NEW AND RESTRUCTURED
POST-GRADUATE CURRICULA & SYLLABI

Agricultural Engineering
&
Technology
Farm Machinery & Power Engineering
Soil & Water Engineering
Processing & Food Engineering

Education Division
Indian Council of Agricultural Research
New Delhi
April 2009
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EXECUTIVE SUMMARY

There is an urgent need for developing appropriate technology in Agricultural Engineering & Technology and imparting proper training to the farmers, which is possible only if the graduates and post graduates produced by the universities are themselves properly educated in the advances in engineering and technology as applicable to agriculture. This becomes more important at the post graduate level where they have not only to learn the recent advances in their subjects but have also to be trained in the modern and latest techniques in their disciplines so that they can participate and contribute in the development and advancement in their related fields. Therefore restructuring the curricula content and delivery system and recast the same to produce globally competitive manpower has gained primacy. Further, the shrinking job opportunities in the National Agricultural Research System (ICAR/SAUs) have put additional pressure on our education system to prepare students in tune with the demands of the private sector.

The new and restructured PG programmes in Agricultural Engineering & Technology have been designed by taking into consideration demands of private sector harnessing commercial aspects, modern research tools and their applications, supplementary skills required, and enhancing the global competitiveness and employability of students. Considerable efforts have, therefore, gone in for the preparation of PG course curricula and syllabi in Agricultural Engineering & Technology. Three major specializations in the discipline of Agricultural Engineering and degrees in these at M.Tech. and Ph.D. level have been recommended as: (i) Farm Machinery & Power Engineering; (ii) Processing & Food Engineering; and (iii) Soil and Water Engineering.

The salient features of revised course curricula in these specializations are as under:-

Farm Machinery & Power Engineering

- Emphasis has been given on design of fuel efficient engines. For this a new course FMPE-501 Design of Farm Machinery & Power Systems at M. Tech. level has been incorporated.
- New courses FMPE 512 Agro-Energy Audit and Management & FMPE 603 Energy Conservation and Management in Farm Machinery and Power Engineering have been added at M. Tech. and Ph. D. level in Farm Machinery & Power Engineering keeping in view the course contents for NET examination conducted by ICAR.
- New courses FMPE 601 Advances in Farm Machinery and Power Engineering, FMPE 602 Simulation Modeling in Farm Machinery and Power Engineering, FMPE605 Machinery for Natural Resource Management and Precision Farming & FMPE 606 Advances in Hydraulics and Electro-Pneumatic Controls, have been added at Ph.D. level
- The existing contents have been examined critically, restructured and updated keeping in view the latest developments in the subject areas.

Processing & Food Engineering

- In Processing & 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 & Water Engineering the emphasis has been given on GIS, remote sensing, precision irrigation, modeling management and accordingly new courses SWE 511 GIS and Remote Sensing for Land and Water Resource Management at M.Tech. level and SWE 605 Hydro Chemical Modeling and Pollutant Management, SWE 607 Advances in Irrigation and Drainage at Ph.D. Level have been incorporated.

• The course SWE 606 Plant Growth Modeling and Simulation has been restructured which takes care of relationship between soil, water and plant growth.

• 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 FMPE/PFE/SWE/595 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**

o Evaluation as well as final viva-voice examination of Masters’ Thesis should be external.

o The external element of examination having weightage of 50% of theory syllabi should be introduced for compulsory courses at post graduate level.

o Institute should follow the titles of courses strictly.

o In view of inclusion of new emerging fields in the course contents, faculty should be deputed for training for appraisal of emerging trends.

o Every teacher should attend at least one training once in five years at national/international level.

o Industrial/Institute training of minimum of three weeks duration has been recommended as compulsory non credit course for industrial exposure to all Masters’ Degree students.

o The contingencies for M.Tech. & Ph. D. students provided by the ICAR should be earmarked department wise and it may be enhanced appropriately from time to time.

o 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.

o 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.

