Post Graduate Curricula and Syllabi 2009

M Tech (Agricultural Engineering)

Specialisations

Farm Machinery and Energy
Agricultural Processing & Food Engineering
Soil and Water engineering

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(A constituent college of Kerala Agricultural University)

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PREAMBLE

The country is on the threshold of a second "Green Revolution" but this time around, the emphasis is not merely on food production and food security, but also on the "Green Energy" imperatives .To lead this two-pronged 2nd green revolution from the front, various organization under the central and state governments are gearing up and busy drawing up a road map, as it were, about the tasks ahead, in the coming years. What is more the Central Government has announced its intention to pass the Rights to food act in the parliament which makes the food production imperatives all the more important.

As per a report prepared by the US based **I**nternational **F**ood **P**olicy **R**esearch **I**nstitute **(IFPRI)** in collaboration with **Concern Worldwide, California**, it reads as follows: *"when Indian states are compared to countries in the 2008 Global Hunger Index, Madhya Pradesh ranks between Ethiopia and Chad. Punjab, the best performing state is below Gabon, Honduras and Vietnam"*. The country-report released in India on the eve of the World Food Day, by the Prime Minister's Economic Advisor G.K.Chadha has put a seal of approval on the finding of IFPRI which should serve to regard these 2 reports as sort of wake-up call to make the agriculturists to spring into action from what is an apparent slumber. Again when the **I**ndia **S**tate **H**unger **I**ndex **(ISHI)** makes the startling revelation that, *"India is home to the world's largest food insecure population, with more than 200 million people who are hungry",* the task set by the government to pass the Rights to Food Act appears to be none too an easy task.

To add to the daunting task before the country are the other challenges like climate change and economic recession. While climate change induced alternating spells of heavy rainfall and drought had driven the farmers to the verge of suicide, economic meltdown had simultaneously put a heavy constraint on the finances so much so that many of them had for some time thought of abandoning farming altogether , as a vocation. It has been estimated by Project -Green an initiative of The Energy and Resourses Institute (TERI) that there is close to 24 million hectares of cultivable fallow land that is lying unutilized. In Andhra Pradesh, particularly in the eastern Godavari belt there is an initiative to use such fallow land for Jatropha-farming for production of bio fuel, which in turn will go long way towards demonstrating, how Green revolution can go hand in hand with, and green energy initiative. From green revolution, to green energy and then to green jobs: that is the current concept which can also beat recession- induced job loss.

For boosting agricultural out put, we have to bank on innovative agricultural methods on a never before scale touching upon a wide spectrum of activities from pre-farming technologies to post harvest technologies. There is also a necessity to place a premium on value-addition and cutting edge technologies. We see technology at work when, Norway

created a Noah's Arch like seed vault near the North Pole which is intended to serve as a safety net for food security in an era of anthropogenic climate change. Like wise modern science and technology have placed a number of technologies-tools at the disposal of the agro technologists one of which is Recombinant DNA technology by which novel genetic combinations can be created. Development of salinity-tolerant seeds and transgenic rice strains pronvides opportunities to grow crops in deep water as well as flood prone Indo-Gangetic plain. At the other side of the globe, research is progressing towards using even sea water for cultivation in what is called Sahara Project of Solar Farming where sea water evaporators are used for pumping damp cool air, through the Green house, which project has met with immense success.

The practical applications of Agricultural engineering and technology studies have to percolate to the level of farmers. This will be possible only if the under graduates and post graduates who are supposed to impart training to the farmers are themselves in the first place, sufficiently trained in agro-engineering areas and keep themselves abreast of advancements in science and technology, which in turn calls for an overhaul of the present educational system in terms syllabi & curricular reforms at the university level

It has to be seen that it is reform time for syllabus all over the country. The syllabus and curriculum of the M.Tech course in Agricultural Engineering stream was stuck in a time warp as the current syllabus dates back to the late seventies. There has been no revision thereafter. Higher Education in Kerala is admittedly in a state of flux. With a view to fine tuning the higher education and bringing about curricular reforms a new education policy is taking shape under the aegis of the Kerala State Higher Education Council. Likewise, the National Knowledge commission under Sam Pitroda and the Committee to Advise on Innovation and Rejuvenation of Higher Education in India, under Prof.Yash Pal, have all kick started a serious thinking about the quality makeover to the higher-end Engineering education. All these together seek to give

P.G .engineering education a curricular architecture and a depth and breadth hitherto absent. The thrust is to infuse the much needed quality into teaching of engineering courses. The necessity for syllabi revision is more especially when some of the premier Educational Institutions in the country have since taken rapid strides in this direction, and are now toying with the idea of introducing the Open Courseware, with accent on Technology Enabled Learning, on the model popularized by the Massachusetts Institute of Technology, USA.

Kerala Agricultural University has taken up curricular reform as its main task. It seeks to create curricular framework based on the principles of mobility within the full range of curricular areas and integration of skills with academic depth. It is in the frontier technology areas such as Energy, soil and water etc where the KAU is running its present

PG engineering courses. As the knowledge Commission rightly puts it, our effort is to promote niche skills required in industry and to increase the hands on work experience, at all levels, in keeping with “Global vision training”

While undertaking to revise the M.Tech syllabus, the ICAR which did it first , had gone into all aspects, based on a precise taxonomy and the KCAET under the KAU proposes to follow entirely the ICAR pattern without any change, as it is prepared after utmost circumspection . It is hoped that by adopting the ICAR Syllabus, the high academic standard and uniformity of P.G, Education in Agricultural Engineering will be fully achieved.

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EXECUTIVE SUMMARY

In the context of various cross currents at play in the agricultural sector gaining sway and the winds of change let loose by Globalization, climate change, the world trade agreement and the economic recession, all converging as a cascading force and sweeping all over the agricultural front and the imponderables reaching the flash point, the scene emerging from the farm front is one of despair. While the government is making all out effort for a resurgence and to boost agricultural growth by placing cheap credit, subsidized fertilizer inputs and other supports at the disposal of the farmers, much remains to be done. Since the question of increasing the farm output is closely connected with better farming practices coupled with technology support right from the time of sowing seeds to the time of harvesting, the role of agricultural technologists and Engineers comes into sharp focus and is of paramount importance. There is an urgent need to develop appropriate cost effective technology commensurate with the varying needs of the farmers. This will be possible only if the graduates and post graduates in the field of Agricultural engineering are themselves adequately exposed to the latest strides and advancements in technology. On the other hand the farmers have to take technology in their stride, as the only way to progress is innovation. It is in this context, the revision of syllabi in engineering subjects, assumes an unprecedented importance. Obsolete technology has to be inevitably replaced by current cutting edge technology which is the overriding priority at the moment and this has to be reflected in the syllabus.

The revised syllabus for the P.G course proposed here for follow-up, in the faculty of Agricultural Engineering is an exact replica or reproduction of the ICAR syllabus as it is the collective view of the various departments in KCAET that the ICAR syllabus takes care of all current and futuristic requirements without losing sight of the Industry specific requirements, who constitutes one of the prominent stake holders, the other stake holders being, the society, the alumni, the recruits, the students and the government. Three, major specializations in Agricultural Engineering, as proposed by ICAR and concurred by us as ideal are as here under:

Farm Power Machinery & Energy

- Emphasis has been given on design of fuel efficient engines. For this a new course Fmpe 5001 Design of Farm Machinery & Power Systems at M. Tech. level has been incorporated.
- New courses Fmpe 5012 Agro-Energy Audit and Management has been added at M. Tech. level in Farm Machinery & Power Engineering keeping in view the course contents for NET examination conducted by ICAR.
- The existing contents have been examined critically, restructured and updated keeping in view the latest developments in the subject areas.

Processing and Food Engineering

- In Processing and Food Engineering emphasis has been given on food packaging; food quality & safety engineering; food processing equipments & plant design and energy management in food processing industries.
- Separate courses on processing of fruits & vegetables; meat; cereals; pulses and

oil seeds have been included in the curriculum.

- Emphasis has been given on value addition of agricultural waste and by-products.

Soil & Water Engineering

- In Soil and Water Engineering the emphasis has been given on GIS, remote sensing, precision irrigation, modeling management and accordingly new courses Swce 5011 GIS and Remote Sensing for Land and Water Resource Management at M.Tech level.
- The courses have been revised, updated and restructured in view of current developments and emerging trends in Soil and Water Engineering.

In addition

- A course Fpme/ Pafe/ Swce/ 5095 Industrial/Institute training of minimum of three weeks duration has been recommended as compulsory non credit course for exposure of students to demands and problems of industries.
- With a view to strengthen Industry-Institute/ Institute-Institute linkages it is recommended that research problems to P.G. students be given as per needs of the Institute/Industry as far as possible. This will go a long way for strengthening Research and Development Program.

Recommendations

- Evaluation as well as final viva-voice examination of Masters' Thesis should be external.
- The external element of examination having weightage of 50% of theory syllabi should be introduced for compulsory courses at post graduate level
- In view of inclusion of new emerging fields in the course contents, faculty should be deputed for training for appraisal of emerging trends.
- Every teacher should attend at least one training once in five years at national/international level.
- Industrial/Institute training of minimum of three weeks duration has been recommended as compulsory non credit course for industrial/Institute exposure to all Masters' Degree students.
- The contingencies for M.Tech. students provided by the ICAR should be earmarked department wise and it may be enhanced appropriately from time to time.
- At least 4-5 experts be identified as resource persons for each specialized course and contents and others details be got prepared from them. In addition E-courses and Web based courses be developed by them. It will help in maintaining uniformity as well as standard in the country.
- For strengthening Industry-Institute/Institute-Institute linkages research problems to P.G. students be given as per needs of the Institute/Industry as far as possible.

This will go a long way for strengthening Research and Development Program.

- Proper Research and Development Centers with suitable infrastructure and facilities need to be identified & strengthened at Industry & Institute level.
- Agricultural Engineering subject be included in Central Services Examinations.

ORGANIZATION OF COURSE CONTENTS & CREDIT REQUIREMENTS

Code Numbers

- All courses pertain to Master's level.
- Credit seminar for Master's level is designated by code no. 5091.
- Similarly, code 5099 has been given for Master's research.

Course Contents

The contents of each course have been organized into:

- Objective – to elucidate the basic purpose.
- Theory units – to facilitate uniform coverage of syllabus for paper setting.
- Suggested Readings – to recommend some standard books as reference material. This does not unequivocally exclude other such reference material that may be recommended according to the advancements and local requirements.

