KERALA AGRICULTURAL UNIVERSITY

CURRICULA AND SYLLABI

Ph.D 2012

(Agricultural Engineering)

Faculty of Agricultural Engineering &Technology

Kelappaji College of Agricultural Engineering and Technology

Thavanur P.O. Malapuram Dist.

679 573

Ph. D (Agricultural Engineering)

The curricula and syllabi for the proposed Ph.D are prepared according to the guide lines issued by the Indian Council of Agricultural Research. The minimum credit requirements for Ph.D programme is as follows:

1. Course work

   Major subject: 15 credits

   Minor subject: 08 credits

   Supporting subjects: 05 credits

   Non credit compulsory subjects- courses 6 nos. (Exempted if already studied in Masters Programme)

   Seminar: 0+2 credits (Two seminars of 0+1 credits)

   Total for course work: 30 credits (Including Seminars)

2. Thesis: 45 credits

   Total credits: Course work+ Research: 30+45 = 75

Ph. D (Agricultural Engineering)

Discipline: Soil and Water Engineering

COURSE STRUCTURE

MAJOR SUBJECTS

CODE	COURSE TITLE	CREDITS
Swce 6001**	ADVANCED HYDROLOGY	3+0
Swce 6002**	SOIL AND WATER SYSTEMS' SIMULATION AND MODELLING	2+1
Swce 6003	MODELLING SOIL EROSION PROCESSES	2+1
Swce 6004	ADVANCED HYDRO-MECHANICS IN SOIL AQUIFER SYSTEMS	3+0
Swce 6005	HYDRO-CHEMICAL MODELLING AND POLLUTANT MANAGEMENT	3+0
Swce 6006	PLANT GROWTH MODELLING AND SIMULATION	3+0
Swce 6007	ADVANCED IRRIGATION ENGINEERING	2+0
Swce 6008	ADVANCED DRAINAGE ENGINEERING	2+0
Swce 6010	WATERSHED MANAGEMENT AND MODELLING	2+1
Swce 6091	DOCTORAL SEMINAR I	0+1
Swce 6092	DOCTORAL SEMINAR II	0+1
Swce 6093	SPECIAL PROBLEM	0+1
Swce 6099	DOCTORAL RESEARCH	45

**** Compulsory for Ph.D Programme**

MINOR SUBJECTS

CODE	COURSE TITLE	CREDITS
Cven 6001	OPEN CHANNEL FLOW	3+0
Cven 6002	DAMS & RESERVOIR OPERATIONS	2+1
Cven 6003	FLUVIAL HYDRAULICS	2+1
Cven 6004	EXPERIMENTAL STRESS ANALYSIS	2+1
Cven 6005	LAND DEVELOPMENT AND EARTH MOVING MACHINERY	2+0
Cven 6006	ADVANCED GIS AND REMOTE SENSING FOR LAND AND WATER RESOURCE MANAGEMENT	2+1
Cven 6007	SOIL PHYSICS	2+1
Cven 6008	FARM STRUCTURES AND ENVIRONMENTAL CONTROL	1+1

SUPPORTING SUBJECTS

CODE	COURSE TITLE	CREDITS
Cven 6009	WATER QUALITY AND POLLUTION CONTROL	1+1
Cven 6010	DIMENSIONAL ANALYSIS AND SIMILITUDE	2+1
Cven 6011	ADVANCED OPERATIONS RESEARCH FOR WATER RESOURCE PLANNING	2+1
Cven 6012	APPLIED INSTRUMENTATION IN SOIL AND WATER ENGINEERING	2+1
Stat 6001	TIME SERIES ANALYSIS	1+1

COMPULSORY NON-CREDIT COURSES (Common for all disciplines)

(Compulsory for Ph.D. scholars if they have not studied during M.Tech)

CODE	**COURSE TITLE**	**CREDITS**
PGS 501	LIBRARY AND INFORMATION SERVICES	0+1

PGS 502	TECHNICAL WRITING AND COMMUNICATIONS SKILLS	0+1
PGS 503 (e-Course)	INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE	1+0
PGS 504	BASIC CONCEPTS IN LABORATORY TECHNIQUES	0+1
PGS 505 (e-Course)	AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES	1+0
PGS 506 (e-Course)	DISASTER MANAGEMENT	1+0

CODE COURSE TITLE CREDITS

Course Contents

PGS 501 LIBRARY AND INFORMATION SERVICES (0+1)

Objective

To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of informationsearch.

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 (0+1)

Objective

To equip the students/scholars with skills to write dissertations, research papers, etc.

To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

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 Readings

Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.
Collins' Cobuild English Dictionary. 1995. Harper Collins.
Gordon HM & Walter JA. 1970. *Technical Writing*. 3rd Ed. Holt, Rinehart & Winston.
Hornby AS. 2000. *Comp. Oxford Advanced Learner's Dictionary of Current English*. 6th Ed. Oxford University Press.
James HS. 1994. *Handbook for Technical Writing*. NTC Business Books.
Joseph G. 2000. *MLA Handbook for Writers of Research Papers*. 5th Ed. Affiliated East-West Press.
Mohan K. 2005. *Speaking English Effectively*. MacMillan India.
Richard WS. 1969. *Technical Writing*. Barnes & Noble.
Robert C. (Ed.). 2005. *Spoken English: Flourish Your Language*. Abhishek.
Sethi J & Dhamija PV. 2004. *Course in Phonetics and Spoken English*. 2nd
Ed. Prentice Hall of India.
Wren PC & Martin H. 2006. *High School English Grammar and Composition*. S. Chand & Co.

PGS 503 INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE (1+0) e-course

Objective

The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

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 GeneticResources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings

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

Ganguli P. 2001. *Intellectual Property Rights: Unleashing Knowledge Economy*. McGraw-Hill.

Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC & 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 (0+1)

Objective

To acquaint the students about the basics of commonly used techniques in laboratory.

Practical

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; 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, sand bath, water bath, oilbath; Electric wiring and earthing. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy

Suggested Readings

Furr AK. 2000. *CRC Hand Book of Laboratory Safety*. CRC Press.

Gabb MH & Latchem WE. 1968. *A Handbook of Laboratory Solutions*. Chemical Publ. Co.

PGS 505 AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES(1+0) e-course

Objective

To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

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 globalagricultural 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 Readings

Bhalla GS & Singh G. 2001. *Indian Agriculture - Four Decades of Development*. Sage Publ.

Punia MS. *Manual on International Research and Research Ethics*. CCS, Haryana Agricultural University, Hisar.

Rao BSV. 2007. *Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives*. Mittal Publ.

Singh K.. 1998. *Rural Development - Principles, Policies and Management.* Sage Publ.

PGS 506 DISASTER MANAGEMENT (1+0)

(e-Course)

Objective

To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and capacity building.

Theory

UNIT I

Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion

UNIT II

Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.

UNIT III

Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media. Central, State, District and local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.

Suggested Readings

Gupta HK. 2003. *Disaster Management*. Indian National Science Academy. Orient Blackswan.

Hodgkinson PE & Stewart M. 1991. *Coping with Catastrophe: A Handbook of Disaster Management*. Routledge.

Sharma VK. 2001. *Disaster Management*. National Centre for Disaster Management, India.

SOIL AND WATER ENGINEERING

List of Journals

- Ground Water
- Journal of Hydrology
- Journal of Soil Conservation
- Journal of Water Management
- Transactions of ASAE
- Transactions of ASCE
- Water Resource Research

Suggested Broad Topics for Master's and Doctoral Research

- Groundwater Modeling
- Hydrologic Modeling of Watersheds
- Conjunctive use of surface and groundwater
- Design and evaluation of irrigation and drainage systems and soil conservation measures
- Rainfall runoff modeling
- Evaluation of canal command area
- Water productivity analysis
- Water and energy saving technologies
- Application of modern tools such as Remote Sensing, GIS and simulation modeling for soil and water management strategies

DETAILED SYLLABI

Swce 6001 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 events. Statistical homogeneity.

UNIT II

Probabilistic concept. Probability distribution of hydrologic variables. Frequency analysis.

UNIT III

Co-relation and regression analysis. Probability distribution of hydrological variables.

UNIT IV

Time series analysis. Markov processes.

UNIT V

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

Suggested Readings

Garg SK.1987. *Hydrology and Water Resources Engineering.* Khanna Publ.

Hann CT. *Advanced Hydrology*. Oxford Publ. House.

Linseley RK Jr., Kohler MA & Paulhus JLH. 1975. *Applied Hydrology*. McGraw Hill.

Mutreja KN.1986. *Applied Hydrology*. Tata McGraw Hill.

Swce 6002 SOIL AND WATER SYSTEMS' SIMULATION AND MODELLING (2+1)

Objective

To acquaint and equip the students with the simulation of soil water systems and modeling techniques.

Theory

UNIT I

Systems engineering for water management; Complexity of resources management process, systems analysis.

UNIT II

Rainfall-runoff models - Infiltration models, Simulation methods, structure of a water balance model.

UNIT III

Channel flow simulation - parameters and calibration – Stream flow statistics, surface water storage requirements.

Flood control storage capacity; total reservoir capacity - surface water allocations. Ground water models.

UNIT IV

Design of nodal network, General systems frame work – Description of the model; Irregular boundaries, General –Numerical approaches.

Practical

Rainfall - Runoff models - Infiltration models - Stanford watershed model (SWM) - channel flow simulation problems - stream flow statistics – model parameters and input data requirements of various softwares of surface hydrology and groundwater – Hydrologic Modelling System – Soil Water Management Model – Soil Water Assessment Tool – Catchments, Simulation Hydrology Model – Stream flow model and use of dimensionless unit hydrograph – Generalized groundwater models.