o Proper Research and Development Centers with suitable infrastructure and facilities need to be identified & strengthened at Industry & Institute level.

o Agricultural Engineering subject be included in Central Services Examinations.
BSMA Committee on Agricultural Engineering  


(Constituted by ICAR vide Office order No.F.No.13(1)/2007- EQR dated January 14, 2008)

<table>
<thead>
<tr>
<th>Name</th>
<th>Address</th>
<th>Specialization</th>
</tr>
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<tbody>
<tr>
<td><strong>Dr. V. R. Sharma Convener</strong></td>
<td>Ex Dean, College of Agricultural Engineering, Punjab Agricultural University, Ludhiana Principal, Sant Baba Bhag Singh Institute of Engineering and Technology, Padhiana, Distt. Jalandhar, Punjab</td>
<td>Civil Engineering</td>
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<td>Deptt. of Agril. Processing &amp; Food Engineering, College of Agril. Engg. &amp; Tech. Bhubaneswar</td>
<td>Agr. Processing</td>
</tr>
<tr>
<td><strong>Dr. Partap Singh Prof. and Director of Research</strong></td>
<td>FMPE, MPUAT Udaipur</td>
<td>Farm Machinery &amp; Power Engineering</td>
</tr>
<tr>
<td><strong>Dr. G.P. Sharma Assoc. Prof.</strong></td>
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<td><strong>Dr. T.C. Thakur National Professor</strong></td>
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<td>Farm Machinery &amp; Power Engineering</td>
</tr>
<tr>
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<td>SWE</td>
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<td>Farm Machinery &amp; Power Engineering</td>
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PREAMBLE

Indian agricultural scenario has witnessed phenomenal strides over the last fifty years. From acute food shortages to the ushering in of green revolution, led to food stocks bulging to the seams. However, during the past few years, there has been a steady decline in the overall agricultural growth rate, leading to a situation of worrisome depletion in reserve food stocks, with resultant emergent imports to keep the food stocks at desired levels. The stagnation in agricultural growth has been a topic of debate among the planners and decision makers of agricultural policies. Signing of world trade agreement by India has exposed Indian farmers to the global competition. This demands rapid modernization of Indian agriculture so that our farm produce meets not only national but international quality standards, is produced at international competitive price and is sustainable. This, therefore, calls for developing appropriate technology and imparting proper training to the farmers, which is possible only if the graduates and post graduates produced by the universities are themselves properly educated in the advances in engineering and technology as applicable to agriculture. This becomes more important at the post graduate level where they have not only to learn the recent advances in their subject but have also be trained in the modern and latest techniques in their discipline so that they can participate and contribute in the development and advancement in their chosen fields.

Consequently, restructuring the curricula content and delivery systems and recast the same to produce globally competitive manpower has gained primacy. Further, the shrinking job opportunities in National Agricultural Research System (ICAR/SAUs) have put additional pressure on our education system to prepare students in tune with the demands of the private sector.

To fulfill these objectives, the Indian Council of Agricultural Research (ICAR) over the years has developed strong academic linkages with various institutions and professionals of the country to induce vital reforms in agricultural education for improving its quality, relevance and uniformity across the country. Under this process, the Council has recently revised course curricula and syllabi of UG programmes through IV Deans’ Committee. For restructuring of PG academic programme, a National Core Group (NCG) constituted by the ICAR has now been mandated to revise the curricula and syllabi of Masters and Doctoral programmes in all the disciplines of agriculture. The NCG further
constituted 18 Broad Subject Matter Area (BSMA) Committees to undertake this exercise in their respective subject matter domains.

The BSMA Committee on Agricultural Engineering (Annexure) seriously deliberated upon the issues concerning agricultural education in general and Agricultural Engineering in particular. The curricula and syllabi of all the three disciplines, viz., Farm machinery & Power Engineering, Processing & Food Engineering and Soil & Water engineering, were discussed at length in the meetings and workshop convened by the BSMA Committee. The BSMA Committee reviewed the opinions and suggestions invited from institutions, eminent scientists, and other stakeholders. The new look and restructured PG programmes in Agricultural Engineering have been designed in considerations based on: demands of private sector harnessing commercial aspects, modern research tools and their applications, supplementary skills required, and to enhance the global competitiveness and employability of our students. Considerable efforts have, therefore, gone in for the preparation of this final document.