Minimum Credit Requirements

Subject	Master's Programme
Major	**20**
Minor	**09**
Supporting	**05**
Seminar	**01**
Research	**20**
Total Credits	**55**
Compulsory Non-credit Courses	**See relevant section**

Major subject: The subject (department) in which the students takes admission

Minor subject: The subject closely related to students major subject (e.g., if the major subject is Processing and Food Engineering, the appropriate minor subjects should be Farm power Machinery & Energy and Soil and Water Engineering).

Supporting subject: The subject not related to the major subject. It could be any subject considered relevant for student's research work.

Non-Credit Compulsory Courses: Please see the relevant section for details. Six courses (Ccpg 5001-Ccpg 5006) are of general nature and are compulsory for Master's programme.

FARM POWER MACHINERY AND ENERGY

Course Structure

CODE	COURSE TITLE	CREDITS
Fpme 5001*	DESIGN OF FARM POWER AND MACHINERY SYSTEMS	3+1
Fpme 5002*	SOIL DYNAMICS IN TILLAGE AND TRACTION	2+1
Fpme 5003*	TESTING AND EVALUATION OF TRACTORS AND FARM EQUIPMENT	2+1
Fpme 5004*	SYSTEM SIMULATION AND COMPUTER AIDED PROBLEM SOLVING IN ENGINEERING	2+1
Fpme 5005	APPLIED INSTRUMENTATION IN FARM MACHINERY AND STRESS ANALYSIS	2+1
Fpme 5006	SYSTEM ENGINEERING AND PRODUCTIVITY	2+1
Fpme 5007	FARM MACHINERY DYNAMICS NOISE & VIBRATION	3+1
Fpme 5008	TRACTOR DESIGN	2+1
Fpme 5009	OPERATIONS RESEARCH IN FARM POWER & MACHINERY MANAGEMENT	2+1
Fpme 5010	ERGONOMICS AND SAFETY IN FARM OPERATION	2+1
Fpme 5011	ENGINEERING PROPERTIES OF BIOLOGICAL MATERIALS	2+1
Fpme 5012	AGRO-ENERGY AUDIT AND MANAGEMENT	2+0
Fpme 5013	DESIGN AND ANALYSIS OF RENEWABLE ENERGY CONVERSION SYSTEMS	3+0
Fpme 5014	RESEARCH METHODOLOGY	0+1
Fpme 5091	MASTER'S SEMINAR	0+1
Fpme 5092	SPECIAL PROBLEM	0+1
Fpme 5095#	INDUSTRY/ INSTITUTE TRAINING	NC
Fpme 5099	MASTERS RESEARCH	0+20
	Total	**29+34**

*Compulsory for Master's programme;
FPM 5095 – Minimum of Three Weeks Training
Note: Some of the identified Minor/Supporting fields are Mechanical Engineering, Processing and Food Engineering, Energy in Agriculture, Civil Engineering, Computer Science, Electrical Engineering, Mathematics and Statistics; the contents of some of the identified Minor/Supporting courses have been given.

FARM POWER, MACHINERY AND ENERGY

Course Contents

Fpme 5001 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

1. Arther W Judge 1967. *High Speed Diesel Engines*. Chapman & Hall.
2. Barger EL, Liljedahl JB & McKibben EC 1967. *Tractors and their Power Units*. Wiley Eastern.
3. Bernacki C,Haman J & Kanafajski CZ.1972. *Agricultural Machines.*Oxford & IBH. Bindra OS & Singh Harcharan 1971.*Pesticides Application Equipments*. Oxford & IBH.
4. Bosoi ES, Verniaev OV & Sultan-Shakh EG. 1990. *Theory,Construction and Calculations of Agricultural Machinery.*Vol. I. Oxonian Press.
5. Klenin NI, Popov IF & Sakoon VA. 1987. *Agricultural Machines. Theory of Operations, Computing and Controlling Parameters and the Condition of Operation.* Amrind Publ.
6. Lal R & Dutta PC. 1979. *Agricultural Engineering* (through solved examples). Saroj Parkashan.
7. Maleev VL. 1945.Internal Combustion Engines. McGraw Hill.

8. Mathur ML & Sharma RP. 1988. A Course in Internal Combustion Engines. Dhanpat Rai & Sons.
9. Ralph Alcock.1986. Tractor Implements System. AVI Publ.
10. Raymond N, Yong Ezzat A & Nicolas Skiadas 1984. *Vehicle Traction Mechanics*. Elsevier.
11. Sharma PC & Aggarwal DK. 1989. *A Text Book of Machine Design*. Katson Publishing House.
12. *Theory and Construction*. Vol. I. U.S. Dept. of Commerce, National Technical Information Service, Springfield, Virginia.
13. Thornhill EW & Matthews GA. 1995. *Pesticide Application quipment for Use in Agriculture*. Vol. II. *Mechanically Powered Equipment*. FAO Rome.
14. William. R Gill & Glen E Vanden Berg. 1968. *oil Dynamics in Tillage and Traction*. US Govt. Printing Office, Washington, D.C.
15. Yatsuk EP.1981. *otary Soil Working Machines Construction, Calculation and Design*. American Publ. Co.

Fpme 5002 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

1. Daniel Hill. 1962. *Fundamentals of Soil Physics*. Academic Press.
2. Gill & Vandenberg.1968. *Soil Dynamics in Tillage and Traction*. Supdt. of Documents, U.S. Govt. Printing Office, Washington, D.C.
3. Sineokov GN. 1965. *Design of Soil Tillage Machines*. INSDOC, New Delhi.
4. Terzaghi K & Peck Ralph B.1967. *Soil Mechanics in Engineering Practices*. John Wiley & Sons.

Fpme 5003 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

1. Anonymous. 1983. *RNAM Test Code & Procedures for Farm Machinery*. Technical Series 12.
2. Barger EL, Liljedahl JB & McKibben EC. 1967.*Tractors and their Power Units*. Wiley Eastern.
3. *Indian Standard Codes for Agril. Implements*. Published by ISI, New Delhi.
4. Inns FM. 1986. *Selection, Testing and Evaluation of Agricultural Machines and Equipment*. FAO Service Bull. No. 115.
5. Lal R & Dutta PC. 1979. *Agricultural Engineering* (through solved examples). Saroj Parkashan,
6. 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.

7. 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 5004 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

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

7. Veerarajan T & Ramachnadran T. 2004. *Numerical Methods with Programmes in C and C++*. Tata McGraw Hill.
8. Wilks SS. 1962. *Mathematical Statistics*. John Wiley & Sons.

Fpme 5005 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, strain gauges. Mechanical, optical, electrical acoustical and pneumatic etc. and their use. Various methods of determining strain/stresses experimentally. Measuring devices for displacement (linear and rotational), velocity, force, torque and shaft power. Strain gauges: types and their application in two and three dimensional force measurement. Design and analysis of strain gauges.

UNIT II

Introduction to functional elements of instruments. Active and passive transducers, Analog and digital modes, Null and deflection methods. Performance characteristics of instruments including static and dynamic characteristics.

UNIT III

Devices for measurement of temperature, relative humidity, pressure, sound, vibration, flow etc. Recording devices and their type. Measuring instruments for calorific value of solid, liquid, and gaseous fuels. Measurement of gas composition using GLC.

UNIT IV

Basic signal conditioning devices -data acquisition system -micro computers for measurement and data acquisition. Data storage and their application.

Practical

Calibration of instruments, Experiment on LVDT, strain gauge transducer, inductive and capacitive pick ups, speed measurement using optical devices, vibration measurement exercises , making of thermocouples and their testing-basic electronic circuits and application of linear ICs.

Suggested Readings

1. Ambrosius EE. 1966. *Mechanical Measurement and Instruments*. The Ronald Press.
2. BeckwithTG. 1996. *Mechanical Measurements*. Addison-Wesley.
3. Doeblin EO. 1966. *Measurement System -Application and Design*. McGraw Hill.
4. Ernest O Doebelin.1995. *Measurement Systems -Application and Design*. McGraw Hill.

5. Holman P 1996. *Experimental Methods for Engineers*. McGraw Hill.
6. Nachtigal CL. 1990. *Instrumentation and Control. Fundamentals and Application*. John Wiley & Sons.
7. Oliver FJ. 1971. Practical; Instrumentation Transducers. Hayden Book Co.
8. Perry CC & Lissner HR.1962. *The Strain Gauge Primer*. McGraw Hill.

Fpme 5006 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

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

Fpme 5007 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

1. Ballaney PL. 1974. *Theory of Machines*. Khanna Publ.
2. Bosoi ESO, Verniaev V, Smirnov & Sultan-Shakh EG. 1990. *Theory,*

Construction and Calculations of Agricultural Machinery. Vol. I. Oxonian Press Pvt. Ltd. No.56.
3. Getzlaff GE. 1993. Comparative Studies on Standard Plough Body. Engineering Principles of Agricultural Machines. ASAE Text Book No. 6.
4. Grover GK. 1996. Mechanical Vibrations. New Chand & Bros., Roorkee.
5. Harris CM & Crede CE. 1976. Shock and Vibration Hand Book. McGraw Hill. Holowenko AR. 1967. Dynamics of Machinery. McGraw Hill.
6. Kelly SG. 2000. Fundamental of Mechanical Vibration. 2nd Ed. McGraw Hill.
7. Kepner RA, Bainer R & Berger EL. 1978. Principles of Farm Machinery. AVI Publ. Co.
8. Klenin NI, Popov IF & Sakoon VA. 1987. Agricultural Machines. Theory of Operations, Computing and Controlling Parameters and the Condition of Operation. Amrind Publ. Co.
9. Marples.1969. Dynamics of Machines. McGraw Hill.
10. Meirovitch L. 1986. *Elements of Vibration Analysis*. 2 Ed. McGraw Hill. Nartov PS. 1985. *Disc Soil Working Implements*. A. A. Balkema, Rotterdam. Srivastav AC. 2001. *Elements of Farm Machinery*. Oxford & IBH.
11. Steidal.1986. *Introduction to Mechanical Vibrations*. Wiley International & ELBS Ed.
12. William T Thomson. 1993. *Theory of Vibration with Application.* Prentice Hall.

Fpme 5008 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,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

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

3. Macmillan RH. TheMechanics of Tractor -Implement Performance, Theory and Worked Example. University of Melbourne.
4. Maleev VL. 1945. Internal Combustion Engines. McGraw Hill.
5. Ralph Alcock 1986. Tractor Implements System. AVI Publ. Co.

Fpme 5009 OPERATIONS RESEARCH IN FARM POWER & MACHINERY MANAGEMENT (2+1)

Objective

To acquaint and equip with the mechanization status in the country and management techniques for future requirements.

