



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



Master's Programme in Farm Machinery and Power Engineering

Course Layout

Minimum Credit Requirements

Sr. No.	Subject	Minimum credit(s)
1	Major	20
2	Minor	09
3	Supporting	05
4	Seminar	01
5	Research	20
	Total	55
	Non Credit Compulsory Course	06

Sr. No.	Course Number	Course Title	Credits
A) Major Subjects (Min. 9 Credits)			
1	FMPE-501*	Design Of Farm Power & Machinery System	4 (3+1)
2	FMPE-502*	Soil Dynamics In Tillage & Traction	3 (2+1)
3	FMPE-503*	Testing And Evaluation Of Tractor And Farm Equipment	3 (2+1)
4	FMPE-504	System Simulation And Computer Aided Problems Solving In Engineering	2 (1+1)
5	FMPE-507	Farm Machinery Dynamics Noise And Vibration	4 (3+1)
6	FMPE-508	Tractor Design	3 (2+1)
7	FMPE-509	Operational Research In Farm Power And Machine Management	3 (2+1)

8	FMPE-510	Ergonomics And Safety In Farm Operation	3 (2+1)
9	FMPE - 592	Special Problem	1 (0+1)
10	FMPE – 595 [#]	Industry/Institute Training	NC
B) Minor Subjects (Min. 9 Credits)			
1	FMPE-505	Instrumentation And Stress Analysis	3 (2+1)
2	FMPE- 521	Computer Aided System Design	2 (0+2)
3	RES -501	Renewable Energy Sources	3 (2+1)
4	RES- 505	Agro Energy Audit And Management	2 (2+0)
5	RES- 506	Design And Analysis Of Renewable Energy Conversion Systems	3 (3+0)
6	RES -508	Alternate Fuels For IC Engine	2 (2+1)
7	PFE-502	Engineering Properties Of Biological Material	3 (2+1)
8	BSCT-501	Computer Graphics	2 (2+1)
C) Supporting Courses (Min. 5 Credits)			
1	FMPE-531	Pesticides application techniques	3 (2+1)
2	FMPE-532	Advanced manufacturing technology	3 (2+1)
3	STAT- 511	Statistical methods for applied Sciences	3 (2+1)
4	MATHS-502	Methods of Numerical Analysis	2 (1+1)
5	FMPS-505	Research methodology	1 (0+1)
D) Seminar (01 credit)			
1	FMPE-591	Master's seminar	1 (0+1)
E) Master's Research (20 Credits)			
1	FMPE- 599	Master's research	20 (0+20)
F) Non Credit Compulsory Courses			
1	PGS -501	Library and information services	1 (0+1)
2	PGS -502	Technical writing and communication skill	1 (0+1)
3	PGS -503 (e-course)	Intellectual property and its management in agriculture	1 (1+0)
4	PGS -504	Basic concept 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)

* Compulsory

#Minimum of three weeks

Course Contents

A) Major Subjects

FMPE 501	Design of Farm Power and Machinery Systems	4(3+1)
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Theory

UNIT I

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.

UNIT II

Analytical design considerations of linkages/ components in farm machinery and its application.

UNIT III

Design of selected farm equipments: – tillage, seeding, planting, interculture, plant protection, harvesting and threshing. Design of rotary, vibrating and oscillating machines.

UNIT IV

Design and selection of matching power unit.

UNIT V

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.

Suggested Books

Arther W Judge 1967. High Speed Diesel Engines. Chapman & Hall.

Barger EL, Liljedahl JB & McKibben EC 1967. Tractors and their PowerUnits. Wiley eastern.

Bernacki C, Haman J & Kanafajski CZ.1972. Agricultural Machines Oxford & IBH.

Bindra OS & Singh Harcharan 1971. Pesticides Application Equipments.
Oxford & IBH.

Bosoi ES, Verniaev OV & Sultan-Shakh EG. 1990. Theory, Construction and Calculations of Agricultural Machinery. Vol. I. Oxonian Press.

Klenin NI, Popov IF & Sakoon VA. 1987. Agricultural Machines. Theory of Operations, Computing and Controlling Parameters and the Condition of Operation. Amrind Publ.

Lal R & Dutta PC. 1979. Agricultural Engineering (through solved examples). Saroj Parkashan.

Maleev VL. 1945. Internal Combustion Engines. McGraw Hill.

Mathur ML & Sharma RP. 1988. A Course in Internal Combustion Engines. Dhanpat Rai & Sons.

Ralph Alcock.1986. Tractor Implements System. AVI Publ.

Raymond N, Yong Ezzat A & Nicolas Skiadas 1984. Vehicle Traction Mechanics. Elsevier.