The first basic draft for M. Tech. course curriculum and syllabi was prepared by faculty of Agricultural Engineering and Technology, CCS HAU, Hisar. The first meeting of extended BSMA committee members was held on April 26-27, 2008 at College of Agricultural Engineering, PAU, Ludhiana for revision of Masters’ and Doctorate Course Curriculum and Syllabi in Agricultural Engineering and second draft was prepared based on discussions and suggestions received from various quarters. The second meeting of extended BSMA committee members was held at 2.30 PM. on 30-5-2008 in Committee Room of College of Agricultural Engineering, PAU, Ludhiana to review the 2nd draft for revision of Masters’ and Doctorate Course Curriculum and Syllabi in Agricultural Engineering and subsequent suggestions and comments received from Dr. V.K.Tewari, Professor, IIT Kharagpur and Dr. T.C. Thakur, National Professor, GBPUA&T, Pantnagar and from the various quarters were discussed in this meeting. The necessary suggestions/comments were incorporated after detailed deliberations & discussions and syllabi were modified accordingly. The second modified draft was presented in the workshop held on 31st May, 2008 in which 52 faculty members and PG students and 41 representatives from industries attended.

During the Open House Discussion the members were apprised of the titles of the courses for M.Tech and Ph.D in various disciplines of Agricultural Engineering viz. Farm Machinery & Power Engineering, Processing & Food Engineering and Soil & Water
Engineering All the members actively participated in the discussions and came up with the suggestions which have been incorporated in Draft-III. In view of deliberations & discussions the course titles and credit hours for M.Tech. and Ph.D. were finalized and have been incorporated. The recommendations of BSMA meetings and workshop were presented in the meeting of member secretaries under the Chairmanship of Dr. J.C Katyal, Chairman, National Core Group on June 14th, 2008 at CCS HAU Hisar. The fourth meeting of BSMA was again convened on June 20th, 2008 for taking suggestion and comments in the finalization of draft in Agricultural Engineering.

We wish to place on record the help rendered by Dr J.C. Katyal, Vice Chancellor, CCS HAU Hisar, Dr M.S. Kang, Vice Chancellor, PAU Ludhiana, Dr. P.K. Gupta, Dean, College of Agricultural Engineering, PAU Ludhiana and Dr. Partap Singh, Dean COAE&T, CCS HAU Hisar to hold the various BSMAC meetings and workshop of Stake-holders. The help rendered by Dr. (Mrs.) S. K. Mann, Dean, Postgraduate Studies, PAU Ludhiana, Dr. R. T. Patil, Director, CIPHEt Ludhiana, Dr. S. R. Verma, former Dean, COAE, PAU Ludhiana, Dr. K. D. Mannan, former, Dean PGS, PAU Ludhiana, Dr. V.K. Sharma, former Registrar, PAU Ludhiana, is gratefully acknowledged. We are thankful to the faculty of PAU, Ludhiana and CCS HAU, Hisar in general and Dr. Mukesh Garg, Dr. M.S. Sidhpuria, Dr. Y.P. Yadav from CCS HAU, Hisar and Dr. A.K. Jain, Dr. K.G. Singh, Dr. Ashok Kumar, Dr. Shashi Pal, Dr. Jaspal Singh, Dr. Rohinish Khurana and Dr. Mahesh Kumar from PAU, Ludhiana in particular, who were the resource persons and worked very hard for developing the curriculum and syllabi for various courses of their fields of specialization. We are grateful to all the participants of the extended BSMAC meetings and workshop for their keen interest and efforts in revising the curricula and syllabi.