Suggested Readings

Biswas AK. 1976. *Systems Approach to Water Management*. McGrawHill.
Cox DR & Mille HD. 1965. *The Theory of Stochastic Processes*. JohnWiley & Sons.
Eagleson PS. 1970. *Dynamic Hydrology*. McGraw Hill.
Ven Te Chow, David R Maidment & Mays LW. 1998. *Applied Hydrology*.McGraw Hill.
Ram S Gupta Hydrology and Hydraulic systems 1989. Prentice Hall New jersey
Vijay P Singh. Hydrologic Systems 1988. Prentice Hall New jersey

Swce 6003 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; Modified USLE, Revised USLE, 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.

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. Schwab,G.O,Frevert,R K,Edminister T W and Barnes K K (1993) *Soil and Water Conservation Engineering.* John Wiley and Sons.
Dhruvanarayana, V.V (1993) *Soil and Water conservation research in India*. ICAR. New Delhi

Swce 6004 ADVANCED HYDRO-MECHANICS IN SOIL AQUIFER SYSTEMS (3+0)

Objective

To acquaint and equip the students with the advance soil-aquifer-water mechanics and various techniques for the analysis of the system

Theory

UNIT I

Soil aquifer system. Flow of water in partially saturated soils. Partial differential equation of flow.

UNIT II

Determination of unsaturated hydraulic conductivity and models for its estimation.

UNIT III

Infiltration and exfiltration from soils in absence and presence of water table.

UNIT IV

Movement of groundwater in fractured and swelling porous media.

UNIT V

Spatial variability. Theory of krigging. Statistical approaches in soil water dynamics.

Suggested Readings

Kirkham & Powers.1972. *Advanced Soil Physics*. John Wiley & Sons.
Ghildyal B P andTripathy R P 2001 Soil Physics . New age International
Shah A K. 2004 Text Book of soil Physics. Kalyani Publishers

Swce 6005 HYDRO-CHEMICAL MODELLING AND POLLUTANT MANAGEMENT (3+0)

Objective

To acquaint and equip the students with the hydrodynamics of fluid and pollutant flow and the impact analysis of contaminant transport through modeling

Theory

UNIT I

Hydrodynamics in flow through porous media, Hydrodynamic dispersion, diffusion, convection equation.

UNIT II

Analytical and numerical models of contaminant transport in unsaturated soil profile and ground water.

UNIT III

Water quality management in lakes and reservoirs; physical characteristics; hydrologic and chemical budgets; bio-geochemical processes of pollutants; assessment methods.

UNIT IV

Classical wastewater problems; Water reclamation, reuse, water quality constraints and considerations for reuse in irrigation and industry; Biological wastewater treatment.

UNIT V

Modern stream pollution problem. Quality of groundwater and sources of contaminants. Cost economics – environment impact assessment.

Suggested Readings

Larry W Mays 1996. *Water Resources Handbook*. McGraw Hill.

Metcalf and Eddey 1994. *Wastewater Treatment Engineering and Reuse*. JohnWiley.

Soli J Arceivala 1998. *Wastewater Treatment for Pollution Control*. Tata McGraw-Hill.

Swce 6006 PLANT GROWTH MODELLING AND SIMULATION (3+0)

Objective

To acquaint and equip the students with the simulation and modeling techniques in the soil, plant and water environment for crop growth.

Theory

UNIT I

Introduction to crop growth modeling. Simulation and simulation techniques. Types of models and modeling approaches.

UNIT II

Relational diagram for principal process, structures of a generalized agricultural simulator.

UNIT III

Input environment and techniques of monitoring plant environment.

UNIT IV

process and aspect of growth and development. Input yield models.

UNIT V

Quantitative analysis of plant processes light photo-syntheses, respiration, growth, water uptake etc. and their mathematical modeling.

Suggested Readings

Loomis RS, Connor DJ.1992. *Crop Ecology: Productivity and Management in Agricultural System.* Cambridge Univ. Press.

Spedding CRW. 1979. *An Introduction to Agricultural Systems*. Applied Science Publ.

Thornley JHM & Johnson IR. 1990. *Plant and Crop Modelling. AMathematical Approach to Plant and Crop Physiology*. ClarendonPress. Oxford Science Publ.

Swce 6007 ADVANCED IRRIGATION ENGINEERING (2+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- Hydro dynamics of surface irrigation, Surge irrigation: effect of surging on surface flow hydraulics, cablegation: water supply management.

UNIT II

Soil plant water relationship- Estimation of crop water requirements- Penmann and Penmann Monteith equations- softwares for ET computaion

UNIT III

Hydraulics of drip and sprinkler irrigation-Atomization in sprinkler and micro irrigation system; multipurpose and special uses of micro irrigation. Centre pivot and LEPA irrigation.

UNIT IV

Canal irrigation management, canal outlets, canal regulation, performance evaluation.

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.

Swce 6008 ADVANCED DRAINAGE ENGINEERING (2+0)

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

Theory

UNIT 1

Drainage problems of various agro climatic regions- Special reference to soils of Kerala-kari soils of Kuttanad-acid sulphate soils

UNIT II

Sub surface flow to drains -steady and unsteady flow equations in subsurface drainage system- Hooghoudt's equation-equivalent depth- Ernest equation- Glower Dumm Equation- De Zeeuw Hellinga equations.

UNIT III

Surface and sub surface drainage system design, Influence of irrigation on drainage- drainage of rice fields

UNIT IV

Synthetic materials for drainage systems. Environmental issues related to drainage. Socio-economic impacts of drainage systems. Controlled drainage for reducing agricultural non point pollution. Application of simulation models for drainage systems.

Suggested Readings

Ritzema HP. (Ed.). 1994. *Drainage Principles and Applications*. ILRI.

James N Luthin (1978) Drainage Engineering. Krieger Pub Co; Revised edition

Swce 6010 WATERSHED MANAGEMENT AND MODELLING (2+1)

Objective

To acquaint and equip the students with the watershed management modeling and modeling systems

Theory

UNIT I

Problems of desertification and degradation. Models of sediment yield

UNIT II

Survey, monitoring, reclamation and conservation of agricultural and forest lands, hill slopes and ravines. Concept of operational watershed. National land use policy, legal and social aspects

UNIT III

Watershed management research instrumentation and measurement, problem identification, simulation and synthesis

UNIT IV

Modelling of flood and drought phenomenon, drought management and dry farming

Practical

Preparation of watershed development proposal, preparation of water shed evaluation report. Application of Models of flood and drought phenomenon. Application of watershed models.

Suggested Readings

Isobel W Heathcote**.** 1998. *Integrated Watershed Management: Principles and Practice*. Wiley Publ.

Kenneth N Brooks, Peter F Ffolliott, Hans M Gregersen, Leonard F DeBano. 1991. *Hydrology and the Management of Watersheds*.Wiley-Blackwell.

Venkateswara Rao., Reddy R K Sarala C and Raju K (2003) *Hydrology and Watershed Management*. Proc. Of the international Conference. B S Publications, Hyderabad.

MINOR SUBJECTS

Cven 6001 OPEN CHANNEL FLOW (3+0)

Objective

To acquaint and equip with different techniques of Open Channel Flow and its importance in the engineering.

Theory

UNIT I

Open channel and their properties. Energy and momentum principles. Critical flow computations and applications.

UNIT II

Uniform flow. Its development. Formula and design computation.

UNIT III

Boundary layer concept. Surface roughness. Velocity distribution and
instability of uniform flow.

UNIT IV

Gradually varied flow theory and analysis. Method of computations.

UNIT V

Hydraulic jump and its use as levelling energy dissipation.Spatially varied flow. Unsteady flow. Rapidly varied flow.

Suggested Readings

Henderson FM.1966. *Open Channel Flow*. Macmillan.
Subramaninum 1960. *Open Channel Flow*. McGraw Hill.
Ven T Chow. 1959. *Open Channel Flow*. McGraw Hill.

Cven 6002 DAMS & RESERVOIR OPERATIONS (3+1)

Objective

To acquaint and equip with different types of dams, their design philosophies and use.

Theory

UNIT I

Dams classification. Suitable site selection for dams & reservoirs. Survey & planning of storage projects.

UNIT II

Type of concrete dams. Forces acting on concrete dams. Stability analysis.Methods of design of gravity dams. Temperature control for dams.

UNIT III

Earth dams and their types. Methods of construction. Causes of failure & remedial measures. Seepage and stability analysis of earth dams.

UNIT IV

Foundation treatment. Abutment grunting. Instrumentation in dams. Spill way and spillway capacities and spillway gates.

UNIT V

Reservoir planning, Storage, sedimentation, Losses, Economics. Flood routing.

Practical

Exercises on above topics.

Suggested Readings

Bharat Singh. 2002. Earthen Dams. New Chand & Bros., Roorkee.
Creager WP, Justin JD, Hinds J. 1945. *Engineering for Dams*. Vols. I-III.
John Wiley & Sons.
Sharma HD. 1981. *Concrete Dams*. Metropolitan.

Cven 6003 FLUVIAL HYDRAULICS (2+1)

Objective

To acquaint and equip the students with different aspects of Fluvial Hydraulics and their importance in the engineering.

Theory

UNIT I

Sediment properties, Sediment problems. Incipient motion of sediment particles.

UNIT II

Regimes of flow. Resistance to flow.Bed load. Suspended load. Total load transport.

UNIT III

Alluvial streams and their hydraulic geometry. Bed level variations in alluvial streams.

UNIT IV

Sediment samples and sampling. Alluvial river models. Sediment transport through pipes. Bed level variations in alluvial streams. River models.

Practical

Problems on determination of sediment properties, regimes of flow, resistance to flow, incipient motion, bed load, suspended load, total load transport and sediment transport.

Suggested Readings

Garde RJ & Ranga Rajan KG. 2001. *Mechanics of Sediment Transport and Alluvial Stream Problems.*
Howard H Chang. 1988. *Fluvial Process in River Engineering*. John Wiley & Sons.
Raudkivi AJ. 1990. *Loose Boundary Hydraulics*. Pergamon Press.

Cven 6004 EXPERIMENTAL STRESS ANALYSIS (2+1)

Objective

To acquaint and equip students with different techniques/methods of stress analysis and its importance in Engineering.