Sharma PC & Aggarwal DK. 1989. A Text Book of Machine Design.

Katson Publishing House.

Theory and Construction. Vol. I. U.S. Dept. of Commerce, National Technical Information Service, Springfield, Virginia.

Thornhill EW & Matthews GA. 1995. Pesticide Application Equipment for Use in Agriculture. Vol. II. Mechanically Powered Equipment. FAO Rome.

William. R Gill & Glen E Vanden Berg. 1968. Soil Dynamics in Tillage and Traction.

US Govt. Printing Office, Washington, D.C.

Yatsuk EP.1981. Rotary Soil Working Machines Construction, Calculation and Design. American Publ. Co.

FMPE 502	Soil Dynamics in Tillage and Traction	3(2+1)
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Theory

UNIT I

Dynamic properties of soil and their measurement, stress-strain relationships, theory of soil failure.
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UNIT II

Mechanics of tillage tools and geometry of soil tool system, design parameters and performance of tillage tools.
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UNIT III

Dimensional analysis of different variables related to soil-tyre system; soil vehicle models; mechanics of steering of farm tractor; special problems of wet land traction and floatation.
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UNIT IV

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,
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Wheel slippage and tyre selection,

Design and performance of traction devices and soil working tools.
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Suggested Books

Daniel Hill. 1962. Fundamentals of Soil Physics. Academic Press.

Gill & Vandenberg.1968. Soil Dynamics in Tillage and Traction. Supdt. Of Documents, U.S. Govt. Printing Office, Washington, D.C.

Sineokov GN. 1965. Design of Soil Tillage Machines. INSDOC, New Delhi.
 Terzaghi K & Peck Ralph B.1967. Soil Mechanics in Engineering Practices. John Wiley & Sons.

**FMPE 503 Testing and Evaluation of Tractors and Farm Equipment
 3(2+1)**

Theory

UNIT I
Types of tests; test procedure, national and international codes.
UNIT II
Test equipment; usage and limitations. Power losses in dynamometers and hydraulic test equipment.
UNIT III
Prototype feasibility testing and field evaluation. Laboratory and field testing of selected farm equipment. Non-destructive testing techniques.
UNIT IV
Tractor performance testing, evaluation and interpretation of results.
UNIT V
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.

Suggested Books

Anonymous. 1983. RNAM Test Code & Procedures for Farm Machinery. Technical Series 12.
 Barger EL, Liljedahl JB & McKibben EC. 1967. Tractors and their PowerUnits. Wiley Eastern.
 Indian Standard Codes for Agril. Implements. Published by ISI, New Delhi.
 Inns FM. 1986. Selection, Testing and Evaluation of Agricultural Machines and Equipment. FAO Service Bull. No. 115.
 Lal R & Dutta PC. 1979. Agricultural Engineering (through solve examples). Saroj Parkashan,
 Metha ML, Verma SR, Mishra SK & Sharma VK. 1995. Testing and Evaluation of Agricultural Machinery. National Agricultural Technology Information Centre, Ludhiana.
 Nebraska Tractor Test Code for Testing Tractor, Nebraska, USA.
 Smith DW, Sims BG & O'Neill D H. 2001. Testing and Evaluation of Agricultural Machinery and Equipment - Principle and Practice.
 FAO Agricultural Services Bull. 110.

FMPE 504 System Simulation and Computer Aided Problem Solving in Engineering 2(1+1)

Theory

UNIT I
Concept, advantages and limitation of dimensional analysis, dimensions and units, fundamental and derived units, systems of units, conversion of units of measurement, conversion of dimensional constants, conversion of equations in different units, complete set of dimensionless products and their formulation methods- the Rayleigh's method, Buckingham's Pi theorem and other methods.
UNIT II
Mathematical modeling and engineering problem solving.
UNIT III
Computers and softwares – software development process – Algorithm design, – program composition- quality control- documentation and maintenance – software strategy.
UNIT IV
Approximation- round off errors- truncation errors. Nature of simulation systems models and simulation- discrete event simulation- time advance mechanisms- components of discrete event simulation model. Simulation of singular server que- programme organization and logic-development of algorithm.
UNIT V
Solving differential equation on computers- modeling engineering systems with ordinary differential equations- solution techniques using computers.

