: ACompendium on Law and Policies*. Daya Publ. House.

The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.

PGS 504 Basic Concepts in Laboratory Techniques 1(0+1)

Practical

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vascupets; washing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; Electric wiring and earthing. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy

Suggested readings

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

PGS 505 Agricultural Research, Research Ethics and Rural Development Programmes 1(1+0) (e-Course)

Theory

UNIT I

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR); International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

UNIT II

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

UNIT III

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive agricultural District Programme, Special group –Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/Non-Governmental Organizations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested readings

- Bhalla GS & Singh G. 2001. *Indian Agriculture - Four Decades of Development*. Sage Publ. Punia MS. *Manual on International Research and Research Ethics*. CCS, Haryana Agricultural University, Hisar.
- Rao BSV. 2007. *Rural Development Strategies and Role of Institutions -Issues, Innovations and Initiatives*. Mittal Publ.
- Singh K.. 1998. *Rural Development - Principles, Policies and Management*. Sage Publ.

PGS 506 Disaster Management 1(1+0) (e-Course)

Theory

UNIT I
Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion
UNIT II
Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.
UNIT III
Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media. Central, State, District and local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.

Suggested readings

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

FARM MACHINERY AND POWER ENGINEERING

List of Journals

- Journal of Agricultural Engineering, ISAE, New Delhi
- Journal of Arid Land Research Management
- Journal of Agricultural Engineering Research
- Transactions of American Society of Agricultural Engineers(TASAE)
- Journal of Computer and Electronics in Agriculture
- Journal of Terramechanics
- Indian Journal of Agriculture Sciences
- Agricultural Engineering Today
- Journal of Agricultural Mechanization in Asia, Africa and Latin America(AMA)
- Agricultural Engineering Journal(AIT Bangkok)
- Seed research Journal, New Delhi