Department of Agricultural Engineering

Course curriculum

M.Tech. Agricultural Engineering (Process and Food Engineering)

S. No.	Course No.	Course Title	Credit	Sub-total		
Core Courses major						
1	PFE-506	Processing of Cereals, Pulses and oilseeds	3(2-0-1)			
2	PFE-508	Fruits and Vegetables Process	3(2-0-1) 3(2-0-1)			
2.	112 500	Engineering	5(2 0 1)			
3.	PFE-503	Advanced Food Process Engineering	3(2-0-1)			
4.	PFE-512	Farm Structures and Environmental	2(1-0-1)			
		Control	_(1 0 1)	20		
5.	PFE 501	Transport Phenomena in Food Processing	3(2-0-1)			
6.	PFE-504	Unit Operation in Food Process	3(2-0-1)			
		Engineering	· · · ·			
7.	PFE-502	Engineering Properties of Food Materials	3(2-0-1)			
Core co	urses- minor		· · · ·			
8.	FMPE 512	Agro-Energy Audit and Management	2(2+0)			
9.	FMPE 513	Design and Analysis of Renewable	3(3+0)			
		Energy Conversion Systems		09		
10.	FMPE 601	Advances in Farm Machinery and Power	4(3+1)			
		Engineering				
Basic Su	pporting Cou	rses	1	1		
11.	MCA-502	Introduction to Networking and Internet	2(1-0-1)			
		application		06		
12.	BPS 661	Experimental Statistics	4(3-0-1)			
Semina	ſ					
13.	PFE-591	Master Seminar	1	01		
Non-cre	dit Compulso	ry courses				
14.	PGS-501	Library and information Services	1			
15.	PGS-502	Technical writing and communication	1			
1.6		skills				
16.	PGS-503	Intellectual property and its management	1	06		
17	DCG 504	in agriculture	1	VO		
1/.	PGS-504	Basic concepts in laboratory techniques	1			
18.	PGS-505	Agriculture research, research ethics and	1			
10		rural development	1			
19. Thesia I	PUS-300	Disaster Management	1			
1110315 Nessearch 20 20 20 DEE 500 Master Bassarch 20						
20.	ггс-зуу	WIASIEI KESEAICII	20	<u> </u>		
		Total	1	04		

Semester wise course curriculum

M.Tech. Agricultural Engineering (Process and Food Engineering)

Semester	Course code	Courses offered	Credit hr(s)
	PFE-506	Processing of Cereals, Pulses and oilseeds	3(2-0-1)
	PFE-508	Fruits and Vegetables Process Engineering	3(2-0-1)
Ι	I FMPE 512 Agro-Energy Audit and Management		2(2-0-0)
	MCA-502	Introduction to Networking and Internet application	2(1-0-1)
	PGS-504 Basic concepts in laboratory techniques		1
	PGS-506	Disaster Management	1
	PGS-505	Agriculture research, research ethics and rural development	1
	PGS-501	Library and information Services	1
	PGS-503	Intellectual property and its management in agriculture	1
	PFE-512	Farm Structures and Environmental Control	2(1-0-1)
II	PFE 501	Transport Phenomena in Food Processing	3(2-0-1)
	PFE-503	Advanced Food Process Engineering	3(2-0-1)
	FMPE 513	Design and Analysis of Renewable Energy Conversion Systems	3(3-0-0)
	PGS-502	Technical writing and communication skills	1
III	PFE-502	Engineering Properties of Food Materials	3(2-0-1)
	FMPE 601	Advances in Farm Machinery and Power Engineering	4(3-0-1)
	BPS -661	Experimental Statistics	4(3-0-1)
	PFE-591	Seminar	1
	PFE-599	Master Research	5
IV	PFE-504 Unit Operations in Food Process Engineering		3(2-0-1)
	PFE-599	Master Research	15
		Total credits	62

Core course syllabus

PFE-501 Transport phenomena in food processing 3(2-0-1)

UNIT I: Introduction to heat and mass transfer and their analogous behaviour, steady and unsteady state heat conduction, analytical and numerical solution of unsteady state heat conduction equations, use of Gurnie-Lurie and Heisler Charts in solving heat conduction problems. Applications in food processing including freezing and thawing of foods.