Suggested Books

- Averill M. Law & W David Kelton.2000. Simulation Modeling and Analysis. McGraw Hill.
- Balagurusamy E. 2000. Numerical Methods. Tata McGraw Hill.
- Buckingham E. 1914. On Physical Similar System. Physical Reviews 4: 345.
- Langhar H. 1951. Dimensional Analysis and Theory of Models. John Wiley & Sons.
- Murphy J. 1950. Similitude in Engineering. The Roland Press Co. Robert J Schilling
- Sandra L Harries. 2002. Applied Numerical Methodsfor Engineers Using MATLAB and C. Thomson Asia.
- Simpson OJ. 2000. Basic Statistics. Oxford & IBH.
- Singh RP. 2000. Computer Application in Food Technology. Academic Press.
- Steven Chopra & Raywond Canale. 1989. Introduction to Computing for Engineers. McGraw Hill.
- Veerarajan T & Ramachnadran T. 2004. Numerical Methods with Programmes in C and C++. Tata McGraw Hill.
- Wilks SS. 1962. Mathematical Statistics. John Wiley & Sons.

FMPE 507 Farm Machinery Dynamics, Noise & Vibrations 4(3+1)**Theory**

UNIT I

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

UNIT II

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 transplanters.

UNIT III

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.

UNIT IV

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.

UNIT V

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, and MI by free vibration test.

Evaluation of logarithmic decrement and damping factor.

Whirling of shaft. Heat motion in two pendulum system.

Detailed analysis of multi-degree of freedom system.

Suggested Books

Ballaney PL. 1974. Theory of Machines. Khanna Publ.

Bosoi ESO, Verniaev V, Smirnov & Sultan-Shakh EG. 1990. Theory, Construction and Calculations of Agricultural Machinery. Vol. I. Oxonian Press Pvt. Ltd. No.56.

Getzlaff GE. 1993. Comparative Studies on Standard Plough Body. Engineering Principles of Agricultural Machines. ASAE Text Book No. 6.

Grover GK. 1996. Mechanical Vibrations. New Chand & Bros., Roorkee.

Harris CM & Crede CE. 1976. Shock and Vibration Hand Book. McGraw Hill.

Holowenko AR. 1967. Dynamics of Machinery. McGraw Hill.

Kelly SG. 2000. Fundamental of Mechanical Vibration. 2nd Ed. McGraw Hill.
 Kepner RA, Bainer R & Berger EL. 1978. Principles of Farm Machinery. AVI Publ. Co.
 Klenin NI, Popov IF & Sakoon VA. 1987. Agricultural Machines. Theory of Operations, Computing and Controlling Parameters and the Condition of Operation. Amrind Publ. Co.
 Marples.1969. Dynamics of Machines. McGraw Hill.
 Meirovitch L. 1986. Elements of Vibration Analysis. 2nd Ed. McGraw Hill.
 Nartov PS. 1985. Disc Soil Working Implements. A. A. Balkema, Rotterdam.
 Srivastav AC. 2001. Elements of Farm Machinery. Oxford & IBH.
 Steidal.1986. Introduction to Mechanical Vibrations. Wiley International & ELBS Ed.
 William T Thomson. 1993. Theory of Vibration with Application. Prentice Hall.

FMPE 508	Tractor Design	3(2+1)
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Theory

UNIT I
Technical specifications of tractors available in India, modern trends in tractor design and development, special design features of tractors in relation to Indian agriculture.
UNIT II
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
UNIT III
Mechanics of tractor. Computer aided design and its application in agricultural tractors.

Practical

Extensive practices on the packages mentioned in the theory.
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Suggested Books

Arther W Judge 1967. High Speed Diesel Engines. Chapman & Hall.
 Barger EL, Liljedahl JB & McKibben EC. 1967. Tractors and their PowerUnits. Wiley Eastern.
 Macmillan RH. The Mechanics of Tractor - Implement Performance, Theory and Worked Example. University of Melbourne.
 Maleev VL. 1945. Internal Combustion Engines. McGraw Hill.
 Ralph Alcock 1986. Tractor Implements System. AVI Publ. Co.

FMPE 509	Operations Research In Farm Power & Machinery Management 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 Books

- 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

FMPE 510 Ergonomics and Safety in Farm Operations 3(2+1)

Theory

UNIT I
Concept and design criteria for optimum mutual adjustment of man and his work: Importance of ergonomics and its application in agriculture, liberation and transfer of energy in human body, concept of indirect calorimeter, work physiology in various agricultural tasks.
UNIT II
Physiological stress indices and their methods of measurement: Mechanical efficiency of work, fatigue and shift work.
UNIT III
Anthropometry and Biomechanics: Anthropometric data and measurement techniques, joint movement and method of measurement, analysis and application of anthropometric data, measurement of physical and mental capacities.

UNIT IV

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.

UNIT V

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.