We are immensely thankful and indebted to members of BSMAC for their consistent and tireless efforts and innovative ideas put in personally and through e-mails, which have gone a long way in bringing the document in the present form. The committee is also indebted to Dr S. P. Tiwari, DDG (Education) and Dr R. K. Mittal, ADG (EQR), ICAR for providing all the administrative support. The document in the present form would not have been possible without consistent and focused guidelines, directions and critical review from time to time by Dr. J.C. Katyal, Chairman of National Core Group and Vice Chancellor, CCS HAU, Hisar for which we are indebted to him. We hope that this document will serve as a guide and help in achieving uniformity and high academic standards of post graduate education in the discipline of Agricultural Engineering.
ORGANIZATION OF COURSE CONTENTS
&
CREDIT REQUIREMENTS

Code Numbers
- All courses are divided into two series: 500-series courses pertain to Master’s level, and 600-series to Doctoral level. A Ph. D. student must take a minimum of two 600 series courses, but may also take 500-series courses if not studied during Master’s programme.
- Credit seminar for Master’s level is designated by code no. 591, and the two seminars for Doctoral level are coded as 691 and 692, respectively.
- Similarly, 599 and 699 codes have been given for Master’s research and Doctoral research, respectively.

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.
- A list of journals pertaining to the discipline is provided at the end which may be useful as study material for 600-series courses as well as research topics.
- E-Resources - for quick update on specific topics/events pertaining to the subject.
- Broad research topics provided at the end would facilitate the advisors for appropriate research directions to the PG students.

Minimum Credit Requirements

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<th>Subject</th>
<th>Master’s programme</th>
<th>Doctoral programme</th>
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<td>Minor</td>
<td>09</td>
<td>08</td>
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<tr>
<td>Supporting</td>
<td>05</td>
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<tr>
<td>Seminar</td>
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<td>02</td>
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<tr>
<td>Research</td>
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<td>45</td>
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<td><strong>Total Credits</strong></td>
<td><strong>55</strong></td>
<td><strong>75</strong></td>
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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 Entomology, the appropriate minor subjects should be Plant Pathology & Nematology).
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 (PGS 501-PGS 506) are of general nature and are compulsory for Master’s programme. Ph. D. students may be exempted from these courses if already studied during Master’s degree.
## Course Structure - at a Glance