Theory

UNIT I

Strain and stress, Strain relationship.

UNIT II

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

UNIT III

Rosette analysis, Train gauge circuits, Strain measurements at high temperatures. Two dimensional & three dimensional photo elastic method of strain analysis.

UNIT IV

Bifringent coatings and scattered light in photo elasticity, Brittle coating methods, Moire method of strain analysis, Grid Method of strain analysis, Photoelastic strain gauges.

Practical

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

Suggested Readings

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

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

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

Cven 6005 LAND DEVELOPMENT AND EARTH MOVING MACHINERY (2+0)

Objective

To acquaint and equip the students with the Land Development and Earth Moving Machinery modeling and modeling systems.

Theory

UNIT I

Objectives, methods and equipment for land clearing and development. Machinery selection, mechanics of operation and vegetation types.

UNIT II

Earth moving machinery and earthmoving mechanics. Grading of sloppy lands. Principles of mechanisms used in crawler mounted tractors.

UNIT III

Earth diggers and ditchers. Bull dozers and scrapers. Elevating and self powered graders. Automation of earth moving and grading machines. Lazer guided leveler with global positioning system.

UNIT IV

Boring machines. Different methods of boring.

Suggested Readings

Dutta SK. 1987. *Soil Conservation and Land Management*. International Distributors, Dehradun.

Eric C Orlem.1997. *Earth-Moving Machines*. Motorbooks International.

Kuhar JE. 1977. *The Precision Farming Guide for Agriculturalist*. Lori J. Dhabalt, USA.

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.

Roger V Amato & Donald J Heimburger 2003. *Classic Vintage Crawlers and Dozers*. B Heimburger House Publ.
Singh G.1991. *Manual of Soil and Water Conservation Engineering*. Oxford & IBH.

Cven 6006 ADVANCED GIS AND REMOTE SENSING FOR LAND AND WATER RESOURCE MANAGEMENT (2+1)

Objective

To acquaint and equip with the techniques of Remote Sensing and application of GIS for land and water resources management.

Theory

UNIT I

Basic principles of remote sensing and sensors. Elements of photogrametry.

UNIT II

Electromagnetic spectrum. Energy interaction with surface features, Aerial photo and satellite imagery. Photo and image interpretation.

UNIT III

Principles of Geographical Information System tools, their types and capabilities, Advantages of GIS over conventional methods.

UNIT IV

Importance of ground truth establishment, GIS and remote sensing for land and water resources data collection, analysis and interpretation, Application of GIS in water and land resource development and management.

Practical

Familiarization with remote sensing and GIS hardware, software and their principle of working, Methods of establishing ground truth, Comparison between ground truth and remotely sensed data, Application of GIS packages.

Suggested Reading

De Mess MN. 2004. *Fundamental of Geographic Information System*. John Wiley & Sons.
Lille Sand T & Kaiffer R.1987. *Remote Sensing and Image Interpretation.*John Wiley & Sons.
Sabbins F.1987. *Remote Sensing Principle and Interpretation*. Freeman

Cven 6007 SOIL PHYSICS (2+1)

Objective

To acquaint and equip the students about soil physics in relation to soil and water conservation

Theory

UNIT 1

Scope of soil physics and its application in soil and water engineering-Soil as a three phase system-soil texture-mechanical analysis

Soil consistency-dispersion and workability-soil compaction and consolidation- swelling and shrinkage

UNIT II

Soil structure-characterization and management of soil structure- soil aggregation –aggregate stability-soil tilth-soil crusting-soil conditioners.

UNIT III

Soil water content and potential- soil water retention-soil water constants-energy state of soil water-soil water potential-soil moisture characteristics curve-hysteresis-measurement of soil water potential

UNIT IV

Hydraulic conductivity-permeability and diffusivity- hydraulic conductivity of saturated and unsaturated soils

Practicals

Mechanical analysis of soil

Measurement of Atterberg limits

Measurement of soil water potential-pressure plate apparatus

Determination of soil moisture characteristic curves

Suggested Readings

Baver L.D. Gardner W H and Gardner W R .Soil Physics. John Wiley and Sons

Ghildyal B P andTripathy R P 2001 Soil Physics . New age International

Shah A K. 2004 Text Book of soil Physics. Kalyani Publishers

Lal R andShukla M. K 2004. Principles of soil physics. Marcel Decker.

Cven 6008 FARM STRUCTURES AND ENVIRONMENTAL CONTROL (1+1)

Objective

To acquaint and equip the students with the techniques to control temperature, humidity and other composition of air to create favourable environment in the agricultural structures.

Theory

UNIT I

Thermodynamic properties of moist air, psychorometric chart and computer programmes for thermodynamic properties.

UNIT II

Farm structures, their design , constructional details and design of low cost structures. Heating, ventilating and exhaust systems, air distribution and air cleaning, combustion of fuels and equipment.

UNIT III

Drying and dehumidification system, air-water contact operations and evaporation, process and product air conditioning, energy efficient environmental control practices. Instruments and measurements; codes and standards.

Practical

Calculation of heating and cooling load; design calculation of moisture condensation in agricultural buildings; study of moisture migration behaviour in storage bins; design aspect of cold storage.

Suggested Readings

Albright LD. 1990. *Environmental Control for Animals and Plants*. ASAE Textbooks.

Esmay ML & Dixon JE. 1986. *Environmental Control for Agricultural Buildings*. The AVI Corp.

Gaudy AF & Gaudy ET. 1988. *Elements of Bioenvironmental Engineering*.

Engineering Press.
Moore FF. 1994. *Environmental Control Systems: Heating, Cooling, Lighting*. Chapman & Hall.
Threlkeld JL. 1970. *Thermal Environmental Engineering*. Prentice Hall.

SUPPORTING SUBJECTS

Cven 6009 WATER QUALITY AND POLLUTION CONTROL (1+1)

Objective

To acquaint and equip with different aspects of wastes and waste water quality, treatment and their importance**.**

Theory

UNIT I

Impurities in water. Water analysis (Physical, Chemical and Bacteriological).

UNIT II

Indices of water quality for domestic and industrial uses. Monitoring of water quality from various sources of water pollution.

UNIT III

Purification of water supplies.Waste water characteristics and disposal methods. Waste water treatment

UNIT IV

Mathematical modeling on pollution control. Environmental legislation on water pollution in India and abroad.

Practical

Determination of pH, dissolved and suspended solids, Chlorides, Sulphates, turbidity, dissolved oxygen hardness, BOD, COD, Nitrogen (Ammonical, nitrate, nitrite), MPN, Total count of bacteria in water/sewage samples.

Suggested readings

Garg SK. 2004. *Environmental Engineering.* Vol. II. Khanna Publ.
Garg SK. 2004. *Environmental Engineering*. Vol. I. Khanna Publ.
Howard S Peavey, Donald R Rod & Tchobanglous G. 1985. *EnvironmentalEngineering.* McGraw Hill.
Manual of Water Supply and Treatment. 1999 Ministry of Urban Development, New Delhi.
Metcalf and Eddy. 2003. *Waste Water Engineering Treatment and Reuse*.Tata McGraw Hill.

Cven 6010 DIMENSIONAL ANALYSIS AND SIMILITUDE IN ENGINEERING (2+1)

Objective

To acquaint and equip the students with different aspects of similitude in Engineering and its importance in engineering.

Theory

UNIT I

Scope of dimensional analysis; Dimensions and units.Dimensional homogeneity- Sets of dimensionless function. Buckingham Pi theorem; Rayleigh's method

UNIT II
Dimensional and similarity analysis. Theory of models. Criteria for modeling
UNIT III
True, distorted and dissimilar models. Scale effects
UNIT IV
Application to different systems with special reference to Structural and
fluid flow systems, Analogues.

Practical

Problems on flow and dams-different types of weirs-orifices-flow through pipes and pump
Analogue model experiments

Suggested Readings

Green Murphy.1950. *Similitude in Engineering*. Ronald Press.
Huntley HE. 1974. *Dimensional Analysis*. Dover Publ.
Stephen J Klin.1965. *Similitude and Approximation Theory*. McGraw Hill.

Cven 6011 ADVANCED OPERATIONS RESEARCH FOR WATER RESOURCE PLANNING (2+1)

Objective

To acquaint and equip the students with the techniques of operations research and its application in water resource planning

UNIT I
The nature of water resource system
UNIT II
Linear programming Techniques-Simplex Method, Karmarkar's Algorithm
Duality and Sensitivity analysis, Integer programming, statistical applications
UNIT III
Non linear programming and its examples, Kunhn-Tucker conditions
Quadratic programming. Convex programming. Basics of Stochastic programming. Applications
UNIT IV
Dynamic programming- optimal control theory, Application in water resource planning

Practicals

Problems based on classical optimization techniques; problems based on optimization techniques with constraints; minimization problems using numerical methods; LP problems through graphical method;LP problem with Simplex method(Two phase method); LP problem using Karmarkars method;Problems based on integer programming;problems based on quadriatic programming;problems based on dynamic programming;water resource planning problems

Suggested readings

Rao SS 2007 *Engineering optimization:Theory and Practice* 3rd edition New Age
Rustagi JS 1994 *Optimization Techniques in Statistics*. Academic Press
Taha H A 2007 *Operations Research: Introduction with CD* 8th Ed. Pearson Edu.
Zeleny M. 1974. *Linear Multi objective Programming* Springer.

Cven 6012 APPLIED INSTRUMENTATION IN SOIL AND WATER ENGINEERING (2+1)

Objective

To acquaint and equip with the concept of instrumentation used in soil and water engineering and allied fields and measuring devices for force, torque and other parameters.

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 Flow measuring instruments, current meters,water level recorders, stage recorders, Silt sampling instruments, instrumentation for erosion monitoring, flumes.

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. Current meters, flumes, silt samplers

Suggested Readings

Ambrosius EE. 1966. *Mechanical Measurement and Instruments*. The Ronald Press.