UNIT II: Convective heat transfer in food processing systems involving laminar and turbulent flow heat transfer in boiling liquids, heat transfer between fluids and solid foods. Functional design of heat exchangers: Shell and tube, plate and scraped surface heat exchangers, Jacketed vessels.

UNIT III : Radiation heat transfer and its governing laws, its applications in food processing.

UNIT IV: Molecular diffusion in gases, liquids and solids; molecular diffusion in biological solutions and suspensions molecular diffusion in solids, unsteady state mass transfer and mass transfer coefficients, molecular diffusion with convection and chemical reaction, diffusion of gases in porous solids and capillaries, mass transfer applications in food processing.

Practical: Solving problems on steady and unsteady state conduction with or without generation; numerical analysis; problems in natural and forced convection; radiation; design of heat exchangers; performing experiments on heat conduction, convection and radiation heat transfer.

PFE-502 Engineering properties of food materials 3(2-0-1)

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 states of materials, classical ideal material, rheological models and equations, visco- elasticity, 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: Experiments for the 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.

PFE-503Advanced food process engineering3(2-0-1)

UNIT I: Thermal processing: Death rate kinetics, thermal process calculations, methods of sterilization and equipments involved, latest trends in thermal processing. Evaporation: Properties of liquids, heat and. mass balance in single effect and multiple effect evaporator, aroma recovery, equipments and applications. Drying: Rates, equipments for solid, liquid and semi-solid material and their applications, theories of drying, novel dehydration techniques.

UNIT II: Non-thermal processing: Microwave, irradiation, ohmic heating, pulsed electric field preservation, hydrostatic pressure technique etc.

UNIT III: Freezing: Freezing curves, thermodynamics, freezing time calculations, equipments, freeze drying, principle, equipments. Separation: Mechanical filtration, membrane separation, centrifugation, principles, equipments and applications, latest developments in separation and novel separation techniques.

UNIT IV: Extrusion: Theory, equipments, applications. Distillation and leaching: Phase equilibria, multistage calculations, equipments, solvent extraction.

Practical: Solving problems on single and multiple effect evaporator, distillation, crystallization, extraction, leaching, membrane separation and mixing, experiments on rotary flash evaporator, humidifiers, reverse osmosis and ultra filtration - design of plate and packed tower, visit to related food industry.

PFE-504Unit operation in food process engineering3(2-0-1)

UNIT I: Review of basic engineering mathematics; Units and dimensions; Mass and energy balance.

UNIT II: Principles of fluid flow, methods of heat transfer, heat exchangers and their designs.

UNIT III: Psychrometry, dehydration, EMC, Thermal processing operations; Evaporation, dehydration/drying, types of dryers, blanching, pasteurization, distillation, steam requirements in food processing.

UNIT IV: Refrigeration principles and Food freezing. Mechanical separation techniques, size separation equipments; Filtration, sieving, centrifugation, sedimentation. Material handling equipment, conveyors and elevators; Size reduction processes; Grinding and milling.

UNIT V: Homogenization; Mixing- mixers, kneaders and blenders. Extrusion. Membrane technology. Non-thermal processing techniques.

UNIT VI: Food plant design; Food plant hygiene- cleaning, sterilizing, waste disposal methods, engineering aspects of radiation processing. Food packaging: Function materials, technique, machinery and equipment.

Practical: Fluid flow properties, study of heat exchangers problems, application of psychrometric chart, determination of EMC, study of driers, elevating and conveying equipments, size reduction equipments, cleaning and sorting equipments, mixing equipments, sieve analysis, kinetics of fruits and vegetables dehydration, calculation of refrigeration load, food plant design, gas and water transmission rate, solving of numerical problems.

PFE-506 Processing of cereals, pulses and oil seeds 3(2-0-1)

UNIT I: Production and utilization of cereals and pulses, grain structure of major cereals, pulses and oilseeds and their milling fractions; grain quality standards and physico-chemical methods for evaluation of quality of flours.