<table>
<thead>
<tr>
<th>CODE</th>
<th>COURSE TITLE</th>
<th>CREDITS</th>
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<tbody>
<tr>
<td>FMPE 501*</td>
<td>DESIGN OF FARM POWER AND MACHINERY SYSTEMS</td>
<td>3+1</td>
</tr>
<tr>
<td>FMPE 502*</td>
<td>SOIL DYNAMICS IN TILLAGE AND TRACTION</td>
<td>2+1</td>
</tr>
<tr>
<td>FMPE 503*</td>
<td>TESTING AND EVALUATION OF TRACTORS AND FARM EQUIPMENT</td>
<td>2+1</td>
</tr>
<tr>
<td>FMPE 504*</td>
<td>SYSTEM SIMULATION AND COMPUTER AIDED PROBLEM SOLVING IN ENGINEERING</td>
<td>1+1</td>
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<td>FMPE 505</td>
<td>APPLIED INSTRUMENTATION IN FARM MACHINERY AND STRESS ANALYSIS</td>
<td>2+1</td>
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<td>FMPE 506</td>
<td>SYSTEM ENGINEERING AND PRODUCTIVITY</td>
<td>2+1</td>
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<tr>
<td>FMPE 507</td>
<td>FARM MACHINERY DYNAMICS NOISE &amp; VIBRATIONS</td>
<td>2+1</td>
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<td>FMPE 508</td>
<td>TRACTOR DESIGN</td>
<td>2+1</td>
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<td>FMPE 509</td>
<td>OPERATIONS RESEARCH IN FARM POWER &amp; MACHINERY MANAGEMENT</td>
<td>2+1</td>
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<tr>
<td>FMPE 510</td>
<td>ERGONOMICS AND SAFETY IN FARM OPERATIONS</td>
<td>2+1</td>
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<tr>
<td>FMPE 511/PFE 502</td>
<td>ENGINEERING PROPERTIES OF BIOLOGICAL MATERIALS</td>
<td>2+1</td>
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<tr>
<td>FMPE 512</td>
<td>AGRO-ENERGY AUDIT AND MANAGEMENT</td>
<td>2+0</td>
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<td>FMPE 513</td>
<td>DESIGN AND ANALYSIS OF RENEWABLE ENERGY CONVERSION SYSTEMS</td>
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<td>FMPE 514</td>
<td>RESEARCH METHODOLOGY</td>
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<td>FMPE 591</td>
<td>MASTER'S SEMINAR</td>
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<td>FMPE 592</td>
<td>SPECIAL PROBLEM</td>
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<td>FMPE 595#</td>
<td>INDUSTRY/ INSTITUE TRAINING</td>
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<td>FMPE 599</td>
<td>MASTER'S RESEARCH</td>
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<td>FMPE 601**</td>
<td>ADVANCES IN FARM MACHINERY AND POWER ENGINEERING</td>
<td>3+1</td>
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<td>FMPE 602**</td>
<td>SIMULATION MODELLING IN FARM MACHINERY AND POWER ENGINEERING</td>
<td>2+0</td>
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<tr>
<td>FMPE 603</td>
<td>ENERGY CONSERVATION AND MANAGEMENT IN FARM MACHINERY AND POWER ENGINEERING</td>
<td>2+0</td>
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<tr>
<td>FMPE 604</td>
<td>COMPUTER AIDED ANALYSIS AND DESIGN OF FARM MACHINERY</td>
<td>2+1</td>
</tr>
<tr>
<td>FMPE 605</td>
<td>MACHINERY FOR NATURAL RESOURCE MANAGEMENT AND PRECISION FARMING</td>
<td>3+1</td>
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<tr>
<td>FMPE 606</td>
<td>ADVANCES IN HYDRAULICS AND ELECTRO PNEUMATIC CONTROLS</td>
<td>2+0</td>
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<tr>
<td>FMPE 691</td>
<td>DOCTORAL SEMINAR I</td>
<td>1+0</td>
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<tr>
<td>FMPE 692</td>
<td>DOCTORAL SEMINAR II</td>
<td>1+0</td>
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<tr>
<td>FMPE 693</td>
<td>SPECIAL PROBLEM</td>
<td>0+1</td>
</tr>
<tr>
<td>FMPE 694</td>
<td>CASE STUDY</td>
<td>0+1</td>
</tr>
<tr>
<td>FMPE 699</td>
<td>DOCTORAL RESEARCH</td>
<td>45</td>
</tr>
</tbody>
</table>

Compulsory for Master’s programme; ** Compulsory for Doctoral programme  
# FPM 595 – Minimum of Three Weeks Training

**Note:** Some of the identified Minor/Supporting fields are Mechanical Engineering, Processing & 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 MACHINERY AND POWER ENGINEERING
Course Contents

FMPE 501 DESIGN OF FARM POWER AND MACHINERY SYSTEMS

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

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
FMPE 502  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
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
*Indian Standard Codes for Agril. Implements*. Published by ISI, New Delhi.
Saroj Parkashan,
Nebraska Tractor Test Code for Testing Tractor, Nebraska, USA.
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 Pe theorem and other methods.

UNIT II
Mathematical modeling and engineering problem solving.

UNIT III

UNIT IV

UNIT V
Solving differential equation on computers- modeling engineering systems with ordinary differential equations- solution techniques using computers.

Suggested Readings

FMPE 505 APPLIED INSTRUMENTATION IN FARM MACHINERY 2+1
AND STRESS ANALYSIS

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

FMPE 506    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

FMPE 507 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**

**Suggested Readings**
FMPE 508  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

Practical
Extensive practices on the packages mentioned in the theory.