Theory

UNIT I

Nature, methods, impact and scope of operational research; linear programming and integer programming models and applications. Network terminology, shortest route and minimal spanning tree problems, maximal flow problem, project planning and control with PERT and CPM.

UNIT II

System approach in farm machinery management and application of programming techniques to the problems of farm power and machinery selection.

UNIT III

Maintenance and scheduling of operations. Replacement of old machines, repair and maintenance of agricultural machinery, inventory control of spare parts, work study, productivity, method study. First order Markov chains and their applications in sales forecasting and in problems of inventory control and modeling of workshop processes and quality control.

UNIT IV

Time and motion study. Man-machine task system in farm operations, planning of work system in agriculture. Computer application in selection of power units and to optimize mechanization system.

Practical

Management problems and case studies.

Suggested Readings

1. Carville LA. 1980. *Selecting Farm Machinery*. Louisiana Cooperative Extn. Service Publication.
2. Culpin C & Claude S.1950. *Farm Mechanization; Costs and Methods*. McGraw Hill.
3. Culpin C & Claude S. 1968. *Profitable Farm Mechanization*.
4. Crosby Lockwood & Sons. FAO.1984. *Agricultural Engineering in Development: Selection of Mechanization Inputs*. Agricultural Service Bulletin.
5. Hunt D. 1977. *Farm Power and Machinery Management*. Iowa State University

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

Fpme 5010 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 for operator, 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 for operator. 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

1. Bridger RS. 1995. *Introduction to Ergonomics*. McGraw Hill.
2. Charles D Reese. 2001. *Accident / Incident Prevention Techniques*. Taylor & Francis.

3. Gavriel Salvendy. 1997.*Hand Book of Human Factors and Ergonomics*. John Wiley & Sons.
4. Kromer KHE. 2001. *Ergonomics*. Prentice Hall.
5. Mathews J & Knight AA.1971. *Ergonomics in Agricultural Design*. National Institute of Agric. Engineering, Wrest Park Silsoe, Bedford.
6. Mathews J Sanders, Cormicks MS &MCEj. 1976. *Human Factors in Engineering and Design*. 4 Ed. McGraw Hill.
7. William D McArdle.1991. *Exercise Physiology*.1991.
8. Lea & Febiger. Zander J. 1972. *Principles of Ergonomics*. Elsevier. Zander J.1972. *Ergonomics in Machine Design.*Elsevier.

Fpme 5011 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, 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

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

1. Hallstrom B, Meffert HF, Th Spesis WEL & Vos G. 1983. *Physical Properties of Food*. Elsevier.
2. Mohesenin NN. 1980.*Physical Properties of Plant and Animal Materials*. Gordon & Breach Science Publ.
3. Mohesenin NN. 1980. *Thermal Properties of Foods and Agricultural Materials*. Gordon & Breach Science Publ.
4. Peleg M & Bagelay EB. 1983. *Physical Properties of Foods*. AVI Publ. Co.
5. Rao MA & Rizvi SSH. (Eds.). 1986. *Engineering Properties of Foods*. Marcel Dekker.
6. Ronal Jowitt, Felix Escher, Bengt Hallsrram, Hans F, Th. Meffert, Walter EC Spices & Gilbert Vox. 1983. *Physical Properties of Foods*. Applied Science Publ.
7. Singhal OP & Samuel DVK. 2003. *Engineering Properties of Biological Materials*. Saroj Prakasan.

Fpme 5012 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

1. Kennedy WJ Jr. & Wayne C Turner.1984. *Energy Management*. Prentice Hall. Pimental D. 1980. *Handbook of Energy Utilization in Agriculture*. CRC
2. Fluck RC & Baird CD.1984. *Agricultural Energetics*. AVI Publ.
3. Rai GD. 1998. *Non-conventional Sources of Energy*. Khanna Publ. Twindal JW & Anthony D Wier 1986. *Renwable Energy Sources*. E & F.N. Spon Ltd.
4. Verma SR, Mittal JP & Surendra Singh 1994. *Energy Management and Conservation in Agricultural Production and Food Processing*. USG Publ. & Distr., Ludhiana.

Fpme 5013 DESIGN AND ANALYSIS OF RENEWABLE ENERGY CONVERSION SYSTEMS (3+0)

Objective

To acquaint and equip with the conventional and non-conventional energy sources. Energy from 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

1. Boyle Godfrey. 1996. *Renewable Energy: Power for Sustainable Future*. Oxford Univ. Press.
2. Culp AW. 1991. *Principles of Energy Conservation*. Tata McGraw Hill.
3. Duffle JA & Beckman WA. 1991. *Solar Engineering of Thermal Processes*.
4. John Wiley. Garg HP & Prakash J.1997. *Solar Energy -Fundamental and Application*. Tata McGraw Hill.
5. Grewal NS, Ahluwalia S, Singh S & Singh G. 1997. *Hand Book of Biogas Technology. Solar Energy Fundamentals and Applications*. TMH New Delhi.
6. Mittal KM. 1985. *Biomass Systems: Principles & Applications*. New Age International.
7. Odum HT & Odum EC. 1976. Energy Basis for Man and Nature. Tata McGraw

Hill.
8. Rao SS & Parulekar BB.1999. Non-conventional, Renewable and Conventional . Khanna Publ.
9. Sukhatme SP.1997. Solar Energy -Principles of Thermal *Collection and Storage*. 2nd Ed. Tata McGraw Hill.

Fpme 5014 RESEARCH METHODOLOGY (0+1)

Practical

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

Suggested Readings

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

Fpme 5095 INDUSTRY / INSTITUTE TRAINING 0+1 (NC)

Objective

To expose the students to the industry.

Theory

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

FARM POWER MACHINERY AND ENERGY

List of Journals

• Journal of Agricultural Engineering, ISAE, New Delhi
• Journal of Arid Land Research Management
• Journal of Agricultural Engineering Research
Journal of Tropical Agriculture, KAU
• 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

Suggested Broad Topics for Master's 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
• Cotton pickers-for picking cotton balls
• Crop harvesters – for berseem
• 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

PROCESSING AND FOOD ENGINEERING

Course Structure

CODE	COURSE TITLE	CREDITS
Pafe 5001*	TRANSPORT PHENOMENA IN FOOD PROCESSING	2+1
Pafe 5002*	ENGINEERING PROPERTIES OF FOOD MATERIALS	2+1
Pafe 5003*	ADVANCED FOOD PROCESS ENGINEERING	2+1
Pafe 5004*	UNIT OPERATIONS IN FOOD PROCESS ENGINEERING	2+1
Pafe 5005	ENERGY MANAGEMENT IN FOOD PROCESSING INDUSTRIES	2+1
Pafe 5006	PROCESSING OF CEREALS, PULSES AND OILSEEDS	2+1
Pafe 5007	FOOD PROCESSING EQUIPMENT AND PLANT DESIGN	2+1
Pafe 5008	FRUITS AND VEGETABLES PROCESS ENGINEERING	2+1
Pafe 5009	MEAT PROCESSING	2+1
Pafe 5010	FOOD PACKAGING	2+1
Pafe 5011	FOOD QUALITY AND SAFETY ENGINEERING	2+1
Pafe 5012	FARM STRUCTURES AND ENVIRONMENTAL CONTROL	1+1
Pafe 5013	STORAGE ENGINEERING AND HANDLING OF AGRICULTURAL PRODUCTS	2+1
Pafe 5014	SEED DRYING, PROCESSING AND STORAGE	2+1
Pafe 5015	BIOCHEMICAL AND PROCESS ENGINEERING	2+1
Pafe -5016	ADVANCED FOOD & DAIRY ENGINEERING	2+1
Pafe 5091	MASTER'S SEMINAR	0+1
Pafe 5092	SPECIAL PROBLEM	0+1
Pafe 5095#	INDUSTRY/ INSTITUTE TRAINING	NC
Pafe 5099	MASTER'S RESEARCH	0+20
	Total	**31+38**

* Compulsory for Master's programme;
#Pafe 5095 – Minimum of Three Weeks Training
Note: Some of the identified Minor/Supporting fields are Mechanical Engineering, Farm power Machinery & Energy, Energy in Agriculture, Civil Engineering, Computer Science, Electrical Engineering, Mathematics and Statistics. The contents of some of the identified Minor/Supporting courses have been given.

PROCESSING AND FOOD ENGINEERING

Course Contents

Pafe 5001 TRANSPORT PHENOMENA IN FOOD PROCESSING (2+1)

Objective

To acquaint and equip the students with the principles of heat and mass transfer and its applications in food processing.

Theory

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, 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.

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.

Suggested Readings

1. Benjamin G. 1971. *Heat Transfer*. 2nd Ed. Tata McGraw Hill.
2. Coulson JM & Richardson JF. 1999. *Chemical Engineering*. Vol. II, IV.
3. The Pergamon Press. Earle RL. 1985. *Unit Operations in Food Processing*. Pergamon Press.
4. EcKert ERG & Draker McRobert 1975. *Heat and Mass Transfer*. McGrawHill.
5. Geankoplis J Christie 1999. *Transport Process and Unit Operations*. Allyn& Bacon.
6. Holman JP. 1992. *Heat Transfer*. McGraw Hill.
7. Kreith Frank. 1976. *Principles of Heat Transfer*. 3rd Ed. Harper & Row.
8. McCabe WL & Smith JC. 1999. *Unit Operations of Chemical Engineering*.

McGraw Hill.
9. Treybal RE. 1981. *Mass Transfer Operations*. McGraw Hill.
10. Warren Gredt H. 1987. *Principles of Engineering Heat Transfer*. Affiliated East-West Press.

Pafe 5002 ENGINEERING PROPERTIES OF FOOD MATERIALS (2+1)

Objective

To acquaint and equip the students with different techniques of measurement of engineering properties and their importance in the design of processing equipments.

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 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.

Suggested Readings

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

2. Mohesenin NN. 1980.*Physical Properties of Plant and Animal Materials*. Gordon & Breach Science Publ.
3. Mohesenin NN. 1980. *Thermal Properties of Foods and Agricultural Materials*. Gordon & Breach Science Publ.
4. Peleg M & Bagelay EB. 1983. *Physical Properties of Foods*. AVI Publ. Co.
5. Rao MA & Rizvi SSH. (Eds.). 1986. *Engineering Properties of Foods*. Marcel Dekker.
6. Ronal Jowitt, Felix Escher, Bengt Hallsrram, Hans F, Th. Meffert, Walter EC Spices & Gilbert Vox. 1983. *Physical Properties of Foods*. Applied Science Publ.
7. Singhal OP & Samuel DVK. 2003. *Engineering Properties of Biological Materials*. Saroj Prakasan.