BeckwithTG. 1996. *Mechanical Measurements*. Addison-Wesley.

Doeblin 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.

Stat 6001 TIME SERIES ANALYSIS(1+1)

To acquaint and equip the students the concepts involved in time series data analysis. Exposure to the components of time series, stationary models and forecasting/projecting will be provided.

UNIT 1

Components of a time series. Autocorrelation and partial correlation functions, correlogram and periodogram analysis.

UNIT II

Linear stationary models: Autoregressive, Moving average and mixed processes

Linear non stationary model: Auto regressive integrated moving average processes.Forecasting: Minimum mean square forecasts and their properties, Calculating and updating forecasts.

UNIT III

Model identification: Objectives, Techniques and initial estimates. Model estimation: Likelihood function, sum of squares function, Least squares estimates, and seasonal models. Intervention analysis models and outlier detection.

PRACTICAL

Time series analysis,auto correlations, correlogram and periodogram; Linear stationary model;linear non stationary model; Model identification and model estimation; intervention analysis and outliers detection.

Suggested Readings

Box GEP, Jenkins GM & Reinsel GC 2007 *Time series Analysis: Forecasting and Control* 3rd Ed. Pearson Edu.

Brockwell P J & Davis R A 2002 *Introduction to time series and Forecasting* 2nd Ed.Springer

Chatterjee S, Hadi A and Price B 1999 *Regression Analysis by Examples*. John Wiley

Montgomery D C & Johnson LA 1976 *Forecasting and Time Series Analysis* Mc Graw Hill

Shumway RH & Stoffer D S 2006 *Time series analysis and its applications with examples*.2nd Ed.Springer.

Johnson J 1984 *Econometric Methods*. Mc Graw Hill

Ph.D (Agricultural Engineering)
Discipline: Farm Power and Machinery

The minimum credit requirements for Ph.D programme is as follows:

Course work

Major subject: 15 credits

Minor subject: 08 credits

Supporting subjects: 05 credits

Non credit compulsory subjects- courses 6 nos. (Exempted if already studied in Masters Programme)

Seminar: 0+2 credits (Two seminars of 0+1 credits)

Total for course work: 30 credits (Including Seminars)

Thesis: 45 credits

Total credits: Course work+ Research: 30+45 = 75

List of courses

CODE	COURSE TITLE	CREDITS
MAJOR COURSES (15)		
Fpme 6001**	ADVANCES IN FARM POWER AND MACHINERY	3+1
Fpme 6002**	SIMULATION MODELLING IN FARM POWER AND MACHINERY	2+0
Fpme 6003	ENERGY CONSERVATION AND MANAGEMENT IN FARM POWER AND MACHINERY	2+0
Fpme 6004	COMPUTER AIDED ANALYSIS AND DESIGN OF FARM MACHINERY	2+1
Fpme 6005	MACHINERY FOR NATURAL RESOURCE MANAGEMENT AND PRECISION FARMING	3+1
Fpme 6006	ADVANCES IN HYDRAULICS AND ELECTRO PNEUMATIC CONTROLS	2+0
MINOR COURSES/ SUPPORTING (8 + 5)		
Fpme 6101	DESIGN OF FARM POWER AND MACHINERY SYSTEMS	3+1
Fpme 6102	SOIL DYNAMICS IN TILLAGE AND TRACTION	2+1
Fpme 6103	TESTING AND EVALUATION OF TRACTORS AND FARM EQUIPMENT	2+1
Fpme 6107	SYSTEM SIMULATION AND COMPUTER AIDED PROBLEM SOLVING IN ENGINEERING	1+1

Fpme 6111	APPLIED INSTRUMENTATION IN FARM MACHINERY AND STRESS ANALYSIS	2+1
Fpme 6112	SYSTEM ENGINEERING AND PRODUCTIVITY	2+1
Fpme 6104	FARM MACHINERY DYNAMICS NOISE & VIBRATIONS	3+1
Fpme 6105	TRACTOR DESIGN	2+1
Fpme 6106	OPERATIONS RESEARCH IN FARM POWER & MACHINERY MANAGEMENT	3+0
Fpme 6110**	ERGONOMICS AND SAFETY IN FARM OPERATIONS	2+1
Aphe 6101	ENGINEERING PROPERTIES OF BIOLOGICAL MATERIALS	2+1
Fpme 6108	AGRO-ENERGY AUDIT AND MANAGEMENT	2+0
Fpme 6109	DESIGN AND ANALYSIS OF RENEWABLE ENERGY CONVERSION SYSTEMS	3+0
Sust 6101	STATISTICAL METHODS	1+1
	SEMINAR	
Fpme 6091	DOCTORAL SEMINAR I	1+0
Fpme 6092	DOCTORAL SEMINAR II	1+0
Fpme 6093	SPECIAL PROBLEMS IN FARM POWER & MACHINERY	0+1
	RESEARCH	
Fpme 6099	DOCTORAL RESEARCH	45
	Total credit	**15+13+2+45 =75**

** Compulsory Courses to be credited

Course Contents

Fpme 6001-ADVANCES IN FARM POWER AND MACHINERY (3+1)

Objective

To acquaint and equip with the latest mechanisms being used on the farm equipment and their analysis using computers.

Theory

UNIT I

Farm machinery systems, their utilization and performance characteristics and evaluation. Hydraulic and mechanical power transmission systems. Linkages and safety devices on agricultural machines. 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

Design characteristics and force analysis of various soil working tools; design standards and operation of seed drills and planters; design and operation of machines for chemical plant protection; design of forage, root crops and grain harvesting equipment; design factors and equipment for threshing and winnowing of crops

UNIT III

Engine design principles, modern trends in tractor design. Traction, drawbar performance, mechanics of 2WD & 4WD farm tractors, tractor stability analysis. Mechanical and power Steering, tractor hydraulics, power transmission systems, tractor tests and performance. Pollution control technologies, human engineering factors in tractor design

UNIT IV

Computer aided design principles of machines. Computer representation of models and drawings. Features of various solid modeling packages. 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 V

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 VI

Application of various vibration analysis methods. Tractor dynamics; development of the model. Checking, interpretation and statistical analysis of results.

Practical

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

Suggested Readings

Bevan T. 1962. *The Theory of Machines*. Longman.
Close CM, Fredrick DK & Newwell IC. 2001. *Modelling and Analysis of Dynamic System*. John Wiley & Sons.
Franklin GF & Powell JD. 1980. Digital Control of Dynamic System. Addison Wesley Publ.
Kepner RA, Bainer R & Berger EL. 1978. *Principles of Farm Machinery*. AVI Publ.
Mabie HH & Ocrirk FW.1987. *Mechanism and Dynamics of Machinery*. John Wiley & Sons.
Shigley JE & Uicker JJ .1980. *Theory of Machinery and Mechanism*. McGraw Hill.

Fpme 6002-SIMULATION MODELLING IN FARM POWER AND MACHINERY (2+0)

Objective

To acquaint and equip with the mathematical modeling of farm machinery, development of models using various techniques.

Theory

UNIT I

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

UNIT II

Experimentation with physical models and their application in farm machinery design. Sensitivity of models, scale effects, scale factors. Use of models. Complete similarity, kinematics and dynamic similarity. Model laws, empirical methods in model engineering. Principle of similarity in mathematical investigations. Mathematical modelling and its limitations, etc.

UNIT III

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

Practical

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

Suggested Readings

Langhaar HL.1954. *Dimensional Analysis and Similitude*. McGraw Hill.
Sedov LI. 1991. *Similarity and Dimensional Methods in Mechanics*. Mir Publ., Moscow.
VJF Kumar and D Durairaj. 2003. *Solved problems in Dimensional Analysis*.

Fpme 6003-ENERGY CONSERVATION AND MANAGEMENT IN FARM POWER AND MACHINERY (2+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

Farm energy resources, their forms and uses, energy coefficients for agricultural inputs and products; Energy consumption patterns in agricultural production and processing sectors, energy conservation and waste minimization methods, energy efficient machinery systems;

UNIT II

Energy requirement of different operations in agricultural production systems viz. crop, livestock, post harvest operations 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

Energy management concepts, energy audit, energy costs, energy performance, system efficiencies, material and energy balance, financial analysis, development of computer program for efficient energy management in a given agricultural production system. Energy use planning and forecasting for a given system.

UNIT IV

Energy forecasting and demand-supply optimization, fuel and energy substitution, energy action planning

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.

De, Dipankar. 2005. Energy use in crop production system in India. Book No. CIAE/2005/2, C.I.A.E., Bhopal

Fpme 6004-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.

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 linear programming, 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. Exposure to MS Project software, exercise on agricultural engineering system

analysis. Description of the machinery scheduling problem in harvesting and transport system. Investigation of existing software models – cases studies.

Suggested Readings

Chris McMahon & Jimmie Browne. 2000. *CAD /CAM/ Principles, Practice and Manufacturing Management*. Pearson Edu.
Grover Mikell P. 2003. *Automation, Production Systems and Computer Integrated Manufacturing*. Prentice-Hall of India.
Radhakrishnan P, Subramanyan S & Raju V. 2003. *CAD/CAM/CIM*. New Age International.
Rao PN. 2002. *CAD/CAM Principles and Applications*. Tata McGraw Hill.
Zeid Ibrahim.1998. *CAD/CAM Theory and Practice*. Tata McGraw Hill.

Fpme 6005-MACHINERY FOR NATURAL RESOURCE MANAGEMENT AND PRECISION FARMING (3+1)

Objective

To acquaint and equip with the farm machinery used for natural resources management and machinery for precision farming. Use of GIS and GPS in farm machinery.

Theory

UNIT I

Functional design, specifications, requirements and working of farm machinery needed for natural resources management like rotavator, zero till drill, Precision sowing and planting machines, Field plot 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, Computers and Geographic information systems. Precision farming - Issues and conditions. Role of electronics in farm machinery for
precision farming.

