Course Title with Credit Load
Ph.D. in Agricultural Engineering

Course Code	Course Title	Credits Hours	Remarks
AEG 601*	Research methodology and technique in Agricultural Engineering	4+0	Compulsory as per UGC regulation
AEG 602*	Precision agriculture	3+1	Compulsory as per ICAR-BSMA guidelines
AEG 603*	Review of literature and synopsis presentation	0+4	Compulsory as per UGC regulation
AEG 604*	Research and publication ethics	2+0	Compulsory as per UGC as well as ICAR-BSMA guidelines
AEG 605	Advances in farm machinery and power engineering	4+0	Optional
AEG 606	Advances in food processing	4+0	Optional
AEG 607	Advances in irrigation and drainage	4+0	Optional
AEG 608	Energy conservation and management	4+0	Optional
AEG 609	Computer aided analysis and design of farm machinery	2+1	Optional
AEG 610	Mathematical models in food processing	3+0	Optional
AEG 611	Agricultural waste and by-products utilization	2+1	Optional
AEG 612	Advanced hydrology	3+0	Optional
AEG 613	Modelling Soil Erosion Processes	2+1	Optional
AEG 691	Doctoral seminar-I	1+0	Compulsory as per ICAR regulation
AEG 692	Doctoral seminar-II	1+0	Compulsory as per ICAR regulation

*Core course

Detail Syllabus

AEG 601 Research Methodology and Technique in Agricultural Engineering 4+0

Objective

To create awareness among the students about different research techniques available to carry out quality research in Agricultural Engineering domain. It will support student to carry out statistical analysis of the collected test data.

Theory

Unit I

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.

Unit II

Image analysis software – applications. General computational software for research – MATLAB – applications – statistical applications,

Unit III

Report writing – interpretation and reporting. Scientific writing techniques. Presentation -techniques.

Unit IV

Research ethics. One way and two way ANOVA, chi square test.

Suggested Readings

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 Q

Outcome

The students will learn different statistical technique for anlyzing their experimental data. They will able to prepare good research report.

AEG 602 Precision Farming 3+1

Objective

To acquaint and equip with the farm machinery used for natural resources management and machinery for precision farming. To use of GIS and GPS in agricultural sector creating new employability opportunity.

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. Projects on commercial application of Precision Agriculture.

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

Outcome

Get sound knowledge in Geo-informatics. Able to handle remote sensing data and monitor crop field without visiting the field. Can get employment opportunity in relevant field of agriculture and modern farming.

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 farmimg 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.

AEG 605 Advances in Farm Machinery and Power Engineering 4+0

Objective

To acquaint and equip with the latest mechanisms being used on the farm equipment and their analysis using computers. With the knowledge in advance machinery, the student will able to contribute value addition in agriculture sector.

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. Value added product preparation with advanced machinery.

Outcome

They will learn the operation and maintenance of all the advance machinery for agriculture. This will help student creating value added products from agricultural outputs.

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.

AEG 606 Advances in Food Processing 4+0

Objective

To acquaint and equip the students with the modern and latest techniques of food engineering. This course will aim at creating new employment opportunity through entrepreneurship initiatives.

Theory

UNIT I

Preservation of foods – physical and chemical methods-microbiological aspects thermo bacteriology, process calculation and selection.

UNIT II

Low temperature preservation - cooling and cold storage - freeze concentration and membrane separation process - hurdle technology - principles and applications - food irradiation - advantages and applications, microwave processing - interaction with food materials- microwave equipment - hydrostatic pressure treatment of food - equipment, processing and effect on microorganisms.

UNIT III

Application of heat energy and ultrasound - inactivation of microorganisms and enzymes -electrical resistance heating of food - heat generation, ohmic heater, heating models - pulsed electric field preservation- principles and application - influence on microorganisms and food ingredients - decontamination of microorganisms by surface treatment.

UNIT IV

Extrusion cooking - recent developments, methods, equipment, design criteria of extruders. Project work on preparation of value added process products.

Outcome

The students will about to produce new food processed products for common people. There is huge scope for value addition in processing industry. The students can store food products for longer duration.

Suggested Readings

Heldman R Dennis and Lund B Daryl. 1992. Hand Book of Food Engineering. Marcel Dekker.
Goldblith SA, Rey I & Rothmayr WW. 1975. Freeze Drying and Advanced Food Technology. Academic Press.
Gould GW (Ed.).1996. New Methods of Food Preservation. Blackie Academic & Professional.
Leniger HA & Beverloo WA. 1975. Food Process Engineering.

AEG 607 Advances in Irrigation and Drainage 4+0

Objective
To acquaint and equip the students with the advance application of irrigation and drainage system along with applicability of various models.

Theory

UNIT I
Advances in surface irrigation systems- surge irrigation: effect of surgingon surface flow hydraulics, cablegation: water supply management.
UNIT II
Atomization in sprinkler and micro irrigation system; multipurpose and special uses of micro irrigation.
UNIT III
Synthetic materials for drainage systems. Environmental issues related to drainage. Socio-economic impacts of drainage systems.
UNIT IV
Controlled drainage for reducing agricultural non point pollution. Application of simulation models for drainage systems.

Outcome
There is student will able to plan irrigation system for various crops. Can save the crops from water stress conditions.