UNIT II: Pre-milling treatments and their effects on milling quality; parboiling and drying, conventional, modern and integrated rice milling operations; wheat roller flour milling; processes for milling of corn, oats, barley, gram, pulses, paddy and flour milling equipments.

UNIT III: Dal mills, handling and storage of by-products and their utilization. Storage of milled products, Expeller and solvent extraction processing, assessment of processed product quality.

UNIT IV: Packaging of processed products, design characteristics of milling equipments; selection, installation and their performance, BIS standards for various processed products.

Practical: Physical properties of cereals and pulses, raw and milled products quality evaluations; parboiling and drying; terminal velocities of grains and their fractions; study of paddy, wheat, pulses and oilseeds milling equipments; planning and layout of various milling plants, visit to related agro- processing industry.

PFE-508 Fruits and Vegetables Process Engineering 3(2-0-1)

UNIT I: Importance of post harvest technology of fruits and vegetables, structure, cellular components, composition and nutritive value of fruits and vegetables, fruit ripening, spoilage of fruits and vegetables.

UNIT II: Harvesting and washing, pre-cooling, preservation of fruits and vegetables, blanching, commercial canning of fruits and vegetables, minimal processing of fruits and vegetables.

UNIT III: Cold storage of fruits and vegetables, controlled atmosphere packaging of fruits and vegetables, gas composition, quality of storage.

UNIT IV: Dehydration of fruits and vegetables, methods, osmotic dehydration, foam mat drying, freeze drying, microwave heating, applications, radiation preservation of fruits and vegetables, irradiation sources.

UNIT V: Intermediate moisture foods, ohmic heating principle, high pressure processing of fruits and vegetables, applications, sensory evaluation of fruit and vegetable products, packaging technology for fruits and vegetables, general principles of quality standards and control, FPO, quality attributes.

Practical: Determination of size, shape, density, area-volume-mass relationship of fruits and vegetables, sugar-acid ratio of fruits, evaluation of washer, grader and packaging methods, experiments on drying of fruits and vegetables, controlled atmosphere storage and quality evaluation.

PFE-512 Farm structures and environmental control 2(1-0-1)

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.

UNIT IV: 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.

Minor Package Syllabus

FMPE 512 Agro-Energy Audit and Management 2(2+0)

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.

FMPE 513 Design and Analysis of Renewable Energy Conversion Systems 3(3+0)

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.

- 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.

FMPE 601 Advances in Farm Machinery and Power Engineering

4(3+1)

Theory

UNIT I: Farm machinery system, its characteristics and evaluation. Identification of dynamic characteristics of related components of engine and agricultural machines. Mechanism of dynamic elements and analysis of forces, displacement and their equilibrium in machines.

UNIT II: Statement and formulation of design problems. Computer-aided design of mechanical power transmission systems. Half interval search method. Single and double-tie-rod steering systems, development of mathematical models and its computer-aided solutions.

UNIT III: Analysis of forces in tractor implement combinations under two and three dimensional conditions. Vibrations, transmissibility and effect of damping on various agricultural machine systems like engine, cutter-bar, straw walker, threshing cylinder and reaper-binder.

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

Practical

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

- 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.

Non-Credits Course content

PGS 501 LIBRARY AND INFORMATION SERVICES

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 information search.

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 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.

0+1

PGS 503 INTELLECTUAL PROPERTY AND ITS (e-Course) MANAGEMENT IN AGRICULTURE

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

Suggested Readings

- Erbisch FH & Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.
- Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.
- Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC & 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, sandbath, waterbath, oilbath; Electric wiring and earthing. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy

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

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

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 global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

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

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

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 (e-Course)

1+0

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.