UNIT IV

Soil sensors in precision farming. Spectral based sensors. Development of sensors and controls, Variable rate technology. Precision chemical application. Crop yield monitors, Decision support systems; artificial intelligence, Vision systems

UNIT V

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 VI

Land cleaning and reclamation equipment. Land leveling equipment. Power shovels, drag lines, cam shells. Rubber tire for earth moving machinery. Trenching machineries and wagons. Economic analysis of land development machinery. Application of PERT and CPM to the problems related to land development.

Practical

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

Suggested Readings

De Mess M. N. Fundamental of Geographic Information System. John Willy and Sons, New York
Dutta SK. 1987. Soil conservation and land management. International distributors, Dehradun.
Kuhar, John. E. 1977. The precision 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.

Fpme 6006-ADVANCES IN HYDRAULICS AND ELECTRO PNEUMATIC CONTROLS (2+0)

Objective

To acquaint and equip with the latest developments in the field of hydraulics and pneumatics with special reference to the usage of these on the modern day tractors.

Theory

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

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

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

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

Suggested Readings

Anthony Esposito. 2003. *Fluid Power with Applications*. Pearsons Edu.
Krutz G.1984. *Design of Agricultural Machines*. John Wiley & Sons.
Merritt HE. 1991. *Hydraulic Control System*. John Wiley a& Sons.
Majumdar SR. 2003. *Oil Hydraulic System*. Tata McGraw Hill.

Fpme 6101 - DESIGN OF FARM POWER AND MACHINERY SYSTEMS (3+1)

Objective

To acquaint and equip with the latest design procedures of farm power and machinery systems.

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 Readings
Arther W Judge 1967. *High Speed Diesel Engines*. Chapman & Hall.
Barger EL, Liljedahl JB & McKibben EC 1967. *Tractors and their Power Units*. 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.

Fpme 6102 -SOIL DYNAMICS IN TILLAGE AND TRACTION (2+1)

Objective

To acquaint and equip with the dynamic properties of soil, soil failure and design of tillage tools, prediction of traction performance and dimensional analysis of different variables related to soil- tire system.

Theory

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

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

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.

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, wheel slippage and tyre selection, design and performance of traction devices and soil working tools.

Suggested readings
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.

Fpme 6103 -TESTING AND EVALUATION OF TRACTORS AND FARM EQUIPMENT (2+1)

Objective

To acquaint and equip with the procedure of testing & performance evaluation of farm power & machinery as per test standards and interpretation of results.

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 Readings
Anonymous. 1983. *RNAM Test Code & Procedures for Farm Machinery*. Technical Series 12.
Barger EL, Liljedahl JB & McKibben EC. 1967. *Tractors and their Power Units*. 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.

Fpme 6107 -SYSTEM SIMULATION AND COMPUTER AIDED PROBLEM SOLVING IN ENGINEERING (1+1)

Objective

To acquaint and equip with the concept of dimensional analysis, mathematical modeling, software development process and the use of CAD software and in solving the engineering problems related to design of farm machinery

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- discreet event simulation- time advance mechanisms- components of discreet 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 Readings

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 Methods for 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.

Fpme 6111-APPLIED INSTRUMENTATION IN FARM MACHINERY AND STRESS ANALYSIS (2+1)

Objective

To acquaint and equip with the concept of instrumentation used in farm power & machinery and measuring devices for force, torque and other parameters.

Theory

UNIT I

Strain and stress-strain relationship, stress and strain analyses in 3 dimension torsion, bending; stress analysis in agricultural machine designs, strain gauges. Mechanical, optical, electrical acoustical and pneumatic etc. and their uses. 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 Readings

Ambrosius EE. 1966. *Mechanical Measurement and Instruments*. The Ronald Press.
BeckwithTG. 1996. *Mechanical Measurements*. Addison-Wesley.
Doeblin 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.

Fpme 6112 - SYSTEM ENGINEERING AND PRODUCTIVITY (2+1)

Objective

To acquaint and equip with the concept of analysis of data, economic analysis techniques, network theory, dynamic programming and computer use in solving problems of optimization, writing of algorithms for problem solutions and decision making.

Theory

UNIT I
System definition and concept. System engineering function, management and problems. Classification of system analysis models. Economic analysis techniques: Interest and interest estimation of single and multiple alternatives, break even analysis.

UNIT II
Mathematical modeling and analysis: Application of linear programming, Network theory – CPM and PERT, Queuing theory and its application, assignment & transportation models and job scheduling/ allocation for the synthesis of agriculture machine systems.

UNIT III
Dynamic programming, Markov chains, application of forecasting in agricultural engineering systems and products. Concept utilization and mathematical formulation of the labor, equipment and material factors affecting productivity.

UNIT IV
Computer use in solving problems of optimization, writing of algorithms for problem solutions and decision making.

Practical
Extensive practice on the packages mentioned in theory.

Suggested Readings

Danovan SS. 2000. *System Programming*. Tata McGraw.
Gillett G. 2001. *Introduction to Operations Research*. Tata McGraw Hill.
Grawham WJ & Vincent TL. 1993. *Modern Control System Analysis and Design*. John Wiley & Sons.
Lewis FL & Syrmos VL. 1995. *Optimum Control*. 2nd Ed. John Wiley & Sons.
Loomba D. 2000. *Linear Programming*. Tata McGraw.
Puttaswamaiah K. 2001. *Cost Benefits Analysis*. Oxford & IBH.

Fpme 6104 FARM MACHINERY DYNAMICS NOISE & VIBRATIONS (3+1)

Objective

To acquaint and equip with the theoretical aspects of farm machinery used on the farm.

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 Readings

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.

Fpme 6105 -TRACTOR DESIGN (2+1)

Objective

To acquaint and equip with the latest design procedures of tractor and its systems.

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,ergonomic considerations for 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.

Suggested Readings
Arther W Judge 1967. *High Speed Diesel Engines*. Chapman & Hall.
Barger EL, Liljedahl JB & McKibben EC. 1967. *Tractors and their Power Units*. 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.

Fpme 6106 - OPERATIONS RESEARCH IN FARM POWER & MACHINERY MANAGEMENT (3+0)
Objective

To develop scientific skill for solving problems invoving integrated systems of man-machine and material

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.

Suggested Readings

Carville LA. 1980. *Selecting Farm Machinery*. Louisiana Cooperative Extn. Service Publication.
Culpin C & Claude S. 1950. *Farm Mechanization; Costs and Methods*. McGraw Hill.
Culpin C & Claude S. 1968. *Profitable Farm Mechanization*. Crosby Lockwood & Sons.
FAO.1984. *Agricultural Engineering in Development: Selection of Mechanization Inputs*. Agricultural Service Bulletin.
Hunt D. 1977. *Farm Power and Machinery Management*. Iowa State University Press.
Waters WK. 1980. *Farm Machinery Management Guide*. Pennsylvania Agric. Extn. Service Spl. Circular No. 1992

Fpme 6110 -ERGONOMICS AND SAFETY IN FARM OPERATIONS (2+1)

Objective

To acquaint and equip with the ergonomic aspects in the design of farm machinery and tractors for safety of human beings

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 Readings

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.

Aphe 6101 -ENGINEERING PROPERTIES OF BIOLOGICAL MATERIALS (2+1)

Objective

To acquaint and equip with the different techniques of measurement of engineering properties and their importance in the design of biological material handling equipment.

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 Readings

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 Hallsrram, 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.

Fpme 6108 -AGRO-ENERGY AUDIT AND MANAGEMENT (2+0)

Objective

To acquaint and equip about the sources of energy, conservation of energy and its management. Energy use scenario in agricultural production system, agro-based industry. Study of energy efficiency, energy planning, forecasting and energy economics.

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 Readings
Kennedy WJ Jr. & Wayne C Turner.1984. *Energy Management*. Prentice Hall.
Pimental D. 1980. *Handbook of Energy Utilization in Agriculture*. CRC
Fluck RC & Baird CD.1984. *Agricultural Energetics*. AVI Publ.
Rai GD. 1998. *Non-conventional Sources of Energy*. Khanna Publ.
Twindal JW & Anthony D Wier 1986. *Renwable 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.

Fpme 6109 -DESIGN AND ANALYSIS OF RENEWABLE ENERGY CONVERSION SYSTEMS (3+0)

Objective

To acquaint and equip with the non-conventional energy sources. Energy from solar, wind, biomass, conversion of energy from biomass. Development of biogas and biofuels.

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 Readings

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.

Sust 6101 -STATISTICAL METHODS (1+1)

Objective

To acquaint and equip the students with fundamental aspects of statistical tools and statistical analysis.

Theory

Unit I
Measures of Association – simple, partial, rank, biserial and multiple correlation and regression coefficients, coefficient of concordance.

Unit II

Tests of significance based on normal, t, Z and F statistics, Bartletts's tests of significance – run test, sign test, Wilcoxon signed rank test, Maan-Whithey U test, Kolmogoro-Smirnnor test, friendmanls test, Kruskal Wally's test, Cochram's test.

Unit III

Measures of central tendency – measure of dispersion – Skewness and Kurtosis – Correlation and regression.Theoretical frequency distribution – student't' distribution – binomial, Poisson and normal distribution, Chi-square and F-distribution.

Practical

Problems on probability – using probability laws, Fitting of binomial and Poisson distributions - Fitting of normal distribution-t test - Chi square test -One-way analysis of variance (CRD)-Two-way analysis of variance (RBD)-Control charts – X and R charts.

Suggested Reading

Gupta S.P.2005. *Statistical Methods*. Sultan Chand and Sona Educational Publishers, New Delhi.
Kapoor, J.N. Saxsena, V.C. 1997. *Mathematical statistics.* S Chand &Co.
Pandey and Sukame, "*Statistical Methods*", ICAR Publication, New Delhi.
Rangasamy, R. 2002. *A text book of Agricultural Statistics.* New Age International Publishers, New Delhi.
Richard A Johnson 1994. *Miller and Freund's Probability and Statistics for Engineers*, Eastern Economy Edition, Prentice Hall of India P/Ltd., New Delhi.