Pafe 5003 ADVANCED FOOD PROCESS ENGINEERING (2+1)

Objective

To acquaint and equip the students with different unit operations of food industries and their design features.

Theory

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, crystallisation, 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.

Suggested Readings

1. Brennan JG, Butters JR, Cowell ND & Lilly AEI. 1990.*Food Engineering Operations*. Elsevier.

2. Coulson JM & Richardson JF. 1999. *Chemical Engineering*. VolS. II, IV.
3. The Pergamon Press.
4. Earle RL. 1985. *Unit Operations in Food Processing*. Pergamon Press.
5. Fellows P. 1988. *Food Processing Technology: Principle and Practice*. VCH Publ.
6. Geankoplis J Christie. 1999. *Transport Process and Unit Operations*. Allyn & Bacon.
7. Henderson S & Perry SM. 1976. *Agricultural Process Engineering*. 5th Ed. AVI Publ.
8. McCabe WL & Smith JC. 1999. *Unit Operations of Chemical Engineering*. McGraw Hill.
9. Sahay KM & Singh KK. 1994. *Unit Operation of Agricultural Processing*. Vikas Publ. House.
10. Singh RP & Heldman DR. 1993. *Introduction to Food Engineering*. Academic Press.
11. Singh RP. 1991. *Fundamentals of Food Process Engineering*. AVI PubL.

Pafe 5004 UNIT OPERATIONS IN FOOD PROCESS ENGINEERING (2+1)

Objective

To acquaint and equip the students with different unit operations of food industries.

Theory

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.

Suggested Readings

1. Brennan JG, Butters JR, Cowell ND & Lilly AEI. 1990. *Food Engineering Operations*. Elsevier.
2. Earle RL. 1985. *Unit Operations in Food Processing*. Pergamon Press.
3. Fellows P. 1988. *Food Processing Technology: Principle and Practice*. VCH Publ.
4. McCabe WL & Smith JC. 1999. *Unit Operations of Chemical Engineering*. McGraw Hill.
5. Sahay KM & Singh KK. 1994. *Unit Operation of Agricultural Processing*. Vikas Publ. House.
6. Singh RP & Heldman DR. 1993. *Introduction to Food Engineering*. Academic Press.

Pafe 5005 ENERGY MANAGEMENT IN FOOD PROCESSING INDUSTRIES (2+1)

Objective

To acquaint and equip the students with different energy management techniques including energy auditing of food industries.

Theory

UNIT I

Energy forms and units, energy perspective, norms and scenario; energy auditing,data collection and analysis for energy conservation in food processing industries.

UNIT II

Sources of energy, its audit and management in various operational units of the agro-processing units; passive heating, passive cooling, sun drying and use of solar energy, biomass energy and other non-conventional energy sources in agro-processing industries.

UNIT III

Reuse and calculation of used steam, hot water, chimney gases and cascading of energy sources. Energy accounting methods, measurement of energy, design of computer-based energy management systems, economics of energy use.

Practical

Study of energy use pattern in various processing units i.e., rice mills, sugar mills, dal mills, oil mills, cotton-ginning units, milk plants, food industries etc. Energy audit study and management strategies in food processing plants. Identification of energy efficient processing machines. Assessment of overall energy consumption, production and its cost in food processing plants, visit to related food processing

industry.

Suggested Readings

1. Pimental D. 1980. *Handbook of Energy Utilization in Agriculture*. CRC Press.
2. Rai GD. 1998. *Non-conventional Sources of Energy*. Khanna Publ.
3. Twindal JW & Anthony D Wier 1986. *Renewable Energy Sources*. E & F N. Spon Ltd.
4. Verma SR, Mittal JP & Surendra Singh. 1994. *Energy Management and Conservation in Agricultural Production and Food Processing*. USG Publ. & Distr., Ludhiana.

Pafe 5006 PROCESSING OF CEREALS, PULSES AND OIL SEEDS (2+1)

Objective

To acquaint and equip the students with the post harvest technology of cereals, pulses and oilseeds with special emphasis on their equipments.

Theory

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.

Suggested Readings

1. Asiedu JJ.1990. *Processing Tropical Crops*. ELBS/MacMillan. Chakraverty A. 1995. *Post-harvest Technology of Cereals,Pulses and Oilseeds*. Oxford & IBH.
2. Morris Lieberman. 1983.*Post-harvest Physiology and Crop Preservation*. Plenum Press.
3. Pandey PH. 1994. *Principles of Agricultural Processing*. Kalyani.

Pillaiyar P. 1988. *Rice -Post Production Manual*. Wiley Eastern.
4. Sahay KM &Singh KK. 1994. *Unit Operations in Agricultural Processing*. Vikas Publ. House.

Pafe 5007 FOOD PROCESSING EQUIPMENT AND PLANT DESIGN (2+1)

Objective

To acquaint and equip the students with the design features of different food processing equipments being used in the industries and with the layout, planning of different food and processing plants.

Theory

UNIT I

Design considerations of processing agricultural and food products.

UNIT II

Design of machinery for drying, milling, separation, grinding, mixing,evaporation, condensation, membrane separation.

UNIT III

Human factors in design, selection of materials of construction and standard component, design standards and testing standards. Plant design concepts and general design considerations: plant location, location factors and their interaction with plant location, location theory models, computer aided selection of the location.

UNIT IV

Feasibility analysis and preparation of feasibility report: plant size, factors affecting plant size and their interactions, estimation of break-even and economic plant size; Product and process design, process selection, process flow charts, computer aided development of flow charts.

UNIT V

Hygienic design aspects and worker's safety, functional design of plant building and selection of building materials, estimation of capital investment, analysis of plant costs and profitabilities, management techniques in plant design including applications of network analysis, preparation of project report and its appraisal.

Practical

Detailed design and drawing of mechanical dryers, milling equipment, separators, evaporators, mixers and separators. Each individual student will be asked to select a food processing plant system and develop a plant design report which shall include product identification and selection, site selection, estimation of plant size, process and equipment selection, process flow-sheeting, plant layout, and its evaluation and profitability analysis.

Suggested Readings

1. Ahmed T. 1997. Dairy Plant Engineering and Management.4th Ed. Kitab Mahal.
2. Chakraverty A & De DS. 1981. *Post-harvest Technology of Cereals,Pulses and Oilseeds*. Oxford & IBH.
3. Gary Krutz, Lester Thompson & Paul Clear. 1984. *Design of Agricultural*

Machinery. John Wiley & Sons.
4. Hall CW & Davis DC. 1979. Processing Equipment for Agricultural Products.
5. AVI Publ.
6. Henderson S & Perry SM. 1976. *Agricultural Process Engineering*. 5th Ed. AVI Publ.
7. Johnson AJ. 1986. *Process Control Instrumentation Technology*. 2nd Ed. Wiley International & ELBS.
8. Rao T. 1986. Optimization: Theory and Applications. 2nd Ed. Wiley Eastern.
9. Richey CB. (Ed.). 1961. Agricultural Engineers' Hand Book. McGraw Hill.
10. Romeo T Toledo. 1997. Fundamentals of Food Process Engineering. CBS.
11. Slade FH. 1967. Food Processing Plant. Vol. I. Leonard Hill Books.

Pafe 5008 FRUITS AND VEGETABLES PROCESS ENGINEERING (2+1)

Objective

To acquaint and equip the students with processing of fruits and vegetables and the design features of the equipments used for their processing.

Theory

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.

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.

Pafe 5009 MEAT PROCESSING (2+1)

Objective

To acquaint and equip the students with processing of meat and meat products and the design features of the equipments used for their processing.

Theory

UNIT I

Meat and poultry products: Introduction, kinds of meat animals and poultry birds, classification of meat, composition of meat.

UNIT II

Slaughtering: Pre slaughter operations, post slaughter operations, wholesale and retail cuts.

UNIT III

Preservation of poultry: different methods, stuffed products, frozen products, poultry concentrates and flavours, synthetic poultry flavour.

UNIT IV

Different preservation methods of meat: Smoking, curing and freezing, chilling of meat and different methods of chilling, freezing of meat and different methods of freezing of meat, physical and chemical changes during chilling and freezing, packaging of meat and meat products, quality control.

UNIT V

Classification, composition and nutritive value of eggs: Grading of eggs, different quality parameters of eggs, Haugh unit, processing of egg, yolk processing, egg breaking mechanisms, freezing of egg, pasteurization,desugarisation and dehydration of egg, different dehydration methods,quality control and specification of egg products.

UNIT VI

Fish: Nutritional quality of fish and fish products, fillet and steaks, different preservation techniques, chilling, freezing, drying, canning, curing and smoking, quality control in fish processing.

Practical

Experiments in slaughtering, dressing, wholesale and retail cutting: Curing, preservation of meat and meat products, estimation of quality of egg, Haugh unit, desugarisation, preparation of whole egg powder, yolk powder, freezing of fish, drying of fish, canning of fish, visit to meat and fish processing units.

Suggested Readings

1. Chooksey MK & Basu S. 2003. *Practical Manual on Fish Processing and Quality Contro*l. CIFE, Kochi.
2. Chooksey MK. 2003. *Fish Processing and Product Development*. CIFE, Kochi.
3. Hall GM. 1997. *Fish Processing Technology*. Blabie Academic & Professional.
4. Lawrie RS. 1985. *Developments in Meat Sciences*. Vol. III. Applied Science Publ.
5. Mead GC. 1989. *Processing of Poultry*. Elsevier.
6. Pearson AM & Tauber FW. 1984. *Processed Meats*. AVI Publ.
7. Stadelman WJ & Cotterill OJ. 1980. *Egg Science and Technology*. AVI Publ.

Pafe 5010 FOOD PACKAGING (2+1)

Objective

To acquaint and equip the students with packaging methods, packaging materials, packaging machineries, modern packaging techniques etc.

Theory

UNIT I

Introduction of packaging: Package, functions and design. Principle in the development of protective packaging. Deteriorative changes in foodstuff and packaging methods of prevention.

UNIT II

Food containers: Rigid containers, glass, wooden boxes, crates, plywood and wire bound boxes, corrugated and fibre board boxes, textile and paper sacks, corrosion of containers (tin plate); Flexible packaging materials and their properties; Aluminium as packaging material; Evaluation of packaging material and package performance.

UNIT III

Packaging equipments: Food packages, bags, types of pouches, wrappers, carton and other traditional package; Retortable pouches; Shelf life of packaged foodstuff.