Suggested Readings
FAO. 1982. Mechanized Sprinkler Irrigation. FAO Irrigation & Drainage Paper 35.
FAO. 1989. Guidelines for Designing and Evaluating Surface Irrigation System. FAO Irrigation & Drainage Paper 45.
Keller J & Bliesner RD. 1990. Sprinkler and Trickle Irrigation. Chapman & Hall.
Ritzema HP. (Ed.). 1994. Drainage Principles and Applications. ILRI.
Walker WR & Skogerboe GV. 1987. Surface Irrigation: Theory and Practice. Prentice Hall.

AEG 608 Energy Conservation and Management 4+0

Objective
To acquaint and equip with the energy use pattern in agriculture production systems, conservation of energy, energy planning and economics.

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.

Outcome

The students will able to conserve energy in various agricultural operations.

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.

AEG 609 Computer Aided Analysis and Design of Farm Machinery 2+1

Objective

To acquaint and equip with the computer aided design, analysis and manufacturing of farm machinery with the help of CAD. To create employability opportunity as CAD designer.

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.

Outcome

The student can make various design through AutoCAD and SolidWorks software. Student should explore new employment opportunity by expertising the design technology.

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.

AEG 610 Mathematical Models in Food Processing 4+0

Objective
To acquaint and equip the students with the mathematical modeling techniques and their applications in food processing

Theory

UNIT I
An overview of the modeling process. Introduction to mathematical, correlative and explanatory models. Formulation, idealization and simplification of the problems.
UNIT II
Probability models, series and linear mathematical approximation, dynamic and interacting dynamic processes.
UNIT III
Applications of mathematical modelling techniques to food processing operations like parboiling, convective drying, pasteurization, dehydration, shelf-life prediction, fermentaiton, aseptic processing, moisture diffusion, deep fat drying, microwave processing, infrared heating and ohmic heating. Stochastic finite element analysis of thermal food processes. Neural networks approach to modelling food processing operations.

Outcome
The student will able create modern food processing models for long shelf life of food products.

Suggested Readings
Bailey NTJ, Sendov B &.Tsanev R.1974. Mathematical Models in Biology and Medicine. Elsevier. Fischer M, Scholten HJ & Unwin D. 1996. Spatial Analytical Perspectives on GIS. Taylor & Francis.
Fish NM & Fox RI. 1989. Computer Application in Fermentation Technology: Modelling and Control of Biotechnological Processes. Elsevier.
Getz WM.1979. Mathematical Modeling in Biology Processes. Elsevier. Gold HJ.1977. Mathematical Modelling of Biological Systems - An Introductory Guidebook. John Wiley & Sons.
Hunt DR.1986. Enginering Models for Agricultural Production. The AVI Publ.
Kapur JN.1989. Mathematical Modeling. Wiley Eastern. Koeing HE, Tokad Y, Kesacan HK & Hedgers HG. 1967. Analysis of Discrete Physical Systems. Mc Graw Hill.
Meyer JW. 2004. Concepts of Mathematical Modeling. Mc Graw Hill.
Peart RM & Curry RB.1998. Agricultural Systems, Modelling and Simulation. Marcel Dekker.
Tijms HC. 1984. Modelling & Analysis. A Congrtational Approach. Wiley Publ.
Ver Planck & Teare BR 1954. General Engineering Analysis - An Introduction to Professional Methods. John Wiley & Sons.

AEG 611 Agricultural Waste and By-Products Utilization 2+1

Objective
To acquaint and equip the students with the proper utilization of agricultural waste and by-products and also about development of value added products from wastes.

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. Project work on value added products from waste materials

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.

Outcome
The waste management problem could be reduced through new technologies and value added products.
The value added product will have new markets.

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.

AEG 612 Advanced Hydrology 3+0

Objective
To acquaint and equip the students with advanced hydrological process, analysis of hydrological data and their application for modeling.

Theory

UNIT I
Hydrologic models, processes and systems. Uncertainty in hydrological event. Statistical homogeneity.
UNIT II
Probabilistic concept. Frequency analysis. Co-relation and regression analysis. Probability distribution of hydrological variables.
UNIT III
Time series analysis. Markov processes.
UNIT IV7uytrhjv

Formulation of various steps of statistical models and their application in hydrology.

Outcome

The student will able to solve hydrological problems using modern processes and techniques.

Suggested Readings

Garg SK.1987. Hydrology and Water Resources Engineering. Khanna Publ. Hann CT. Advanced Hydrology. Oxford Publ. House.
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Mutreja KN.1986. Applied Hydrology. Tata McGraw Hill.

AEG 613 Modelling Soil Erosion Processes **2+1**

Objective

To acquaint and equip the students with the advance erosion process along with tools required and application of soil erosion models.

Theory

UNIT I

Overland flow, basic theory of particle movement and sediment transport; sediment deposition process.

UNIT II

Estimation of sediment load; mechanics of soil erosion by water and wind.

UNIT III

Water and wind erosion control measures.

UNIT IV

Universal soil loss equation; stochastic models and dynamic models.

Practical

Computation of soil erosion index; Estimation of soil erodibility factor; Design of erosion control structures. Computation of suspended load and sediment load using empirical formulae; Application of sediment yield models, prediction of sediment loss – computation of reservoir sedimentation – sounding method.

Outcome

The students will able to create different soil erosion structure against wind and water.

Suggested Readings

Garde RJ & Ranga Raju KG. 1977. Mechanics of Sediment Transport and Alluvial Stream Problems. Wiley Eastern Ltd. Morgan RPC. (Ed. D. A. Davidson). 1986. Soil Erosion and Conservation. ELBS, Longman. USDA. 1969. A Manual on Conservation of Soil and Water. Oxford & IBH.