FARM POWER AND MACHINERY

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
- International Journal of Agricultural Engineering, Hind Agricultural University, UP.

Suggested Broad Topics for Master's and Doctoral Research

- Farm Machinery for crop residue management to increase soil fertility for higher productivity

• Machinery for precision agriculture for efficient utilization of inputs and saving in cost of production to have higher productivity
• Application of axial flow principle in thresher to have minimum breakage
• Efficient hand tools for pruning and plucking fruits
• Transplanters - to transplant vegetable crops
• Crop harvesters – for mango, arecanut
• Crop planters- for hybrid cotton, bajra and other crops for hybrid seed production
• Efficient tillage and sowing machinery to save irrigation water and increase productivity.
• Development of farm machinery for horticultural crops
• Use of electronics in agriculture
• Use of GIS and GPS in farm machinery for precision agriculture
• Development of software for optimal use of farm machinery under different agro climatic conditions
• Coconut climbing devices
• Paddy harvesters for water logged areas
• Mini driers for paddy

Ph.D (Agricultural Engineering)

Discipline: Agricultural processing and Food Engineering

The minimum credit requirements for Ph.D programme is as follows:

Course work

Major subject: 15 credits

Minor subject: 08 credits

Supporting subjects: 05 credits

Non credit compulsory subjects- courses 6 nos. (Exempted if already studied in Masters Programme)

Seminar: 0+2 credits (Two seminars of 0+1 credits)

Total for course work: 30 credits (Including Seminars)

Thesis: 45 credits

Total credits: Course work+ Research: 30+45 = 75

List of courses

MAJOR SUBJECTS

Course No.	Course title	Credits
1. Core Courses (9 credits)		
Pafe6001**	Textural & Rheological Characteristics of Food Materials	1+1
Pafe6002**	Advances in Food Engineering	3+0
Pafe6003	Mathematical models in Food Processing	3+0
Pafe6004	Advances in Drying of Food materials	2+1
Pafe6005	Biomass and Agricultural byproducts utilization	2+1
Pafe6006	CAD and CAM applications in Food Engineering	1+2
Pafe6007	Advances in Storage Engineering of Agricultural Crops	2+1
Pafe6008	Design of Agricultural Processing Equipments.	2+0
Pafe6009	Advances in Food Processing and Quality Management	3+1
Pafe6091	Doctoral Seminar I	0+1
Pafe6092	Doctoral Seminar II	0+1
Pafe6093	Special problem in Agricultural Processing &Food	0+1

	Engineering	
Pafe6099	Doctoral Research	0+45
	Total	19+55

Course contents

Pafe6001 Textural & Rheological Characteristics of Food Materials (2+1)

Objective

To acquaint and equip the students with the textural & rheological properties of food materials.

Theory

UNIT I

Texture classification. Relation of food texture with structure and rheology. Principles and practices of objective texture measurements, viscosity measurements.

UNIT II

Sensory methods of texture and viscosity measurements and their correlation. Rheological properties of foods.

UNIT III

Mathematical models and their application along with pipe line design and pump selection for non-Newtonian fluids. Recent advances in textural,rheological and viscoelastic characteristics of foods and their associated mathematical models.

Practical

Determination of viscosity of liquid foods, guminess, chewiness, springiness and hardness of various fruits, vegetables and processed foods using texture profile analysis. Determination of force-distance relationship. Sensory evaluation/ subjective measurement and correlation between

subjective and objective measurements of foods.

Suggested Readings

1. Bourne MC. 2002. *Food Texture and Viscosity: Concept and Measurement*. Academic Press

2. Deman JM. *et al.* 1976. *Rheology and Texture in Food Quality*. AVI Publ.
3. Journal of Food Science and Technology
4. Journal of Texture Studies
5. Mohsanin NN.1989. Physical Properties of Plant and Animal Material. Vol.I, II. Gordon and Breach Science Publ.
6. Steffe JF. 1992. *Rheology and Texture in Food Quality*. AVI Publ.

Pafe6002 Advances in Food Engineering (3+0)

Objective

To acquaint and equip the students with the modern and latest techniques of Food Engineering.

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.

Suggested Readings

1. Heldman R Dennis and Lund B Daryl. 1992. *Hand Book of Food Engineering*.Marcel Dekker.
2. Goldblith SA, Rey I & Rothmayr WW. 1975. *Freeze Drying and Advanced Food Technology*. Academic Press.
3. Gould GW (Ed.).1996. *New Methods of Food Preservation*. Blackie Academic & Professional.
4. Leniger HA & Beverloo WA. 1975. *Food Process Engineering*. D. Reidel Publishing Co.
5. Rao MA & Rizvi SSH.. 1986. *Engineering Properties of Foods*. Marcel Dekker.
6. Ronald Jowitt. 1984*. Extrusion Cooking Technology.* Elsevier.

Pafe6003 Mathematical Models in Food Processing (3+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.

Suggested Readings

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

Pafe6004 Advances in Drying of Food products (2+1)

Objective

To acquaint and equip the students with the latest technologies of dehydration of food products and the design features of different dryers

Theory

UNIT 1

Heat transfer characteristics of crops - a review for heating and cooling - mass transfer characteristics - theory of diffusion - enthalpy balance - residence time equation and calculation.

UNIT II.

Sorption isotherms - drying theory - types of drying- fluidized bed dryers - two phase theory for fluidization, mixing in the fluid bed, selection of gas/air velocity for fluidization-construction and operation of vibratory fluidized bed drying system, fluid bed granulation, sprouted bed, agitated fluid bed, centrifugal fluid bed dryer - heat transfer - characteristics.

UNIT III

Microwave and dielectric heating and drying - electro magnetic fields - advantages - equipment and selection - Radio frequency drying and tunnel drying-Ionic conduction - dipolar rotation - interaction of electromagnetic fields with materials. Infra-red drying - radiation - applications - special drying techniques - contact - sorption drying - drying on inert particles - pulse combustion drying - drying with induction heating.

UNIT IV

Freeze drying - recent advances in freeze drying -spouted bed drying - spray drying - recent developments on design and practice of spray drying - drying behaviour of droplets - novel dehydration techniques - flash evaporation - extraction and distillation process – energy requirements in different methods of dehydration.

UNIT V

Heat requirements and thermal efficiency of drying system, aeration, tempering and dehydration, operation of driers and their controls, selection of driers, performance testing of grain driers, drying characteristics of cereals, pulses and oilseeds

Practical

Experiments on batch type thin layer drier, fluidized bed drier, continuous flow mixing type drier, continuous flow non mixing type drier, sand medium drier (conduction type drying), agricultural waste fired furnace drier, spray dryer, drum dryer, foam mat drying ,to evaluate the thermal efficiency and heat utilization factor.

Suggested Readings

1. Bala BK. 1998. *Drying and Storage of Cereal Grains*. Oxford & IBH.
2. Brooker DB, Bakker Arkema FW & Hall CW. 1974. *Drying CerealGrains*. The AVI Publ.
3. Chakraverty A & De DS. 1999. *Post-harvest Technology of Cereals,Pulses and Oilseeds*. Oxford & IBH.

4. Hall CW. 1970. *Drying of Farm Crops*. Lyall Book Depot.
5. Tadensz Kudra & Majumdar AS. 2002. *Advanced Drying Technologies*.Marcel Dekker.
6. Wallace B Van Arsdel & Michael J Copley. 1963. *Food Dehydration*.AVI Publ.

Pafe6005 Biomass and Agricultural Byproducts 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 by products/ 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. Activated carbon

UNIT III

Utilization of wastes for paper production- hydrolysis of cellulose and hemicelluloses-production of particle board, utilization, by-products from rice mill, rice husk, rice bran, utilization.

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. Bio reactors-types single and double -factors-

Practical

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

Suggested Readings

1. ASAE Standards. 1984. *Manure Production and Characteristics*.
2. Bor S Luh (Ed.). 1980. *Rice: Production and Utilization*. AVI Publ.
3. Chahal DS.1991. *Food, Feed and Fuel from Biomass*. Oxford & IBH.
4. Chakraverty A. 1989. *Biotechnology and other Alternative Technologiesfor Utilisation of Biomass/ Agricultural Wastes*. Oxford & IBH.
5. David C Wilson. 1981. *Waste Management - Planning, Evaluation,Technologies*. Oxford.
6. Donald L Klass & Emert H George 1981. *Fuels from Biomass and Wastes*.Ann. Arbor. Science Publ.
7. Srivastava PK, Maheswari RC & Ohja TP. 1995. *Biomass Briquetting andUtilization*. Jain Bros.
8. USDA 1992. *Agricultural Waste Management Field Handbook*. USDA.
9. Wilfred A Cote.1983. *Biomass Utilization*. Plenum Press.

Pafe 6006 CAD and CAM application in Food Engineering (1+2)

Theory

UNIT I

Introduction - Computer Aided Design and Drafting - Computer Aided Manufacturing - hardware and software - workstation - shared peripherals.Computer aided drafting - input and output devices - drawing editor - setting up the drawing - commands - file managing, display, drawing, tools, aids, editing, fill, erase, move, polylines, blocks, modify, text and dimensions - 3D drawings - commands - transforming 2D to 3D - drawing output.

UNIT II

Programming in CAD - interpreter and evaluation - variables - storing and running programmes - planning and organising programmes - solving problems and working with text - editing - output.

UNIT III

Design and drafting of components of agricultural processing equipment - shaft, hoppers, bins and pullies.

Practical

Exercises on computer aided drawing with AutoCAD - drawing commands - taking output - exercises in programming with Auto LISP - design and drawing of components of agricultural processing equipment.

Suggested readings

1. Katz Geneviere. 1991. Teach Yourself AutoCAD-Release 11 First Indian Edition,BPB Publications, New Delhi.
2. Omura George .1990. The ABCs of Auto LISP. First Indian Edition. BPB Publications, New Delhi.
3. Raker Daniel and Harbert Rice . 1987. Inside AutoCAD First Edition,BPB Publications, New Delhi.