Department of Agricultural Engineering

Course Curriculum

S. No.	Course No.	Course Title	Credit hrs	Sub total	
(A) Core Courses-major					
1	PFE-513	Storage Engineering and Handling of Agricultural Products	3(2-0-1)		
2	PFE - 601	Textural and Rheological Characteristics of Food materials	3(2-0-1)		
3	PFE - 602	Advances in Food Processing	3(2-0-1)	15	
4	PFE - 604	Advances in Drying of Food Materials	3(2-0-1)		
5	PFE-605	Agricultural Waste and By-Products Utilization	3(2-0-1)		
(B) (Core courses- n	ninor			
6	FMPE 503	Testing and Evaluation of Tractors and Farm Equipments	3(2-0-1)	08	
7	FMPE 510	Ergonomics and Safety in Farm Operations	3(2-0-1)		
8	FMPE 603	Energy Conservation and Management in Farm Machinery and Power Engineering	2(2-0-0)		
(C)	Basic Supporti	ng Courses	•	•	
9	STAT-512	Experimental Designs	3(2-0-1)	06	
10	STAT 513	Statistical Methods for Social Sciences	3(2-0-1)		
(D)	Non credits con	npulsory Courses			
11	PGS-501	Library And Information Service	1(0-0-1)		
12	PGS-502	Technical writing and communication skills	1(0-0-1)		
13	PGS-503	Intellectual property and its management in agriculture	1(1-0-0)	06	
14	PGS-504	Basic concepts in laboratory techniques	1(0-0-1)		
15	PGS-505	Agricultural research, research ethics and rural development	1(1-0-0)		
16	PGS-506	Disaster management	1(1-0-0)		
(E) Seminar					
17	PFE-691	Doctoral Seminar -1	1	02	
18	PFE-692	Doctoral Seminar – II	1		
(F) Thesis Research					
19	PFE-699	Doctoral Research	45	45	
TOTAL (Credit Hours)				82	

Degree: Ph.D. Agricultural Engineering (Process and Food Engineering)

New course implemented July 2021-22.

Semester	Course	Courses offered	Credit hr (s)
	code		
	PFE 513	Storage Engineering and Handling of Agricultural	3(2-0-1)
Ι		Products	
	PFE 605	Agricultural Waste and Byproduct Utilization	3(2-0-1)
	STAT 512	Experimental Design	3(2-0-1)
	FMPE 603	Energy Conservation and Management in Farm	2(2-0-0)
		Machinery and Power Engineering	
	PGS-504	Basic concepts in laboratory techniques	1
	PGS-506	Disaster Management	1
	PGS-505	Agriculture research, research ethics and rural	1
		development	
	PGS-501	Library and information Services	1
	PGS-503	Intellectual property and its management in	1
		agriculture	
	PFE 604	Advances in Drying of Food Materials	3(2-0-1)
11	PFE 601	Textural and Rheological characteristics of Food	3(2-0-1)
		Materials	
	FMPE 503	Testing and Evaluation of Tractors and Farm Equipment	3(2-0-1)
	FMPE 510	Ergonomics and Safety in Farm Operations	3(2-0-1)
	PGS-502	Technical writing and communication skills	1
III	PFE 602	Advances in Food Processing	3(3-0-0)
	STAT 513	Statistical Methods for Social Sciences	3(2-0-1)
IV	PFE 691	Doctoral Seminar I	1
	PFE 699	Doctoral Research	15
V	PFE 692	Doctoral Seminar II	1
	PFE 699	Doctoral Research	15
VI	PFE 699	Doctoral Research	15
		Total Credits	82

Ph.D. Agricultural Engineering (Process and Food Engineering) degree program

Course Content (Ph.D.) Agric. Engg.

Core Courses-major syllabus

PFE-513: Storage Engineering and Handling of Agricultural Products 3(2-0-1)

UNIT I: Storage of grains, biochemical changes during storage, production, distribution and storage capacity estimate models, storage capacity models, ecology, storage factors affecting losses, storage requirements.

UNIT II: Bag and bulk storage, godowns, bins and silos, rat proof godowns and rodent control, method of stacking, preventive method, bio-engineering properties of stored products, function, structural and thermal design of structures, aeration system.

UNIT III: Grain markets, cold storage, controlled and modified atmosphere storage, effects of nitrogen, oxygen, and carbon dioxide on storage of durable and perishable commodities, irradiation, storage of dehydrated products, food spoilage and preservation, BIS standards.