Suggested Books

Bridger RS. 1995. Introduction to Ergonomics. McGraw Hill.
 Charles D Reese. 2001. Accident / Incident Prevention Techniques. Taylor & Francis.
 Gavriel Salvendy. 1997. Hand Book of Human Factors and Ergonomics. John Wiley & Sons.
 Kromer KHE. 2001. Ergonomics. Prentice Hall.
 Mathews J & Knight AA.1971. Ergonomics in Agricultural Design. National Institute of Agric. Engineering, Wrest Park Silsoe, Bedford.
 Mathews J Sanders, Cormicks MS & MCEj. 1976. Human Factors in Engineering and Design. 4th Ed. McGraw Hill.
 William D McArdle. 1991. Exercise Physiology.1991. Lea & Febiger.
 Zander J. 1972. Principles of Ergonomics. Elsevier.
 Zander J.1972. Ergonomics in Machine Design. Elsevier.

FMPE 592	Special Problem	1(1+0)
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Any related problem based on students requirement

FMPE -595	Industry / Institute Training	0+1 (NC)
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Theory

In-plant training in the relevant farm power and machinery industry during manufacturing, assembly and testing of the machines and equipment. To study the actual working of the equipment and various unit operations. The evaluation will be based on the written report of the student and the comments of the factory managers. The duration of training shall be three weeks. The student shall be required to do training in the institute other than the institute in which he/she is enrolled.

B) Minor Subjects

FMPE 505 Applied Instrumentation in Farm Machinery and 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. 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.
UNIT II
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.
UNIT III
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. Measurement of gas composition using GLC.
UNIT IV
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 pick ups,
Speed measurement using optical devices, vibration measurement exercises , making of thermocouples and their testing-
Basic electronic circuits and application of linear ICs.

Suggested Books

- Ambrosius EE. 1966. Mechanical Measurement and Instruments. The Ronald Press.
Beckwith TG. 1996. Mechanical Measurements. Addison-Wesley.
Doebelin EO. 1966. Measurement System - Application and Design. McGraw Hill.
Ernest O Doebelin. 1995. Measurement Systems - Application and Design. McGraw Hill.
Holman P 1996. Experimental Methods for Engineers. McGraw Hill.
Nachtigal CL. 1990. Instrumentation and Control. Fundamentals and Application. John Wiley & Sons.
Oliver FJ. 1971. Practical; Instrumentation Transducers. Hayden Book Co.
Perry CC & Lissner HR. 1962. The Strain Gauge Primer. McGraw Hill.

FMPE 521	Computer Aided System Design	2(0+2)
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Practical

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

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

Suggested Books

Rammurthy, T. 2001. Computer Aided Mechanical Design and Analysis. Tata McGraw Hill, New Delhi.

Mukhopadhyay, M. 2000. Matrix, Finite Element, Computer and Structural analysis, Oxford & IBH Publishing Co. Pvt Ltd.

Krishnamoorthy, G. 2001. Finite Element Analysis. Theory and Programming. Tata McGraw Hill, New Delhi.

Knudra, C.V. 2000. Numerical Control and Computer Aided Manufacturing. Tata McGraw Hill, New Delhi.

Zeid, K. 2000. CAD/CAM Theory and Practice. Tata McGraw Hill, New Delhi.

RES 501	Renewable Energy Sources	3(2+1)
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Theory

Solar energy solar radiation. radiation exchange process. solar collection. thermosyphon effect; solar applications; direct and indirect heating, cooling, refrigeration. drying, dehydration. Sterilization; Pasteurization; cooking; power generation, biological conversion of solar energy; greenhouse agriculture, performance evaluation, economics of solar energy systems, solar energy materials & energy storage. Energy from biomass and wastes; Production, distribution, sources, plant, human animal and municipal waste, properties, composition, treatments, recycling, anaerobic digestion; crop residues and animal waste digestion, biogas; producer gas engines. Liquid fuels; Ethanol, methanol, anaerobic and aerobic fermentation, Wind energy; velocity and power duration curves, wind mill parameters, power, torque characteristics; design and performance of rotors, wind mill structure design; solar pv systems.

Practical

Calorific value estimation of biogas and producer gas, Design and benefit analysis of community biogas plant, Measurement of heat balance over a flat plate collector, Solar powered refrigeration system. Natural convection and forced convection solar dryers. Conduction, convection, radiation efficiency measurement- simulated anaerobic studies. Solid state fermentation. Study of ethanol and methanol plants, solar pv characteristics.

Suggested Books

- Culp, A.W. (1991) Principles of Energy Conversion, McGraw Hill pub. Co Inc.
Odum. H.T. and Odum, E.C. (1976) Energy Basis For Man and Nature. Mc Graw, Hill Pub.Co.Inc.
Garg, H.P. and Praksh J. (1976) Solar Energy- Fundamentals and Applications. Tata Mc Graw, Hill pub.Co.Inc.
Sukhatmes,S.P. (1997) Solar Energy- Principles of Thermal Collection and Storage Tata Mc Graw Hill. pub. Cp. Ltd.New Delhi.
Duffie, J.A. and Beckman W.A. (1991) Solar Engineering of Thermal Processes. John Willey, New York.
Twidell, J.W. & Weir, A.D. (1986) Renewable Energy Sources, E & FN Spon Ltd. London.
Rai G.D. (2001) Non Conventional Energy Sources, Khanna Publishers, Delhi.