Pafe6007 Advances in Storage Engineering of Agricultural crops (2+1)

Objective

To acquaint and equip with the safe storage of food materials, design of storage structures and methods used in the industries.

Theory

UNIT I

Spoilage mechanisms of grains and seeds in post harvest eco system-factors influencing storage-causes of spoilage- environmental factors-Physicochemical spoilage mechanisms-causes of spoilage, environmental factors-interactions-technological consequences of spoilage. pressure drop due to uni dimensional air flow through grain masses-production of heat and CO_2.

UNIT II.

Aeration of grains and grain temperature in silos-technology of silo construction - detoxification of stored grains-chemical control of stored product insects-characteristics of grain dust-prevention of grain dust explosion-technological value of stored grains. Design of Bulk storage-Analysis of heat, moisture and gas transfer in bulk storage structures. Quality analysis of stored products.

UNIT III

Natural air tight storage- modified atmosphere storage of grains-biochemical, entomological and microbiological aspects of storage-mixture of gases and principles underlying their formation-equipment for creating and regulating modified atmosphere storage-insect traps-suitability-design considerations.

Practical

Estimation of causes of spoilage and environmental factors-Experiment on grain pressure drop and aeration -estimation of CO_2 - released and grain temperature-Experiment on grain dust, modified atmosphere storage and insect traps.

Suggested readings

1. Christensen,C.M.(ed). 1974. Storage of cereal grains and their products. AACC. St.Paul, Minnesota.
2. Metlitskii, I.V., E.G.Salkova, N.I.Volkind, V.I.Bondarev and V.Ya.Yanpuk. 1983. Controlled atmosphere storage of fruits. Amerind Publishing Co.Pvt.Ltd., New Delhi.
3. Multon, J.I. (ed). 1989. Preservation and storage of grains, seeds and their by-products. CBS Publishers and distributors, Delhi.
4. Ripp,B.E. 1984. Controlled atmosphere and fumigation in grain storage. Elsevier Science Publishing Co.
5. Shejbal, J. (ed). 1980. Controlled atmosphere of grains. Elsevier Science Publishing Co.
6. Sinha, R.N. and W.E.Muir, 1973. Grain storage; Part of a system. The AVI Publishing Co.

Pafe6008 Design of Agricultural Processing Equipments (2+0)

Objective

To acquaint with the design features of different food processing equipments.

Theory

UNIT I

Kinetics, dynamics analysis and design procedures of various components and mechanisms of cleaners - graders - separators - shellers - decorticators - pulverizes - dryers - rice and wheat milling machineries - pulse milling machineries - extruders – scrapper. Design of pressure vessels and heat exchangers used in food industry.

UNIT II

Design procedure of handling equipments -apron and plate conveyors - roller and belt conveyors - belt and chain conveyors, bucket elevators - screw and ribbon conveyors - overhead chain trolley conveyors - vibrating trough and shaker conveyors - pneumatic conveyor.

Suggested readings

1. Broughton (Jack). 1994. Process Utility Systems, Introduction to Design, Operation and Maintenance. Institution of Chemical Engineers, Rugby, USA.
2. Gary Krutz, Lester Thompson and Paul Clear. 1984. Design of Agricultural Machinery. John Willey & Sons. New York.
3. Gibb,J.A.C. 1955. Crop Drying, Barn and Storage machinery. Temple Press Ltd., London.
4. Kenneth,G. Budinski. 1979. Engineering Materials, Properties and Selection. Reston Publishing Co. Inc. Virginia.
5. Perry, R.H. (ed) 1973. Chemical Engineers Hand Book. McGraw-Hill Book Co. New York.
6. Richey, C.B. (ed). 1961. Agricultural Engineers Hand Book. McGraw-Hill Book Co. New York.
7. Rudenko,N. 1969. Materials handling equipment. MIR Publishers, Moscow.

Pafe6009 Advances in Food Processing and Quality Management (3+1)

Objective:

To develop an insight among the students about the existing modern techniques so as to aware them about their methodology and applications in food processing as well as to acquaint with food quality parameters and control systems, food standards, regulations, specifications.

Theory

UNIT-I

Introduction to quality, importance of quality, management principles, estimation of quality parameters, quality and business environment.

UNIT II

Quality management standards, ISO/BIS, PFA, AGMARK and QMS standards, quality system components and their requirements., Food Safety and Standards, hazard analysis and critical control points (HACCP), Codex alimentarius, total quality management (TQM), statistical processed control, quality auditing.

UNIT III

Recent advances in processing technologies, aseptic processing, individual quick freezing and cryogenic freezing, high pressure technology, heat and ultrasound, high voltage pulse technology, irradiation, membrane technology, microwave heating, enzymes, natural antimicrobial agents, food additives, fermentation, minimal processing. Principles of food biotechnology, genetic modification of microorganisms in the food industry (lactic acid bacteria, yeasts and moulds), production of high valued food products by microorganisms viz. enzymes, organic acids, SCP, antibodies, nutritional additives, flavors, pigments

Practical

Testing and evaluation of quality attributes of raw and processed foods; Detection and estimation of food additives and adulterants; Quality assurance procedure, GMP, GAP documentation; Preparation of quality policy & documentation, Application of HACCP to products, Preparation of HACCP chart; Preparation of documentation & records, Visit to Units with ISO systems; Visit to Units with HACCP certification; Visit to Units implementing GMP, GAP; Mini-project on preparation of a model laboratory manual.

Suggested Readings

1. Amerine MA, Pangborn RM & Rosslos EB. 1965. *Principles of Sensory Evaluation of Food*. Academic Press.
2. Early R.1995.*Guide to Quality Management Systems for Food Industries*. Blackie Academic.
3. Krammer A & Twigg BA.1973. *Quality Control in Food Industry*. Vol. I, II. AVI Publ.
4. Ranganna S. 2001. *Handbook of Analysis and Quality Control for Fruit and Vegetable Products*. 2nd Ed. Tata-McGraw-Hill.
5. Barbosa-Canovas 2002. *Novel Food Processing Technologies*. CRC.

6. Shi J.(Ed.).2006. *Functional Food Ingredients and Nutraceuticals:Processing Technologies*. CRC.

MINOR/SUPPORTING COURSES

Code	Course title	Credits
Cefe 6001	Similitude Engineering	(2+1)
Cefe 6002	Probabilistic Approach in Design	(2+0)
Cefe 6003	Design of Bins and Silos	(2+1)
Csfe 6001	Computer Graphics	(2+1)
Eefe 6001	Applied Instrumentation	(2+1)
Mefe 6001	Operational Research	(2+1)
Agfe 6001	Food Microbiology	(2+1)
Agfe 6002	Storage Entomology	(2+1)
Agfe 6003	Post Harvest Physiology	(2+1)

Cefe 6001 Similitude in Engineering (2+1)

Objective

To acquaint and equip the students with different aspects of similitude in Engineering and its importance in engineering.

Theory

UNIT I

Dimensions and units.

UNIT II

Dimensional and similarity analysis. Theory of models.

UNIT III

True, distorted and dissimilar models.

UNIT IV

Application to different systems with special reference to Structural and fluid flow systems, Analogues.

Practical

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

Suggested Readings

1. Green Murphy.1950. *Similitude in Engineering*. Ronald Press.
2. Huntley HE. 1974. *Dimensional Analysis*. Dover Publ.
3. Stephen J Klin.1965. *Similitude and Approximation Theory*. McGraw Hill.

Cefe 6002 Probabilistic Approach in Design (2+0)

Objective

To acquaint and equip with different probabilistic methods for dynamic loading design.

Theory

UNIT I

Review of various approaches in engineering design and introduction of probabilistic approach.

UNIT II

Random variables. Probability distribution and density functions. Expected values, Mean. Variance, Conditional probability. Characteristic functions.

UNIT III

Function of random variable. Concepts of stationary, ergodic and nonstationary rocesses.

UNIT IV

Auto correlation. Cross-correlation. Covariance functions. Power spectral and cross spectral density functions and their determination from experimental data.

UNIT V

Broad-band and Narrow band random processes. White noise. Application in various disciplines of engineering.

Suggested Readings

1. Benjamin JR & Allen C. 1975. *Probability Statistics and Decision for Civil*

Engineers. MGH New York.

2. Evan DH.1992. *Probability and its Applications for Engineers*. ASQC

Press & Marcel Dekker.

Cefe 6003 Design of Bins and Silos (2+1)

Objective

To acquaint and equip the students with Design practices for optimum design of grains storage structures.

Theory

UNIT I

Computer aided design manuals. Rankine's and Coloumb's theories of active and passive pressures.

UNIT II

Janssen's and Airy's theories grain pressure theories for design of deep and shallow silos. Reimbert's theory of silo design.

UNIT III

Comparison of Australian (AS) and Indian (BIS) design criteria for bins and silos.

UNIT IV

Computer aided design of grain silos by developing flowcharts and programs for underground and over ground silos.

Practical

Analysis and design of silos of various capacities using available software.Use of different standard codes and theories in the development of flowcharts and design program for various capacity silos.

Suggested Readings

1. AS-3774.1990. *Loads on Bulk Solid Containers*.
2. BS-5061.1974. Specifications for Cylindrical Storage Tower Silos and Recommendations for their use. BIS Relevant Standards.
3. Rajgopalan K. 1989. *Storage Structure*. Oxford & IBH.
4. Reimbert M & Reimbert A.1956. *Design of Bins*

Csfe 6001 Computer Graphics (2+1)

Objective

To acquaint and equip the students with the under lined concepts for generating various geometrical shapes and processing them.

Theory

UNIT I

Graphic display devices, Interactive devices, Line and circle plotting techniques by using Bresenham's algorithm, Windowing and clipping,Sutherland Cophen 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 Readings

1. Hearn Donald.1996. *Computer Graphics*. PHI.
2. Schaum. Series. 2004. *Computer Graphics*. TMH.

Eefe 6001 Applied Instrumentation (2+1)

Objective

To acquaint and equip the students with various types of transducers for study and analysis of various variables.