UNIT IV

Methods to extend shelf life; Packaging of perishables and processed foods; Special problems in packaging of food stuff.

UNIT V

Package standards and regulation; Shrink packaging; Aseptic packaging, CA and MAP, Active packaging; Biodegradable packaging.

Practical

Thickness, substance weight, water absorption capability of flexible packaging materials; Strength properties of packaging materials; Water vapour and gas

transmission rate of flexible packaging materials; Identification and chemical resistance of plastic films; Packaging of fruits/vegetables; Estimation of shelf-life of packaged food stuff; Familiarization of types of packaging material.

Suggested Readings

1. Crosby NT. 1981. *Food Packaging Materials*. Applied Science Publ.
2. Mahadeviah M & Gowramma RV. 1996. *Food Packaging Materials*. Tata McGraw Hill.
3. Palling SJ.(Ed). 1980. *Developments in Food Packaging*. Applied Science Publ.
4. Sacharow S & Grittin RC. 1980. *Principles of Food Packaging*. AVI Publ.

Pafe 5011 FOOD QUALITY AND SAFETY ENGINEERING (2+1)

Objective

To acquaint and equip the students with the latest standards to maintain food quality as well as to study HACCP protocol.

Theory

UNIT I

Food safety, need for quality control and safety, strategy and criteria, microbiological criteria for safety and quality, scope of food toxicology, toxic potential and food toxicants, biological and chemical contaminants.

UNIT II

Food additives and derived substances, factors affecting toxicity, designing safety in products and processes, intrinsic factors, establishing a safe raw material supply, safe and achievable shelf life.

UNIT III

Process equipment and machinery auditing, consideration of risk, environmental consideration , mechanical quality control.

UNIT IV

Personnel hygienic standards, preventative pest control, cleaning and disinfesting system, biological factors underlying food safety.

UNIT V

Preservation and stability, contaminants of processed foods, adulteration, prevention and control, FPO, PFA, Codex, GMP, BIS and HACCP; Practices, principles, standards, specifications, application establishment and implementation; HACCP and quality management system.

Practical

Microbiological examination of food, hazard analysis, premises design, HACCP project plan; CCP, CCP Decision tree, HACCP control chart. HACCP case studies; Survey, BIS, FPO, Codex standards and specifications. Visits to food industries to study the various quality and safety aspects adopted.

Suggested Readings

1. Chesworth N. 1997. *Food Hygiene Auditing*. Blackie AcademicProfessional, Chapman & Hall.
2. David A Shapton & Norah F Shapton. 1991. Principles and Practices for the Safe Processing of Foods. Butterworth-Heinemann.
3. Jacob M 2004. Safe Food Handling. CBS.
4. Jose M Concon. 1988. Food Toxicology, Part A. Principles and Concepts, Part B. Contaminants and Additives. Marcel Dekker.
5. Sara Mortimore & Carol Wallace. 1997. HACCP -A Practical Approach. Chapman & Hall.

Pafe 5012 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

Application of environmental control in agriculture- Use of psychrometric chart and steam tables – phychrometric properties- measurement of Psychrometric properties – processes – Heating and cooling load calculations –steady state heat transfer through walls , ceilings , glazed floors etc. – steady state energy and mass balance – Components of the mass balance – ventilation rate – maximum and minimum ventilation rate –Thermal insulation and moisture barrier

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

Controlled and modified atmosphere storage—Relative humidity and temperature variation in storage structures –Green house environment control - effect of environment on plant growth –environmental control – energy conservation– equipment for heating and cooling -environment modification in inside green houses.

UNIT IV

Instruments and measurements; codes and standards. Control systems -alarm systems . Controllers and Computers. Environment modifications –lighting – watering –water system components—Co_2 enrichments media treatments. Pesticide applications.

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

1. Albright LD. 1990. *Environmental Control for Animals and Plants*. ASAE Textbooks.
2. Esmay ML & Dixon JE. 1986. *Environmental Control for Agricultural Buildings*. The AVI Corp.
3. Gaudy AF &Gaudy ET. 1988.Elements of Bioenvironmental Engineering. Engineering Press.
4. Moore FF. 1994.Environmental Control Systems: Heating, Cooling, Lighting. Chapman & Hall.
5. Threlkeld JL. 1970.Thermal Environmental Engineering. Prentice Hall.

Pafe 5013 STORAGE ENGINEERING AND HANDLING OF AGRICULTURAL PRODUCTS (2+1)

Objective

To acquaint and equip the students with the safe storage of food materials, design of storage structures and the design of different material handling equipments used in the industries.

Theory

UNIT I

Storage of grains, biochemical changes during storage, production, distribution and storage capacity estimate 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.

Suggested Readings

1. FAO. 1984. Design and Operation of Cold Stores in Developing Countries. FAO.
2. Hall CW. 1970.Handling and Storage of Food Grains in Tropical and Sub-tropical Areas. FAO Publ. Oxford & IBH.
3. Henderson S & Perry SM. 1976. Agricultural Process Engineering. 5th Ed. AVI Publ.
4. McFarlane Ian. 1983. Automatic Control of Food Manufacturing Processes. Applied Science Publ.
5. Multon JL. (Ed). 1989. Preservation and Storage of Grains, Seeds and their By-products. CBS.
6. Ripp BE. 1984. Controlled Atmosphere and Fumigation in Grain Storage. Elsevier.
7. Shefelt RL & Prussi SE. 1992. Post Harvest Handling – A System Approach. Academic Press.
8. Shejbal J. (Ed). 1980. Controlled Atmosphere Storage of Grains. Elsevier.
9. Vijayaraghavan S. 1993. Grain Storage Engineering and Technology. Batra Book Service.

Pafe 5014 SEED DRYING, PROCESSING AND STORAGE (2+1)

Objective

To acquaint and equip the students with processing of seeds and the design features of the equipments used for their processing.

Theory

UNIT I

Processing of different seeds and their engineering properties, principles and importance of seed processing.

UNIT II

Performance characteristics of different unit operations such as pre-cleaning, grading, conveying, elevating, drying, treating, blending, packaging and storage, seed processing machines like scalper, debreader, huller, velvet separator, spiral separator, cleaner-cum-grader, specific gravity separator, indent cylinder, disc separator, and colour sorter, seed treater, weighing and bagging machines, their operation and maintenance, installation and determination of their capacity, seed quality maintenance during processing, plant design and layout, economy and safety consideration in plant design.

UNIT III

Seed drying principles and methods, theory of seed drying, introduction to different types of heated air dryers, significance of moisture equilibrium, method of maintaining safe seed moisture, thumb rule and its relevance, importance of scientific seed storage, types of storage structures to reduce temperature and humidity; management and operation/cleanliness of seed stores, packaging-principles, practices, materials and hermetic packaging, seed treatment methods and machines used, method of stacking and their impact, design features of

medium and long term seed storage building.

Practical

Study of various seed processing equipments such as pre-cleaners, scalpers, air screen cleaners, graders, spiral and pneumatic separators, seed treating equipment, bag closures, scale etc. and their performance evaluation, design and layout of seed processing plant and its economics, analysis of cost of operation and unit cost of processed product, effect of drying temperature and duration of seed germination and storability.

Suggested Readings

1. Gregg *et al.* 1970. *Seed Processing*. NSC.
2. Henderson S & Perry SM. 1976.*Agricultural Process Engineering*. 5th Ed. AVI Publ.
3. Sahay KM & Singh KK.1994. *Unit Operation of Agricultural Processing*. Vikas Publ. House.

Pafe 5015 BIOCHEMICAL AND PROCESS ENGINEERING (2+1)

Objective

To acquaint and equip the students with the basic principles of biochemical and process engineering.

Theory

UNIT I

Applications of engineering principles; mass and energy balance, fluid flow principles, unit operations of process engineering.

UNIT II

Fundamentals of growth kinetics, maintenance energy and yield concepts, principles of media sterilization, media formulations of industrial fermentation.

UNIT III

Aerobic and agitated rheology of fermentative fluids, design and scale-up of bioreactors, enzyme reactors.

UNIT IV

Principles of recovery of fermented products in bio-processing, instrumentation, transport phenomenon.

Practical

Kinetics of one substitute reactions, kinetics of growth in batch cultures, design consideration for bioreactors, media preparation and sterilization, microprocessor based monitoring of bioprocess parameters.

Suggested Readings

1. Coulson JM & Richadson JF. 1999. *Chemical Engineering*. Vols. II, IV. The Pergamon Press.
2. Treybal RE. 1981.*Mass Transfer Operations*. 3rd Ed. Harper & Row.

3. Brennan JG, Butters JR, Cavell ND & Lilly AEI. 1990. *Food Engineering Operations*. Elsevier.
4. Greanoplis J Christie. 1999. *Transport Process and Unit Operation*. Allyn & Bacon.

Pafe -5016 ADVANCED FOOD & DAIRY ENGINEERING (2+1)

Theory

Unit-I

Introduction to Food & Dairy Engineering- Evaporation-types of evaporators-Performance of Tubular evaporators-Evaporator capacity and economy-Vapour recompression-Distillation-Flash distillation-continuous distillation with reflux-Design of Sieve-plate columns-plate efficiency-Rectification in packed Towers-Batch distillation-Flash distillation of multi component mixtures-Fractionation of multi component mixtures-Azeotropic and extractive distillation.

Unit-II

Agitation and mixing of liquids-circulation, velocities and power consumption in Agitated vessels-Blending and mixing-suspension of solid particles. Texture of Food materials-classification of methods of Texture evaluation-Objective or Instructional methods-imitative and Empirical Tests-Texture profile method-Dynamic Tests for evaluation of Food Texture-Firmness, Hardness and dynamic hardness.

Unit-III

UHT pasteurization of milk-Vacreation-VHT sterilization of milk-VHT plant with direct and indirect steam heating-Design of a drum dryer-Design of a spray dryer and its components. Design of recovery system of dried product. Asceptic processing and packaging of liquid foods-methods-CIP cleaning of Dairy plants.

Practical

Study of climbing film evaporator.,falling film evaporator-forced circulation evaporator- Agitated film evaporator.-Design of an evaporator.-Study of steam distillation equipment- Study of Batch distillation equipment, mixing equipment, blending equipment. Determination of hardness, firmness, crispness, tenderness of Food products., flow parameters of liquid foods using viscometers, Design of a drum dryer-spray dryer and powder recovery system.Visit to Food & Dairy Processing Plants.