RES 505

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 indirect energy.

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 Books

- 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 and Conservation in Agricultural Production and Food Processing. USG Publ. & Distr., Ludhiana.

RES 508	Design And Analysis of Renewable Energy Conversion Systems	3(3+0)
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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.

Suggested Books

Boyle Godfrey. 1996. Renewable Energy: Power for Sustainable Future. Oxford Univ. Press.
Culp AW. 1991. Principles of Energy Conservation. Tata McGraw Hill.
Duffle 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 508	Alternate fuels for IC Engines	2(1+1)
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Theory

Introduction to alternate fuels, synthetic fuels, production composition and properties. combustion characteristics, bio, fuels (alcohol, methanol, ethanol, biogas, producer gas and hydrogen), Composition and Properties of alternate fuels, comparison with conventional fuels, potential, possibilities and problems, Production of biogas, producer gas, ethanol, methanol, alcohol and hydrogen.
Utilization : Thermal and mechanical applications, utilization in SI and CI engines to run on alternate fuels, utilization for miscellaneous applications, Environmental aspects of alternate fuel : Environmental impact and safety factors. Efficiency of different alternate fuels, Economic and commercial considerations.

Practical

Study of alternate fuels, performance of I.C. engines on alternate fuels, measurement of flue gas parameters, thermal applications of alternate fuels.

Suggested Books

Ratnakar, G.L. Utilization of Biogas in IC Engine

San Pietro, A (ED) (1980), Biochemical and Photosynthetic. Aspects of energy Production, Academic Press. London.

Bungay H.R.(1981), Energy, the Biomass Options, John Willey & Sons, New York.

Twidell, J.W. & Weir, A.D. (1986), Renewable Energy Sources, E & FN Spon Ltd.

PFE 502 Engineering Properties Of Biological Materials 3(2+1)

Theory

UNIT I

Physical characteristics of different food grains, fruits and vegetables; Shape and size, description of shape and size, volume and density, porosity, surface area. Rheology; ASTM standard, terms, physical state of materials, classical ideal material, rheological models and equations, viscoelasticity, creep-stress relaxation, Non Newtonian fluid and viscometry, rheological properties; force, deformation, stress, strain, elastic, plastic behaviour.

UNIT II

Contact stresses between bodies, Hertz problems, firmness and hardness, mechanical damage, dead load and impact damage, vibration damage, friction, effect of load, sliding velocity, temperature, water film and surface roughness. Friction in agricultural materials, rolling resistance, angle of internal friction, angle of repose, flow of bulk granular materials, aero dynamics of agricultural products, drag coefficients, terminal velocity.

UNIT III

Thermal properties: Specific heat, thermal conductivity, thermal diffusivity, methods of determination, steady state and transient heat flow. Electrical properties; Dielectric loss factor, loss tangent, A.C. conductivity and dielectric constant, method of determination, energy absorption from high frequency electric field.

UNIT IV

Application of engineering properties in design and operation of agricultural equipment and structures.

Practical

Determination of physical properties like, length, breadth, thickness, surface area, bulk density, porosity, true density, coefficient of friction, angle of repose and colour for various food grains, fruits, vegetables, spices and processed foods, aerodynamic properties like terminal velocity, lift and drag force for food grains, thermal properties like thermal conductivity, thermal diffusivity and specific heat, firmness and hardness of grain, fruits and stalk, electrical properties like dielectric constant, dielectric loss factor, loss tangent and A.C. conductivity of various food materials.

Suggested Books

Hallstrom B, Meffert HF, Th Spesis WEL & Vos G. 1983. Physical Properties of Food. Elsevier.

Mohesenin NN. 1980. Physical Properties of Plant and Animal Materials. Gordon & Breach Science Publ.

Mohesenin NN. 1980. Thermal Properties of Foods and Agricultural Materials. Gordon & Breach Science Publ.

Peleg M & Bagelay EB. 1983. Physical Properties of Foods. AVI Publ. Co.

Rao MA & Rizvi SSH. (Eds.). 1986. Engineering Properties of Foods. Marcel Dekker.

Ronal Jowitt, Felix Escher, Bengt Hallsram, Hans F, Th. Meffert, Walter EC Spices & Gilbert Vox. 1983. Physical Properties of Foods. Applied Science Publ.