UNIT IV: Physical factors influencing flow characteristics, mechanics of bulk solids, flow through hoppers, openings and ducts; design of belt, chain, screw, roller, pneumatic conveyors and bucket elevators; principles of fluidization; recent advances in handling of food materials.

Practical: Quality evaluation of stored products, design of storage structures, cold storage, load estimation, construction, maintenance, static pressure drop, experiment on controlled and modified atmosphere storage system, estimation of storage loss, and quality of stored products.

PFE – 601 Textural and Rheological Characteristics of Food materials 3(2-0-1)

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.

PFE – 602 Advances in Food Processing

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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.

PFE – 604 Advances in Drying of Food Materials

1)

UNIT I: Importance of drying, principles of drying, moisture determination, equilibrium moisture content, determination of EMC, methods and isotherm models, psychrometry, psychrometric terms, construction and use of psychrometric charts.

UNIT II: Air flow and resistance, principles and equipments for air movement and heating, drying methods and theory of drying, driers, classification and other allied

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3(2-0-

equipment, thin layer drying of cereal grains, deep bed and continuous flow drying, drying models.

UNIT III: 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, microwave drying, radio frequency drying and tunnel drying, principles and equipment.

UNIT IV: Drying of liquid foods, spray drying, drum drying, freeze drying, foam mat drying, heat pump drying, osmotic dehydration; Principles, methods, construction and adjustments, selection of dryers, heat utilization factor and thermal efficiency.

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 and osmotic dehydration, to evaluate the thermal efficiency and heat utilization factor.

PFE-605 Agricultural Waste and By-Products Utilization 3(2-0-1)

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

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

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

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.

Core courses- minor

from Farm Machinery and Power Engg.

FMPE 503Testing and Evaluation of Tractors and Farm Equipment3(2+1)

Theory

UNIT I: Types of tests; test procedure, national and international codes.

UNIT II: Test equipment; usage and limitations. Power losses in dynamometers and hydraulic test equipment.

UNIT III: Prototype feasibility testing and field evaluation. Laboratory and field testing of selected farm equipment. Non-destructive testing techniques.

UNIT IV: Tractor performance testing, evaluation and interpretation of results.

UNIT V: Review and interpretation of test reports. Case studies.

Practical

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

Suggested 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.

FMPE 510 Ergonomics and Safety in Farm Operations

3

(2+1)

Theory

UNIT I: Concept and design criteria for optimum mutual adjustment of man and his work: Importance of ergonomics and its application in agriculture, liberation and transfer of energy in human body, concept of indirect calorimeter, work physiology in various agricultural tasks.

UNIT II: Physiological stress indices and their methods of measurement: Mechanical efficiency of work, fatigue and shift work.

UNIT III: Anthropometry and Biomechanics: Anthropometric data and measurement techniques, joint movement and method of measurement, analysis and application of anthropometric data, measurement of physical and mental capacities.

UNIT IV: Human limitations in relation to stresses and demands of working environments. Mechanical environment; noise and vibration and their physiological effects, thermal environment; heat stress, thermal comfort, effect on performance and behavior, field of vision, color discrimination, general guidelines for designing visual display, safety standards at work

place during various farm operations and natural hazards on the farm. Farm safety legislation.

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

Practical

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

- 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.

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

Theory

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

UNIT II: Energy conservation through proper management and maintenance of farm machinery, planning and management of agricultural production systems for energy conservation and energy returns assessment.

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

Suggested Readings

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

Non-Credits Course content

0+1

PGS 501 LIBRARY AND INFORMATION SERVICES

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 information search.

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 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.

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

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

- 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, sandbath, waterbath, oilbath; Electric wiring and earthing. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy

Suggested Readings

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

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

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 global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

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

UNIT III: Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural

Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes. **Suggested 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 (e-Course)

1+0

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.

Dr. Suresh Chandra Associate Professor Deptt. of Agric. Engg. Dated of prepared; 25.07.2022