Suggested Readings

FMPE 509  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

FMPE 510
ERGONOMICS AND SAFETY IN FARM OPERATIONS 2+1

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

Theory
UNIT I
Concept and design criteria for optimum mutual adjustment of man and his work: Importance of ergonomics and its application in agriculture, liberation and transfer of energy in human body, concept of indirect calorimeter, work physiology in various agricultural tasks.
UNIT II
Physiological stress indices and their methods of measurement: Mechanical efficiency of work, fatigue and shift work.
UNIT III
Anthropometry and Biomechanics: Anthropometric data and measurement techniques, joint movement and method of measurement, analysis and application of anthropometric data, measurement of physical and mental capacities.
UNIT IV
Human limitations in relation to stresses and demands of working environments. Mechanical environment; noise and vibration and their physiological effects, thermal environment; heat stress, thermal comfort, effect on performance and behavior, field of vision, color discrimination, general guidelines for designing visual display, safety standards at work place during various farm operations and natural hazards on the farm. Farm safety legislation.
UNIT V
Man-machine system concept. Human factors in adjustment of man and his work. Design aspects of foot and hand controls on tractors and farm
equipment. Design of operator’s seat for tractors and agricultural equipment.

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

Suggested Readings

FMPE511/ PFE 502
ENGINEERING PROPERTIES OF BIOLOGICAL MATERIALS

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

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

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

UNIT III
Thermal properties: Specific heat, thermal conductivity, thermal diffusivity, methods of determination, steady state and transient heat flow. Electrical properties; Dielectric loss factor, loss tangent, A.C. conductivity and dielectric constant, method of determination, energy absorption from high-frequency electric field.
UNIT IV
Application of engineering properties in design and operation of agricultural equipment and structures.

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

Suggested Readings

FMPE 512 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

Suggested Readings

FMPE 513 DESIGN AND ANALYSIS OF RENEWABLE ENERGY CONVERSION SYSTEMS

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

Suggested Readings


**FMPE 514**  
**RESEARCH METHODOLOGY**  
**0+1**

**Practical**

**Suggested Readings**

**FMPE 595**  
**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.

**FMPE 601**  
**ADVANCES IN FARM MACHINERY AND POWER ENGINEERING**  
**3+1**

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

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

UNIT II

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

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

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

Suggested Readings

FMPE 602

SIMULATION MODELLING IN FARM MACHINERY AND POWER ENGINEERING

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

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

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

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

Suggested Readings

FMPE 603     ENERGY CONSERVATION AND MANAGEMENT IN FARM POWER AND MACHINERY

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

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

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

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

Suggested Readings
FMPE 604  COMPUTER AIDED ANALYSIS AND DESIGN OF FARM MACHINERY  2+1

Objective
To acquaint and equip with the computer aided design, analysis and manufacturing of farm machinery with the help of CAD.

Theory
UNIT I

UNIT II

UNIT III
Application to farm machinery scheduling problem. Application to farm – factory co-ordination – case study. Design of farm machinery with the help of CAD.

Practical
Practical on CAD software, its uses and application in design of farm machinery. Design procedures. Exercise on agricultural engineering system analysis. Description of the machinery scheduling problem in harvesting and transport system. Investigation of existing software models – cases studies.

Suggested Readings

FMPE 605  MACHINERY FOR NATURAL RESOURCE MANAGEMENT AND PRECISION FARMING  3+1

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

Theory
UNIT I
Functional design, specifications, requirements and working of farm machinery needed for natural resources management like rotavator,
Precision sowing and planting machines, laser guided leveller, power sprayer, straw chopper cum spreader, straw bailer, combine harvester etc.

UNIT II
Ag GPS parallel swathing option, data base management, functional systems documentation. Application of relevant software.