Singhal OP & Samuel DVK. 2003. Engineering Properties of Biological Materials. Saroj Prakasan.

BSCT 501	Computer Graphics	3(2+1)
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Theory

UNIT I
Graphic display devices, Interactive devices, Line and circle plotting techniques by using Bresenham’s algorithm, Windowing and clipping, Sutherland Copen algorithm, Cyrus and Beck method.
UNIT II
Curve drawing using Hermite Polynomial, Bezier curve, B Splines, Picture Transformation, translation, rotation, Scaling and Mirroring
UNIT III
3D Graphics, 3D transformation rotation about an arbitrary axis. Curved surface generation, Hidden surface removal.
UNIT IV
Orthogonal Projection and multiple views, Isometric projection, Perspective projection, 3D Clipping
UNIT V
Generation of solids, Sweep method, Interpolation, Graphic Standards, CGS Modeling, applications of Computer Graphics.

Practical

Practical problems on above topics.

Suggested Books

Hearn Donald.1996. Computer Graphics. PHI.

Schaum. Series. 2004. Computer Graphics. TMH.

C) Supporting Subjects

FMPE 514

Research Methodology

1(0+1)

Practical

The research problem -literature review -types of research, experimental & quasi-experimental research-causal comparative & correlation research Survey research- sampling techniques. Optimization software – GAMES – applications, electronic spread sheet – solver. Image analysis software – applications. General computational software for research – MATLAB – applications – statistical applications, Report writing – interpretation and reporting. Scientific writing techniques. Presentation -techniques.

Suggested Books

Hamdy A Taha. 2001. Operations Research. Prentice Hall of India.
Holman JP 1996. Experimental Methods for Engineers. McGraw Hill.
Rudra Pratap. 2003. Getting Started with MATLAB. A Quick Introduction for Scientists and Engineers. Oxford Univ. Press.
Santhosh Gupta. 1979. Research Methodology and Statistical Techniques. Khanna Publ.
Stephen J Chapman. 2003. MATLAB Programming for Engineers. Eastern Press.
Steven C Chapra & Raymond P Canale. 2000. Numerical Methods for Engineers with Programming and Software Applications. Tata McGraw.
William J Palm. 2001. Introduction to Matlab 6 for Engineers. McGraw Hill.

FMPE-531

Pesticide Application Equipments

3(2+1)

Theory

UNIT I

Role of chemical control and formulations. Targets, droplet size, its distribution and determination methods , selection of droplet size, atomizing devices-nozzles, types of sprayers, dusters and granular applicators, manually and power operated sprayers hydraulic energy.

UNIT II

Centrifugal energy, electrical energy, hybrid and air blast sprayers, pumps. Agitators, filters, pressure control devices and systems. Manual and power operated dusters and granular applicators fogging machines, aerial applications of pesticide, application of pesticide in green house, calibration of sprayers.

UNIT III

Design of spraying and dusting equipments, maintenance and selection of spraying equipments

UNIT IV

Application methods and economics of pest control, safety precautions in pesticide application.

Practical:

Study of different types of sprayers, dusters, granular applications fogging machines, nozzles, calibration of sprayers , selection of pesticide application equipment for field and orchard crops, weedicide application, droplet size

Suggested Books:

- G. A. Mathew.1985. Pesticide application methods, English language book society Longman, Harlow, England.
- P.T. Haskell.1985. Pesticide application: principles and practice, Clarendon Press Oxford.
- O.P. Bindra H. singh. 1980. Pesticide application Equipment, Oxford & IBH publishing Co., New Delhi.
- R.A. Kepner, R. Bainer, E. L. Barger. 2000. Principles of farm machinery. CBS Publishers and distributors, New Delhi.
- H. Bernacki, J. haman, Cz. Kanafojske. 1972. Agricultural machines, theory and construction VOI-I, USDA Publications, Warsaw, Poland.

FMPE-532	Advanced manufacturing Technology	3(2+1)
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Theory