Suggested Readings

1. Fellows, P. (1993)., Food processing Technology, Principles & Practice, Ellis Horwood, U.S.A.
2. McCabe, W.L. and Smith, J.C. (1993). Unit Operation in Chemical Engineering. McGraw Hill Book Co., New Delhi.

3. Mohsenin, N.N. (1996). Physical Properties of Plant and Animal Materials. Gordon and Breach Publishers, New York.
4. Tufail Ahmad (1998). Diary Plant Engineering and Management. Kitab Mahal Agencies, Allahabad..

Pafe 5095 INDUSTRY/ INSTITUTE TRAINING (0+1) (NC)

Objective

To expose the students to the industry/Research Institutes.

Theory

In-plant training in the relevant food industry/ Food research Institute during processing operation of the plant to study the actual working of the equipment and various unit operations. The evaluation will be based on the written report of the student and the comments of the factory managers. The duration of training shall be three weeks. The student shall be required to do training in the institute other than the institute in which he/she is enrolled.

PROCESSING AND FOOD ENGINEERING

List of Journals

- Agricultural Mechanization in Asia, Africa and Latin America .
- Indian Food Industry, India
- Journal of Agricultural Engineering Research, UK .
- Journal of Agricultural Engineering, India
- Journal of Food Engineering
- Journal of Food Science
- Journal of Food Science and Technology, India
- Journal of tropical Agriculture, KAU
- Packaging India, India
- Transaction of American Society of Agricultural Engineers

Suggested Broad Topics for Master's Research

- . Controlled atmosphere storage and modified atmosphere packaging Development of crop specific post harvest techniques for reduction in quantitative and qualitative losses to farm produce
- Design and development of need based, demand driven technologies for reduction in post harvest losses to farm produce, livestock and horticultural produce
- Development of post harvest processes and equipment for value addition to farm produce
- Development of processes and equipment for better utilization of agricultural residues and by-products
- . Packaging of fresh and processed foods
- Drying and dehydration of grains, fruits, vegetables and dairy products
- . Engineering properties of food materials

SOIL AND WATER ENGINEERING

Course Structure

CODE	COURSE TITLE	CREDITS
Swce 5001*	WATERSHED HYDROLOGY	2+1
Swce 5002*	DESIGN OF FARM IRRIGATION SYSTEMS	2+1
Swce 5003*	AGRICULTURAL DRAINAGE SYSTEMS	2+1
Swce 5004*	GROUND WATER ENGINEERING	2+1
Swce 5005	SOIL AND WATER CONSERVATION ENGINEERING	2+1
Swce 5006	CROP ENVIRONMENTAL ENGINEERING	2+0
Swce 5007	DESIGN OF PUMPS FOR IRRIGATION AND DRAINAGE	2+1
Swce 5008	OPEN CHANNEL FLOW	3+0
Swce 5009	FLOW THROUGH POROUS MEDIA	2+0
Swce 5010	WATER RESOURCES SYSTEM ENGINEERING	3+0
Swce 5011	GIS AND REMOTE SENSING FOR LAND AND WATER RESOURCE MANAGEMENT	2+1
Swce 5012	WATERSHED MANAGEMENT AND MODELING	2+1
Swce 5013	LAND DEVELOPMENT AND EARTH MOVING	2+0
	MACHINERY	
Swce 5014	SOIL PHYSICS AND APPLICATIONS	2+1
Swce 5091	MASTER'S SEMINAR	0+1
Swce 5092	SPECIAL PROBLEM	0+1
Swce 5095#	INDUSTRY/ INSTITUTE TRAINING	NC
Swce 5099	MASTER RESEARCH	0+20
	Total	**30+31**

* Compulsory for Master's programme;

Swce 5095 – Minimum of Three Weeks Training Note: Some of the identified Minor/Supporting fields are Mechanical Engineering, Processing and Food Engineering, Energy in Agriculture, Civil Engineering, Computer Science, Electrical Engineering, Mathematics and Statistics; The contents of some of the identified Minor/Supporting courses have been given.

SOIL AND WATER ENGINEERING
Course Contents

Swce 5001 WATERSHED HYDROLOGY (2+1)

Objective

To acquaint and equip the students about hydrological process and analysis of hydrological data required for design process.

Theory

UNIT I

Hydrologic processes and systems; Hydrologic problems of small watersheds; Hydrologic characteristics of watersheds.

UNIT II

Measurement and analysis of hydrologic parameters, rainfall-runoff models, stream flow measurement and analysis of data.

UNIT III

Hydrograph analysis; Unit hydrograph theory; Synthetic and dimension less hydrograph, convolution of unit hydrograph.

UNIT IV

Concept of hydraulic flood routing, flood routing (reservoir and channel routing).

UNIT V

Definition and concept of different types of hydrologic models for simulation of hydrologic problems.

Practical

Rainfall analysis, runoff computation, construction of hydrographs, Delineation of watershed, hydrograph analysis, reservoir and channel routing, hydrologic models, visit to dam sites.

Suggested Readings

1. Chow VT, David, M & Mays LW. 1988. *Applied Hydrology*. McGraw Hill.
2. Ghanshyan Das 2000.*Hydrology and Soil Conservation Engineering*. Prentice Hall.
3. Tideman EM. 1996. *Watershed Management*. Omega Scientific Publ.

Swce 5002 DESIGN OF FARM IRRIGATION SYSTEMS (2+1)

Objective

To acquaint and equip with the irrigation principles, design consideration of surface irrigation and micro irrigation systems and their evaluation system.

Theory

UNIT I

Concepts of Irrigation; Irrigation principles, losses, conveyance, distribution; Application, scheduling parameters, water budgeting.

UNIT II

Surface irrigation, hydraulics of water advance and recession, hydraulic resistance to flow, gravity irrigation.

UNIT III

Design of Border irrigation, furrow irrigation, check basin irrigation; Sub Irrigation methods and concepts.

UNIT IV

Preliminary design criteria of sprinkler and micro irrigation systems, hydraulics of sprinkler and micro irrigation systems. Design of lateral, sub-main and main line of sprinkler and micro irrigation. Fertigation aspects.

UNIT V

Underground water conveyance system; Evaluation of irrigation systems and practices.

Practical

Design and evaluation of border, furrow, check basin, sprinkler and micro irrigation, computation of frictional losses, Design of underground water conveyance systems, economics of irrigation methods, visit to mechanized farms.

Suggested Readings

1. Finkel HJ. 1983. *Handbook of Irrigation Technology*. Vols. I-II. CRC Press.
2. Ivan E Henk. 1951. *Irrigation Engineering*. Vol. I. John Wiley & Sons.
3. Karmeli D, Peri G & Todes M. 1985. *Irrigation Systems: Design and Operation*. Oxford Univ. Press.
4. Pillsbury AF. 1972. *Sprinkler Irrigation*. FAO Agricultural Development Paper No. 88, FAO.
5. Rydzewski 1987. *Irrigation Development Planning*. John Wiley & Sons.
6. Sivanappan RK, Padmakumari O & Kumar V. 1987. *Drip Irrigation*. Keerthy Publ. House.
7. Sivanappan RK. 1987. *Sprinkler Irrigation*. Oxford & IBH.

Swce 5003 AGRICULTURAL DRAINAGE SYSTEMS (2+1)

Objective

To acquaint and equip with the importance and phenomenon of drainage system along with design consideration of surface and sub-surface drainage systems.

Theory

UNIT I

Theories and applications of surface and sub-surface drainage, steady state, unsteady state drainage equations for layered and non-layered soils, horizontal sub-surface drainage.

UNIT II

Principle and applications of Earnst, Glover Dumm, Kraijenhoff-van-de-leur equations.

UNIT III

Salt balance, leaching requirement and management practices under drained conditions.

UNIT IV

Design of different components of sub-surface drainage systems, theories of

vertical drainage and multiple well point system.

UNIT V

Disposal of drainage effluents, Management of drainage projects of waterlogged and saline soils, case studies.

Practical

Measurement of in-situ hydraulic conductivity, estimation of drainage coefficient and leaching requirements, Delineation of waterlogged areas through isobar, isobath and topographic maps. Design of surface and subsurface drainage systems, design of filter and envelop materials.

Suggested Readings

1. Battacharaya AK & Micheal AM. 2003. *Land Drainage*. Vikas Publ.
2. Clande Ayres & Daniel Scoates A.E. 1989. *Level Drainage and Reclamation*. McGraw Hill.
3. Luthin JN. 1978. *Drainage Engineering*. Wiley Eastern.
4. Ritzema HP. (Ed.). 1994. *Drainage Principles and Applications*. ILRI
5. Roe CE 1966. *Engineering for Agricultural Drainage*. McGraw Hill.

Swce 5004 GROUNDWATER ENGINEERING (2+1)

Objective

To acquaint and equip with the occurrence, development and hydraulics of groundwater flow.

Theory

UNIT I

Properties affecting groundwater storage and movement, groundwater balance studies.

UNIT II

Well hydraulics, two dimensional flow, steady and unsteady state flow in confined, unconfined and semi-confined aquifers, steady flow in sloping aquifers, partial penetrating wells. Analysis of multi-aquifers.

UNIT III

Flow analysis in interfering wells. Pumping tests and determination of aquifer parameters.

UNIT IV

Groundwater modeling for water resources planning.

UNIT V

Techniques for groundwater recharge.

Practical

Water table contour maps and determination of groundwater flow, estimation of aquifer characteristics, problems on non leaky and leaky aquifers, analysis of pumping test data; Computation of interference of wells; groundwater computer simulation models.

Suggested Readings

1. Boonstra J & de Ridder NA. 1981. *Numerical Modeling of Groundwater Basins*. ILRI.
2. Domenico PA.1972. *Concept and Models in Groundwater Hydrology*. McGraw Hill.
3. Hantush MS. (Ed.). 1964. *Advances in Hydro Sciences*. Vol. I. Academic Press. Harr ME 1990. *Ground Water and Seepage*. Wiley Eastern.
4. Huisman L. 1972. *Groundwater Recovery*. MacMillan. Polubarinova
5. Kochina P Ya 1962. *Theory of Ground Water Movement*. Princeton Univ. Press. Raghunath HM. 1992.*Ground Water.* Wiley Eastern.
6. Todd DK. 1997. *Ground Water Hydrology*. Wiley Eastern.

Swce 5005 SOIL AND WATER CONSERVATION ENGINEERING (2+1)

Objective

To acquaint and equip students with the process of degradation soil and water conservation and their remedial measures including design of structures.

Theory

UNIT I

Probability and continuous frequency distribution; Fitting empirical distributions.

UNIT II

Layout and planning of soil and water conservation measures; Design principles of soil and water structures including contour bunds and terraces; Gully control measures.