Theory

UNIT I

Basic instrumentation systems and transducer principles. Displacement Transducers: Potentiometer, LVDT, Piezoelectric and capacitive transducers. Digital Transducers. Velocity transducers – Analog and Digital.

UNIT II

Acceleration and absolute motion measurement. Force transducer- Strain Gauge, Hydraulic load cell, Cantilever type and Probing ring. Method of separation of force – Torque, Power and energy measuring techniques.

UNIT III

Temperature measurement using Bi-metals, PTRs, Thermistors,Thermocouples, Electronic IC sensors and Pyrometers. Heat flux measurement. Humidity measurement – Dry and Wet bulb, Hair hygrometer and Humister. Soil and Grain moisture transducers, pressure measurement – Manometers, Bourdon Tube, Diaphragm type transducer.High pressure and vacuum sensing techniques.

UNIT IV

Flow transducers, Positive displacement, venturimeter, Rotameter, Drag force, Ultrasonic, Electromagnetic, Hot wire anemometers. Time and frequency measurement.

UNIT V

Level measurement, OD and pH measurement, PCO2 and grain quality measurement. Biomedical measurement – BP, ECG etc., Ultrasonic flaw detection, Spectroscopy.

Practical

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

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

Suggested Readings

1. Doebelin EO.1990. *Measurement Systems Applications and Design*. Tata McGraw Hill.
2. Nakra BC &Chaudhary KK. 2004. *Instrumentation Measurement and Analysis*. Tata McGraw Hill.
3. Sawhney AK. 2008. *Electrical and Electronics Measurement and Instrumentation*. Dhanpat Rai & Sons.

Mefe 6001 Operational Research (2+1)

Objectives

To teach and impart improved management skills by applying management theories in real life, prepare a basic marketing plan, interpret financial statements.

Theory

UNIT I

Introduction to Operational Research - Understand the concepts of OR - Understand the importance of the use of OR application in decision -making environment such as in Resource allocation problems, Production planning problem, Capital Budgeting problem, Advertising ,Media selection, Network Optimization etc - Understand the Scope of OR - General Appreciation of Simulation Techniques in OR

UNIT II

Linear programming -Instructional Objectives- Acquire the skills to formulate LP problem - Identify feasible regions - Obtain Graphical Solutions- Identify unique, multiple solution and unbounded solution- Understand the terms of surplus variables, artificial variables, and pseudo objective function-Identify infeasibility -Graphical Method: Simplex method(2-Phase and Big M methods, etc)

UNIT III

Duality theory and Sensitivity Analysis -Instructional Objectives - Construct the dual problem related to a given primal LP problem-Identify the relationship between the solutions of

primal and dual-problem - Interpret the solutions of primal and solutions - Find the effect in the optimal solution due to the changes in the objective function, resource levels, introduction of new constraints and introduction of new variables.

UNIT IV

Transportation models (TP) -Instructional Objectives - Identify TP problem as an LP problem- Find the initial solution using North West Conner rule, Least Cost Method- Find optimal solution using Stepping Stone method, Modified -Distribution Method- Understand Assignment problem as a transportation model- Apply Hungarian method to solve assignment problem- The assignment model - Formulation as TP - The Hungarian method of solution

UNIT V

Network models -Instructional Objectives - Identify the situation in which minimum spanning tree algorithm can be used- Identify the situation in which shortest path algorithm can be used - Identify the situation in which maximal flow algorithm can be used - Draw network diagram- Analyze the network using Earliest Start Time(ES) Latest Start Time (LS) , Earliest Event Time(ET), Latest Event Time(LT) - Find the probability of completing the project - Identify the simple rules of crashing the projects with cost consideration- Minimal spanning tree problem - Shortest route problem- Maximal flow problem.

UNIT IV

Dynamic programming-Instructional Objectives- Identify the main features of a dynamical programming problem - Understand the recursive nature of computations in DP- Perform forward and backward recursion- Describe the cargo loading models, workforce size model, equipment replacement model, investment model and inventory model.

Practical

Practical Examples for linear programming- Solve General LP problems using two-phased and Big M methods- Graphical Method: Simplex method- Apply sensitivity analysis in practical applications - Transportation models- The assignment model- Identify critical path by calculating Total Float (TF) of each activity- Apply PERT using Optimistic, Most likely, pessimistic times of activities. Critical Path Method (CPM), Program Evaluation and Review Technique (PERT).

Suggested readings

1. Hamdy A. Taha (2002) -Operations Research (seventh edition) Prentice Hall of India Publisher,New Delhi.
2. Kanti Swarup, P.K Gupta, Man Mohan (1988) Operations Research (latest Edition) Sultan Chand& Sons educational publisher, New Delhi.
3. Rao S.S (1980) -Optimization theory and applications -Wiley Eastern Limited Publisher
4. Don.T Phillips, Ravindran A. and James J.Solberg 1986 - Operations Research Principles andPractice

Agfe 6001 Food Microbiology (2+1)

Objectives

This subject is aimed to develop an understanding among the students on various micro flora associated with food products and their beneficial role as well as deleterious effect on processed food products.

Theory

UNIT I

Introduction to Food Microbiology -Growth of Bacteria in Food -Factors influence the microbes in foods -use and types of microorganisms in the food industry - Food poisoning.

UNIT II

Microbiology of milk and milk products –meat, fish-poultry products- fruits and vegetable products and cereal products

UNIT III

Microbial spoilage of foods – food borne pathogens, food poisoning - detection and enumeration of microbes in foods and food poisoning food infection and intoxication. Concept, determination and importance of TDT, F, Z and D value; factors affecting the heat resistance of micro-organisms . Anti-microbial agents – physical and chemical agents – their mechanism of action

Practical

Study of the microbiological quality of milk by MBR test, Estimation of total microbial bacterial plate count of food sample by direct microscopic and SPC method .Estimation of total microbial count of yeast and mould, Estimation of total microbial count of milk products, fruits and vegetable products ,meat, fish and poultry products and canned foods .

Suggested readings

1. Essentials of Microbiology by KS Bilgrami; CBS
2. Food Microbilogy by WC Frazier; Tata McGraw Hill
3. Modern Food Microbilogy by James M Jay; CBS
4. Basic Food Microbilogy: Bannett , Chapman and Hall
5. Food Microbiology by M.R. Adams

Agfe 6002 Storage Entomology (2+0)

Objective

UNIT I

Study of important pests of stored products and their identification. Detection and estimation of infestation. Studies on the development of infestation of important storage pests in different commodities of processed food and at different physical conditions. Estimation of field carry over damage in cereals, pulses, sorghum and pre-harvest spray influence on damage in storage

UNIT II

Production of activated clay, management of stored product pests with activated clay - Gadgets used for management of storage insects - scientific storage structures. Use of insecticides, botanicals and their application procedures in storage insect pest management. IPM in warehouses - collection and submission of stored product pests. Visit to warehouses and storage godowns.

Suggested readings

1. Cotton, R.T. 1963. Insect pests of stored grain and grain products. Identification, habits and methods of control. Burges publication.

2. Harris, K.L. and C.J. Lindbald. 1978. Post harvest grain loss assessment methods - American Association of cereal chemicals.
3. Khare, B.P. 1994. Stored grain pests and their management. Kalyani Publishers, New Delhi.
4. Munro, J.N. 1966. Pests of stored food products, Hutchinson and Co. Ltd., London.
5. Snelson, J.T. 1987. Grain protectants. Australian centre for International Agricultural Research, Canberra,
6. Slough, T.D.R.J. 1988. Insects and Arachnids of Tropical stored products, their biology and identification (A. Training manual)
7. Zakladnoi, G.A. and V.P. Ratanova. 1987. Stored grain pests and their control. Oxonian press Pvt Ltd., New Delhi.

Agfe 6003 Post Harvest Physiology (2+0)

Objective

To acquaint with the preharvest and postharvest physiology of horticultural crops, environmental factors affecting quality, the technology for quality inspection and preservation for high quality products.

Theory

UNIT I

Post harvest handling of fruits and vegetables- maturity indices for harvesting and ripening- pre cooling-various types of storage -ventilated, refrigerated, MAS, CA storage, physical injuries and disorders. Cold chain management

UNIT II

Physiology and biochemistry of fruit ripening and storage, ethylene evolution and ethylene management, prestorage treatments for quality retention and regulation of ripening using chemicals, and growth regulators.

UNIT III

Treatments prior to shipment, viz., chlorination, waxing, chemicals, biocontrol agents and natural plant products. Grading, packing and transportation.

UNIT IV

Principles and methods of preservation, food processing, canning, fruit juices, beverages, pickles, jam, jellies and candies. Dried and dehydrated products, nutritionally enriched products, fermented fruit beverages, processing waste management, food safety standards

UNIT V

Importance of handling, maturity, types of storages, containers, pre-cooling ,transport ,export and physiology of cut and loose flowers –primary and secondary processing-national and international cut flower trade and standards-refer chain and cool chain management –transport and export norms.

Suggested readings

1. Cruesss WV. 2000. *Commercial Fruit and Vegetable Products*. Agrobios.
2. Mircea Enachesca Danthy. 1997. *Fruit and Vegetable Processing*. International Book Publ.
3. Srivastava RP & Sanjeev Kumar. 1994. *Fruit and Vegetable Preservation*. *Principles and Practices*. International Book Distr.
4. Sumanbhatti & Uma Varma. 1995. *Fruit and Vegetable Processing*. CBS.
5. Sudheer.K.P. andV.Indira. 2007. *Post harvest Technology of Horticultural Crops*. New India Publishing house, Pitampura, New Delhi, India
6. Thompson AK. 1996. Post Harvest Technology of Fruits and Vegetables. Blackwell.
7. Verma LR & Joshi VK. 2000. Post Harvest Technology of Fruits and Vegetables. Vols. I ,II. Indus Publ.