UNIT I
Construction of material and their characteristics: The structure of material, properties of material, equilibrium diagram. Time temperature transformation curves. Heat treatment ferrous material alloys, Non ferrous metal alloys, non – metallic material plastic. Elastomers ceramics and composites, material selection surface treatment and finishing.
UNIT II
Measurement and quality assurance: Measurement and inspection. Non destructive inspection and testing. Process capability and quality control, tolerance limits and clearance. Auragraph casting process: Fundamentals of casting, patterns and sand molds, continuous casting, permanent mold casting Die casting, electro forming, the shaw process and powder metallurgy.
UNIT III
Forming processes: The fundamentals of metal forming, mechanism of hot and cold working. Hot rolling of metals, forging processes extrusion, cold rolling, cold forging, cold drawing, forming of plastic ceramic and composites, dies, shearing and blanking and dies: bending and drawing.
UNIT IV
Material removal processes: machining process , cutting tools for matching , turning and boring and related processes, drilling and related hole making processes, milling, broaching–sawing-filling, abrasive machining processes, work holding devices, matching centers, thread, manufacture, gear manufacturing and non traditional machining processes (FCM,EDH,LBM,AJM,wire EDM)
UNIT V
Joining processes: gas flame processes: welding, cutting and straightening, arc processes, welding and cutting, resistance welding, brazing and soldering, adhesive, bonding and mechanical fasteners. Manufacturing concerns in welding and joining.
UNIT VI
Numerical control: command system, codes, programme, cutter position X and Y incremental movements, linear counterling Z movement and commands.
Processes and Techniques related to Manufacturing: manufacturing systems and automation. Production systems and integrated manufacturing production system.

Practical:

Study of physical and mechanical properties of material tensile test. Hardness, impact. Material fatigue and endurance limit, study of metallographic structures of metals, determination of carbon and sulphur content, carbonizing and hardening of plain and medium carbon steel by heating and annealing.

Study and use of measuring and inspection tools, study of limits, tolerance and geometric dimensioning, study and use of optical comparator. Vision system measurement. Co-ordinate measuring machine, surface roughness measurement. Non destructive inspection and testing and statistical process control.

Study of pattern and sand moulding techniques, preparation of small moulds and carry out sand casting, study of different casting processes.

Design and development of simple tooling for shearing bending and deep drawing and use them in workshop, study of different hot and cold working processes practice on different machines like lathe, Drill press, milling machine slotting machine, shaper planers and grinders. Study of non traditional machining processes. Study the tools geometry and their angles for different chip machining processes. Study and practice on gas, arc, resistance, MIG and TIG welding, soldering, brazing and braze welding processes. Study and design of different types of joints for welding. Welding of different materials ferrous, cast iron, non-ferrous and stainless steel. Developing a programme for CNC machines (turning and milling) and practice on operation and turning and milling centers. Study of surface finishing methods. Cleaning, coating and paint application. Carry out the practice on powder coating and painting by different method.

Suggested Books:

Polukhin, P.; Gringerg B., Kantenik, S., Zhadan V. and Vasilyen, D. Metal process engineering, MIR publishers, Moscow. fundamentals of tool design. American Society of Tools and manufacture Engineers.

Gupta, R.B. Production Technology

Jain R.K. 1994. Production Technology: A Text book for Engineering students. Khanna Publishers, New Delhi.

Myron: Begeman, L. and Amsted, B.H. manufacturing processes.

Chapman, (part-III) Workshop Technology

STAT 511	Statistical Methods for Applied Science	3(2+1)
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Theory

UNIT I
Measures of central tendency and dispersion Theory of probability: classical, empirical, axiomatic probability, random variable and mathematical expectation
UNIT II
Discrete and Continuous probability distribution: Binomial, Poisson, Normal and their application. Concept of sampling distribution: Chi-square, t & F distribution. Test of significance based on Normal, Chi-square, t & F distribution. Large sample theory (Z-test).
UNIT III
Correlation and regression: Simple and multiple linear regression model, Stepwise regression, Estimation of parameters, Correlation, Partial and multiple correlation. Rank

correlation, Path analysis, Test of significance of correlation coefficients and regression coefficients, coefficient of multiple determination. Polynomial regression model and their fitting, Estimation of parameters.

UNIT IV

Non-parametric tests: sign, Mann-Whitney U test, Run test, Median test.

Practical

Calculation of mean, median, mode, variance and standard deviation etc. Fitting of Binomial, Poisson and Normal distributions, Large sample test, t, F and Chi-square test, Correlation, Partial and multiple correlation, Rank correlation and linear, multiple and non-linear regression, Path analysis, Non-parametric tests.

Suggested Books

Snedecor G.W. & W.G. Cochran, 1967. Statistical Methods Sixth Edition, Oxford & IBH Publishing Company, Bombay, W.

Anderson TW, 1984. An Introduction to Multivariate Statistical Analysis. 2nd Ed. John Wiley.

Ostle B, 1967. Statistics in Research Oxford & IBH Publishing Company, Bombay,

Robert G. D. Steel and James H. Torrie, 1971. Principles and Procedures of Statistics. Biometrical Approach, McGraw Hill International Book Company, New York

Gupta S. C, V.K. Kapoor, 1991. Fundamental of mathematical statistics, Sultan

MATHS 502

Methods of Numerical Analysis

2(1+1)

Theory

UNIT I

Numerical methods for systems of linear equations, eigen values, interpolation, differentiation.