UNIT III

Hydraulic jump and energy dissipaters for soil conservation structures; Hydrologic, hydraulic and structural design of drop structures.

UNIT IV

Sediment deposition process. Estimation of sediment load, earthen dams, seepage through dams and stability analysis.

UNIT V

Rainwater harvesting, Flood control and stream bank protection measures.

Practical

Design of Drop spillway, chute spillway, drop inlet spillway, hydraulic jump calculation, design of bench terrace, contour bunds and contour trenches, design and problems on earthen dam, silt detention tanks and check dams, visit to soil conservation structures sites.

Suggested Readings

1. Garde RJ & Ranga Raju KG. 1977. *Mechanics of SedimentTransport and Alluvial Stream Problems*. Willey Eastern.
2. Gurmel Singh *et al.* 1994. Manual of Soil and Water Conservation Practices. Oxford & IBH.
3. Hudson N.1971. Soil Conservation. B.T. Batsford Ltd.
4. Murthy VVN. 1998.Land and Water Management Engineering. Kalyani. USDA 1969.A Manual on Conservation of Soil and Water. Oxford & IBH.

Swce 5006 CROP ENVIRONMENTAL ENGINEERING (2+0)

Objective

To acquaint and equip with the process of soil-water-plant relationship and their interaction for crop growth.

Theory

UNIT I

Aerial and edaphic environments for plant growth, energy and mass transfer in and above crop canopies.

UNIT II

Climatic changes and plant response to environmental stresses, evapotranspiration models. Instrumentation and techniques for monitoring plant environments.

UNIT III

Processes and aspects of growth and development, soil-root interface, root sink functions.

UNIT IV

Water movement in soil-plant atmosphere continuum, artificial environments and plant behaviour.

UNIT V

Design and operation of controlled environment facilities and their instrumentation. Crop growth and yield modeling.

Suggested Readings

1. Ghildyal BP & Tripathy RP. 1987. *Fundamental of Soil Physics*. Wiley Eastern.
2. Slatyor OP. 1967.*Plant Water Relationship*. Academic Press.

Swce 5007 DESIGN OF PUMPS FOR IRRIGATION AND DRAINAGE (2+1)

Objective

To acquaint and equip with requirement of pumps for irrigation and drainage system and their design features.

Theory

UNIT I

Basic hydraulic design of centrifugal pump, water hammering problem in centrifugal pump.

UNIT II

Principle and performance characteristics of vertical turbine pump, submersible pump and axial flow pump and their design.

UNIT III

Non-conventional energy sources for pumping, wind mills, micro turbines, solar pumps, hydraulic ram-their selection and design criteria.

UNIT IV

Design of pumping station, techno-economic evaluation. Energy conservation measures for pumping systems.

Practical:

Visit to pump manufacturers and pumping installations . Design problems on

water lifters and pumps- procedures for selection and testing of pumps.

Suggested Readings

1. Church AH & Jagdish Lal 1973. *Centrifugal Pumps and Blowers*. Metropolitan
2. Book Co.
3. Michael AM & Khepar SD. 1989. *Water Well and Pump Engineering*. TataMcGraw Hill.
4. Michael AM. 1990. *Irrigation Theory and Practice*. Vikas Publ. House.
5. Modi PN & Seth SM. 2000 *Hydraulic and Fluid Mechanics*. Standard Book House.

Swce 5008 OPEN CHANNEL FLOW (3+0)

Objective

To acquaint and equip with the hydraulics of surface water flow phenomenon in open channels.

Theory

UNIT I

Open channel and their properties, energy and momentum, critical flow computation and application.

UNIT II

Uniform flow; gradually varied flow theory and analysis, methods of computation.

UNIT III

Practical problems such as design of transitions, flow passing Islands etc. spatially varied flow, rapidly varied flow.

UNIT IV

Hydraulic jump and its use as energy dissipator, flow through channel of nonlinear alignment and flow through non-prismatic channel sections.

UNIT V

Unsteady flow, gradually varied unsteady flow and rapidly varied unsteady flow.

Suggested Readings

1. Chaudhry MH. 1993. *Open Channel Flow*. Prentice Hall.
2. Chow VT. 1959. *Open Channel Hydraulics*. Mc-Graw Hill.
3. Henederson FM. 1966. *Open Channel Flow*. MacMillan.

Swce 5009 FLOW THROUGH POROUS MEDIA (2+0)

Objective

To acquaint and equip with the hydraulics and process of water flow in the water bearing formation under saturated as well as unsaturated conditions.

Theory

UNIT I

Aquifer and fluid properties, forces holding water in soils, hydrodynamics in porous media and limitations of governing laws.

UNIT II

Differential equations of saturated flow, initial and boundary conditions. Dupuit and Business approximations and linearization techniques.

UNIT III

Stream functions, potential functions and flow net theory. Analysis of seepage

from canals and ditches.

UNIT IV

Unsaturated flow theory, Infiltration and capillary rise flux dynamics. Hydro-dynamic dispersion in soil-aquifer system.

Suggested Readings

1. Harr Milton E. 1962. *Groundwater and Seepage*. McGraw-Hill. Jacob Beer 1972. *Dynamics of Fluid Flow in Porous Media*. Elsevier.
2. Muskat M & Wyckoff RD. 1946. *The Flow of Homogeneous Fluids through Porous Media*. JW Edwards.
3. Patrick A Domenico & Schwartz FW. 1998. *Physical and Chemical Hydrogeology*. John Wiley & Sons.
4. Remson I, Hornberger GM & Moiz Fred J. 1971. *Numerical Methods in Subsurface Hydrology*. Wiley Interscience.

Swce 5010 WATER RESOURCES SYSTEM ENGINEERING (3+0)

Objective

To acquaint and equip with the techniques for optimization of water resources for achieving maximum output.

Theory

UNIT I

Concepts and significance of optimization in water resources, objective functions, deterministic and stochastic inputs.

UNIT II

Mathematical programming techniques, linear programming and its extension: gradient method, simplex method, non-linear programming classical optimization.

UNIT III

Geometric programming and dynamic programming, application of optimization techniques for water resources.

UNIT IV

Development and management including conjunctive use, crop production functions and irrigation optimization.

Suggested Readings

1. Larry WM. 1996. *Water Resources Handbook*. McGraw- Hill.
2. Loucks DP *et al.* 1981. *Water Resource System Planning and Analysis*. Prentice Hall.
3. Rao SS. 1978. *Optimization Theory and Applications*. Wiley Eastern.

Swce 5011 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

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

Swce 5012 WATERSHED MANAGEMENT AND MODELING (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

UNIT III

Concept of operational watershed. National land use policy, legal and social aspects UNIT IV

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

UNIT V

Modeling 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

1. Isobel W Heathcote**.** 1998. *Integrated Watershed Management: Principles and Practice*. Wiley Publ.
2. Kenneth N Brooks, Peter F Ffolliott, Hans M Gregersen, Leonard F DeBano. 1991. *Hydrology and the Management of Watersheds*. Wiley-Blackwell.

Swce 5013 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

1. Dutta SK. 1987. *Soil Conservation and Land Management*. International Distributors, Dehradun.
2. Eric C Orlem.1997. *Earth-Moving Machines*. Motorbooks International.
3. Kuhar JE. 1977. *The Precision Farming Guide for Agriculturalist*. Lori J. Dhabalt, USA.
4. Nichols HL & Day DH.1998. *Moving the Earth. The Work Book of Excavation*.McGraw Hill.
5. Peurifoy RL. 1956. *Construction, Planning, Equipment and Methods*. McGrawHill.
6. Roger V Amato & Donald J Heimburger 2003. *Classic Vintage Crawlers and Dozers*. B Heimburger House Publ.
7. Singh G.1991. *Manual of Soil and Water Conservation Engineering*. Oxford &IBH.

Swce 5014 SOIL PHYSICS AND APPLICATIONS (2+1)

Objective

To acquaint and equip with the techniques of soil physics, soil structure, soil moisture soil erosion and their application for land and water resources management.

Theory

Unit-I: Soil as a physical system. Mechanical composition and its significance in soil productivity and classification. Physical classification. Physical and dynamic properties of soil – soil consistency, soil plasticity, shear strength, compression and compaction and resistance to penetration.

Unit-II: Soil structure – genesis and classification. Evaluation of structure and its significance in agriculture. Soil aeration composition of soil air, gaseous exchange and effects on biological activities. Thermal regime of soils – thermal properties, variation in soil temperature and modification of regime.

Unit-III. Soil moisture constants their significance in plant growth. Boil moisture *retention* and classifications. Methods of soil moisture measurements. Soil moisture movement. Flow equations and flow problems. Control of soil moisture regime.

Unit-IV: Soil erosion, Problems of run off and erosion. Mechanics of water erosion and its control. Soil loss equations. Mechanics of wind erosion and its control. Soil conservation projects and efforts in Kerala State.

Practical

Classification of soil physical constants. Soil loss determination. Determination of soil moisture by various methods. Hydraulic conductivity and other important parameters.

Suggested Readings

1. Oswal MC . 1983. Text book of soil physics Oxford & IBH
2. Hanks RI And Ashcraft GL. 1986. Applied soil physics: soil water and temperature applications. Springer- Verlag, New York
3. Daniel Hillel. 2004. Introduction to soil physics Academic Press, New York.
4. Ghildyal BP&Tripathi RP 1987 Soil Physics New Age International, New Delhi
5. Baver LD et.al. 1983. Soil Physics. Wiley Eastern Ltd ,New Delhi
6. Schwab, GO, Fangmeier, D.D., Elliot, W.J. and Frevert, R.K. 1996. Soil and water management systems. John Wiley and Sons, Inc.b New york.

Swce 5095 INDUSTRY / INSTITUTE TRAINING 0+1 (NC)

Objective

To expose the students to the industry.

Theory

In-plant training in the relevant soil and water engineering industry/research Institute. To study the actual working of the equipment and various unit operations. The evaluation will be based on the written report of the student and the comments of the factory managers/ Institute head. The duration of training shall be three weeks. The student shall be required to do training in the institute other than the institute in which he/she is enrolled.