UNIT II

Least squares. Numerical solution of differential equations and non linear equations in several variables.

Practical

Practice on matrix manipulation, Exercises on solution of the systems of linear and non linear equations, solution of differential equations

Suggested Books

Scarborough, G., 2000. Numerical Mathematical analysis. Oxford & IBH Pub.Co. Pvt.Ltd.

Chapra, C., 2000. Numerical Methods for Engineers. Tata McGraw-Hill, New Delhi.

Atkinson, K., 1993. Elementary Numerical Analysis. 2nd Ed John Wiley.

Epperson, J.F., 2002. An introduction to Numerical Methods and Analysis. John Wiley.

D) Seminar

FMPE 591	Master's Seminar	1(0+1)
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E) Master's Research

FMPE 599	Master's Research	20(0+20)
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F) Non-Credit Compulsory Courses

PGS 501	Library And Information Services	1(0+1)
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Practical

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

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

Technical Writing - Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.

Communication Skills - Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers.

Suggested Books

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 503	Intellectual 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 Books

- 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 & Aesthetic Technologies.
- Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.
- Rothschild M & Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.
- Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House.
- The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.

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

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	1(1+0)
(e-Course)	And Rural Development Programmes	

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 Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Books

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 (e-Course)	Disaster Management	1(1+0)
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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 Books

- 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

RES 623	Energy Management and Planning	3(2+1)
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Theory

Human, animal, mechanical energy sources, fuel: solid, liquid, gaseous, crop production energy, plantation, rained, irrigated, tractor owned, bullock frames, crop rotation and energy needs, agro industries/ processing and energy needs, animal raising, domestic purpose, emerge 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 reduction, energy in – flow, out flow in a atypical 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 date collocation on energetic. Estimation of energy equivalents for inflow outflow analysis. Intergraded energy planning exercise for farm. visit to oil mill for energy use pattern date collection visit to sugar mill, village Gur Industry for energy pattern date 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 Books

- 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.
Fowlerm 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). Non,convetional 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. Storage. 2nd Ed. Tata McGraw Hill.

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 indirect energy.

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 Books

- 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 and Conservation in
 Agricultural Production and Food Processing. USG Publ. & Distr., Ludhiana.

C) Supporting Subjects

AE 502	Similitude in Engineering	3(2+1)
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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 Books

Green Murphy.1950. Similitude in Engineering. Ronald Press.

Huntley HE. 1974. Dimensional Analysis. Dover Publ.

MATH 601	Mathematical Modelling and Software Applications	3(1+2)
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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 & 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)
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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 Books

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, Gradient based methods.

UNIT III

Constrained optimization algorithms: Kuhn-Tucker conditions, Transformation methods,

UNIT IV

Sensitivity analysis, Direct search for constrained minimization, Linearized search techniques, Feasible direction method, Generalized reduced gradient method, Gradient projection method

UNIT V

Specialized algorithms: Integer programming, Geometric programming.

UNIT VI

Nontraditional optimization algorithms: Genetic algorithms, simulated annealing, Global optimization.

Suggested Books

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 contrasts; Correlation and regression including multiple regression.

UNIT V

Discriminant function; Factor analysis; Principal component analysis; 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 hypothesis for one sample *t*-test, two sample *t*-test, paired *t*-test, test for large samples - Chi-squares test, F test, One way analysis of variance , contrast and its testing, fixed effect models, random effect models, estimation of variance components; Generalized linear models - analysis of unbalanced 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 Books

- Atkinson AC. 1985. Plots Transformations and Regression. Oxford University Press.
 Chambers JM, Cleveland WS, Kleiner B & Tukey PA. 1983. Graphical Methods for Data Analysis. Wadsworth, Belmont, California.
 Chatfield C & Collins AJ. 1980. Introduction to Multivariate Analysis. Chapman & Hall.
 Chatfield C. 1983. Statistics for Technology. 3rd 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.
 Ehrenberg ASC. 1982. A Primer in Data Reduction. John Wiley.
 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 Product, 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 Evaluating 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 a 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.2000. Systems Survival Guide. Ruby Moon Press.

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

F) 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; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; e-resources access methods.

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); Error analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers.

Suggested Books

- 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 503
(e-Course)

**Intellectual Property and Its
Management in Agriculture**

1(1+0)

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 Books

- 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 & Aesthetic Technologies.
Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.
Rothschild M & Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.

Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House.
The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.

PGS 504	Basic Concepts In Laboratory Techniques	1(0+1)
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Practical

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccumettes; 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 Books

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 (e-Course)	Agricultural Research, Research Ethics And Rural Development Programmes	1(1+0)
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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 Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Books

- 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
(e-Course)**

Disaster Management

1(1+0)

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 Books

- 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