SOIL AND WATER ENGINEERING

List of Journals

- Ground Water
- Journal of Hydrology
- Journal of Soil Conservation
- Journal of Tropical agriculture
- Indian Journal of soil and water conservation
- Journal of Water Management
- Transactions of ASAE
- Transactions of ASCE
- Water Resource Research

Suggested Broad Topics for Master's Research

- Groundwater Modeling
- Hydrolgic Modelling 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

SUGGESTED SUPPORTING COURSES

Civil / Mechanical/ Electrical/Computer Engineering & Statistics

Code	Course Title	Credits
Suce 5001	DAMS & RESERVOIR OPERATIONS	3+1
Suce 5002	WATER QUALITY AND POLLUTION CONTROL	3+1
Suce 5003	FLUVIAL HYDRAULICS	2+1
Suce 5004	EXPERIMENTAL STRESS ANALYSIS	2+1
Suce 5005	CONTROL OF POLLUTION FROM SOLID WASTES	2+0
Sucs 5006	COMPUTER GRAPHICS	2+1
Sucs 5007	NEURAL NETWORK AND ITS APPLICATIONS	2+1
Suee 5008	APPLIED INSTRUMENTATION	2+1
Suee 5009	PROCESS CONTROL SYSTEMS	2+1
Sume5010	MECHANISM ANALYSIS AND SYNTHESES	3+0
Sume5011	VIBRATIONS	3+0
Sust 5012	STATISTICAL METHODS	1+1
	Total	**27+9**

Suce 5001 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.

UNIT V

Spill way and spillway capacities and spillway gates.

UNIT VI

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

Practical

Exercises on above topics.

Suggested Readings

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

Suce 5002 WATER QUALITY AND POLLUTION CONTROL (3+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.

UNIT IV

Waste water characteristics and disposal methods.

UNIT V

Waste water treatment.

UNIT VI

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

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

Suce 5003 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.

UNIT III

Bed load. Suspended load. Total load transport.

UNIT IV

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

UNIT V

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

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

Suce 5004 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, Strain gauges mechanical, optical, electrical, acoustical and pneumatic etc and their use. Different types of electric strain gauges, Semiconductor gauges.

UNIT II

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

UNIT III

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

Practical

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

Suggested Readings

1. Srinath LS.1984. *Experimental Stress Analysis*. Tata McGraw Hill.
2. Singh Sadhu. 1982. *Experimental Stress Analysis*. Khanna Publ.
3. Dally J.W. & W.F. Riley, 1990. *Experimental Stress Analysis*. Tata McGraw Hill

Suce 5005 CONTROL OF POLLUTION FROM SOLID WASTES (2+0)

Objective

To acquaint and equip the students with different methods for management of solid wastes and their importance.

Theory

UNIT I

Definition. Sources. Quality, Classification and characteristics of solid waste collection, Transport and reduction at source.

UNIT II

Handling, Collection , Storage, transport of Solid wastes.

UNIT III

Disposal methods and their merits and demerits.

UNIT IV

Processing of solid wastes. Fertilizers, fuel and food values.

UNIT V

Recycling and reuse materials and energy recovery operations.

Suggested Readings

1. Kreith F & Tchobanoglous G. 2002. *Handbook of Solid WasteManagement*. McGraw Hill.
2. Ramachandra TV. 2006.*Management of Municipal Solid Waste*. Capital Publ. Co.

Sucs 5006 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.

Sucs 5007 NEURAL NETWORK AND ITS APPLICATIONS (2+1)

Objective

To acquaint and equip the students about the concepts of neural network for solving engineering problems.

Theory

UNIT I

Introduction to neural network and its comparison with biological system. Perceptron and linear separable functions, multi-layers perceptrons.

UNIT II

Back propagation, one basic learning algorithm for feed-forward neural network, variation and improvement for back-propagation algorithm, Generalization of learning algorithm.

UNIT III

Recurrent Networks: Hopefield networks and Boltzmann Machine.

UNIT IV

Unsupervised learning and self organized features maps.

UNIT V

Application of neural network in function approximation, time series predictions, pattern recognition, control systems and optimization in engineering problems.

Practical

Development of neural network by back-propagation learning algorithm using MATLAB for function approximation, time series predictions, pattern recognition, control systems and optimization in engineering problems.

Suggested Readings

1. Haykins S.1999. Neural Network-Comprehensive Study. PHI.
2. Hertz J, Krogh A & Palmer RG. 1991. Introduction to Theory of Neural Computation. Addison-Wesley.

Suee 5008 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.

Suee 5009 PROCESS CONTROL SYSTEM (2+1)

Objective

To acquaint and equip the students about the concepts involved in process control system to control variables at the desired level.

Theory

UNIT I

Introduction to Process Control -Controlled Variable, Control strategy, Single Variable and multi variable control systems, Process Control loop, Open loop and closed loop control system, Linear and non linear control system, Transfer function and procedure for determining the Transfer function of Complex Control System, Representation of a Control System by block diagram and its Reduction

UNIT II

Characteristics of real Process -Process Equation, Controlling & Controlled Variable, Transient & steady state response, Self Regulation Property, Control System Parameters, Evaluation of Control System.

UNIT III

Improved Control through Complex Control of process -Controller Modes or actions, On/OFF Mode, Proportional Mode, Integral Mode, Derivative Mode, Composite Control Mode (PD, PI, PID, Modes).

UNIT IV

Analysis of Common loop, involving -Flow control (Solid, liquid and gaseous flow), Pressure regulation (Pressure Transducers), Liquid level (Mechanical & Electrical Systems), Temperature Control (Thermistor and thermocouple).

UNIT V

Introduction to Computer Control of Process Application and design -Signal Conditioning, Design of OP AMPS circuits used to implement Proportional Integral, Derivative and Composite Modes. Study of various computer Controlled Electrical and Mechanical Systems.

Practical

Study of various controllers by using Op-Amps, Use of microprocessors in process control.

Suggested Readings

1.Johnson CD.1977. *Process Control Instrumentation Technology*. PPH.

2.Manke BS.2006. *Linear Control System*. Khanna Publishers.

Sume 5010 MECHANISM ANALYSIS AND SYNTHESIS (3+0)

Objective

To acquaint and equip the students with important area for analysis and design of Farm Machinery Mechanism.

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

Suggested Readings

1. George N Sandor & Arthur G Erdman.1984. *Advanced Mechanism Design - Analysis and Synthesis.* Vols. I, II. Prentice Hall.
2. Norton. 2003. Design of Machinery -An Introduction to the Synthesis and Analysis of Mechanisms and Machines. McGraw Hill.
3. Shigley Vicker. 2007. Theory of Machines and Mechanisms. McGraw Hill.
4. Soni AH. 1974. Mechanism Synthesis and Analysis. McGraw Hill.

Sume 5011 VIBRATIONS (3+0)

Objective

To acquaint and equip the students with Significant field in the study and Analysis of farm machinery dynamics.

Theory

UNIT I

Vibration motion and its terminology. Undamped free vibrations, equations of motion-natural frequency. Energy method, Rayleigh method; effective mass Principle of Virtual work. Equivalent spring stiffness in parallel and in series. Harmonic analysis and Fourier Series. Damping – viscous, solid, coulomb equivalent dampers. Viscosity damped free vibrations, Logarithmic decrement. Forced vibrations with harmonic excitation and rotating unbalance, Energy dissipated by dampling. Forced vibration with damping, Vibration isolation and force and motion transmissibility.

UNIT II

Two degree of freedom systems. Principal modes of vibration, co-ordinate coupling. Vibration absorbers, Free vibration equation of motion for multi-degree of freedom systems. Influence coefficients and Maxwell's reciprocal theorem, stiffness coefficients. Numerical methods for finding natural frequencies for multi degree of freedom systems.

UNIT III

Vibration of lumped parameter systems and continuous systems. Lagrange equations. Vibration measuring instruments: Vibrometers, velocity pickups, Accelerometer and frequency measuring instruments. Applications of vibrations.

Suggested Readings

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

2.Rao SS. 2005. *Mechanical Vibration*. John Wiley.

3.William T Thomson.2004. *Theory of Vibration with Application*. 5th Ed. Marie Dillon Dahleh Amazon Co.

Sust 5012. 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

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

COMPULSORY NON–CREDIT COURSES

(Compulsory for Master's programme in all disciplines)

CODE	COURSE TITLE	CREDITS
Ccpg 5001	LIBRARY AND INFORMATION SERVICES	0+1
Ccpg 5002	AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES (e-Course)	1+0
Ccpg 5003	INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE (e-Course)	1+0
Ccpg 5004	DISASTER MANAGEMENT (e-Course)	1+0
Ccpg 5005	TECHNICAL WRITING AND COMMUNICATIONS SKILLS	0+1
Ccpg 5006	BASIC CONCEPTS IN LABORATORY TECHNIQUES	0+1
	Total	**3+3**

Course Contents

Ccpg 5001 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 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.

Ccpg 5002 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 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 :Gender – concepts, needs and Roles in Agrl. System Technological change and Gender Relations. Gender, Bio Diversity and Food Security – Gender and Organizational change. Gender Analysis – Mainstreaming gender GDI.

UNIT IV

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

1. Bhalla GS & Singh G. 2001. Indian Agriculture -Four Decades of dvelopment. Sage Publ. Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.
2. Rao BSV. 2007. Rural Development Strategies and Role of Institutions Issues, Innovations and Initiatives.
3. Mittal Publ. Singh K.. 1998. Rural Development -Principles, Policies and Management. Sage Publ.
4. Moser, CON (1993) Gender Planning and Development: Theory, practice and Training. London Routledge
5. March, C.et al. (1999) Key concept. A Guide to Gender Analysis Frame works. Section 1.2. Oxford: Oxfam

Ccpg 5003 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 Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings

1. Erbisch FH & Maredia K.1998. *Intellectual Property Rights in Agricultural Biotechnology*. CABI.
2. Ganguli P. 2001. *Intellectual Property Rights: Unleashing Knowledge Economy*. McGraw-Hill. *Intellectual Property Rights: Key to New Wealth Generation. 2001*. NRDC & Aesthetic Technologies.
3. Ministry of Agriculture, Government of India. 2004. *State of Indian Farmer*. Vol.
4. V. *Technology Generation and IPR Issues*. Academic Foundation.
5. Rothschild M & Scott N. (Ed.). 2003. *Intellectual Property Rights in Animal Breeding and Genetics*. CABI.
6. Saha R. (Ed.). 2006. *Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies*. Daya Publ. House.
7. *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.*

Ccpg 5004 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

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

Ccpg 5005 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

1. Gupta HK. 2003. *Disaster Management*. Indian National Science Academy.

Orient Blackswan.
2. Hodgkinson PE & Stewart M. 1991. *Coping with Catastrophe: A Handbook of Disaster Management*. Routledge.
3. Sharma VK. 2001. *Disaster Management*. National Centre for Disaster Management, India.

Ccpg 5006 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 agrochemical 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

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