UNIT III

UNIT IV
Engineering fundamentals related to earth moving machinery: Swell, shrinkage and compaction measurements. Use of tractors & Crawlers and effects of altitude & temperature on their performance. Grade resistance and gradability

UNIT V

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

Suggested Readings
De Mess M. N. Fundamental of Geographic Information System. John Willy and Sons, New York
Peurifoy RL. 1956. Construction, planning, equipment and methods. Mcgraw Hill
Sabbins, F. Remote Sensing Principle and Interpretation. Freeman, New York
Objective
To acquaint and equip with the latest developments in the field of hydraulics and pneumatics with special reference to the usage of these on the modern day tractors.

Theory

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

UNIT II

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

UNIT IV

Suggested Readings
FARM MACHINERY AND POWER ENGINEERING

List of Journals

• Journal of Agricultural Engineering, ISAE, New Delhi
• Journal of Arid Land Research Management
• Journal of Agricultural Engineering Research
• Transactions of American Society of Agricultural Engineers (TASAE)
• Journal of Computer and Electronics in Agriculture
• Journal of Terramechanics
• Indian Journal of Agriculture Sciences
• Agricultural Engineering Today
• Journal of Agricultural Mechanization in Asia, Africa and Latin America (AMA)
• Agricultural Engineering Journal (AIT Bangkok)
• Seed research Journal, New Delhi

Suggested Broad Topics for Master’s and Doctoral Research

• Farm Machinery for crop residue management to increase soil fertility for higher productivity
• Machinery for precision agriculture for efficient utilization of inputs and saving in cost of production to have higher productivity
• Application of axial flow principle in thresher to have minimum breakage
• Efficient hand tools for pruning and plucking fruits
• Transplanter- 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 – at a Glance

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<td>2+1</td>
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<tr>
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<td>ENGINEERING PROPERTIES OF FOOD MATERIALS</td>
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<td>PFE 603</td>
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* Compulsory for Master’s programme; ** Compulsory for Doctoral programme  
# PFE 595 – Minimum of Three Weeks Training  
Note: Some of the identified Minor/Supporting fields are Mechanical Engineering, Processing & 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.
PROCESSING AND FOOD ENGINEERING
Course Contents

PFE 501 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, use of Gurnie-Lurie and Heisler Charts in solving heat conduction problems. Applications in food processing including freezing and thawing of foods.

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

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

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

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

Suggested Readings
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
PFE 503  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
UNIT II
Non-thermal processing: Microwave, irradiation, ohmic heating, pulsed electric field preservation, hydrostatic pressure technique etc.
UNIT III
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
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
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

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

PFE 507 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

PFE 508 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
Sumanbhatti & Uma Varma. 1995. Fruit and Vegetable Processing. CBS.

PFE 509 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

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

PFE 510  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

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

PFE 511 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 disinfecting 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
Jacob M 2004. *Safe Food Handling*. CBS.

**PFE 512**  
**FARM STRUCTURES AND ENVIRONMENTAL CONTROL**  
**Objective**
To acquaint and equip the students with the techniques to control temperature, humidity and other composition of air to create favourable environment in the agricultural structures.

**Theory**
UNIT I
Thermodynamic properties of moist air, psychrometric chart and computer programmes for thermodynamic properties.
UNIT II
Farm structures, their design, constructional details and design of low cost structures. Heating, ventilating and exhaust systems, air distribution and air cleaning, combustion of fuels and equipment.
UNIT III
Drying and dehumidification system, air-water contact operations and evaporation, process and product air conditioning, energy efficient environmental control practices.
UNIT IV
Instruments and measurements; codes and standards.

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

**Suggested Readings**

**PFE 513**  
**STORAGE ENGINEERING AND HANDLING OF AGRICULTURAL PRODUCTS**

**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, storage capacity models, ecology, storage factors affecting losses, storage requirements.

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

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

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

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

Suggested Readings
FAO. 1984. Design and Operation of Cold Stores in Developing Countries. FAO.

PFE 514 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
Gregg et al. 1970. Seed Processing. NSC.

PFE 515  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

PFE 595 INDUSTRY/INSTITUTE TRAINING 0+1 (NC)
Objective
To expose the students to the industry.

Theory
In-plant training in the relevant food industry 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.

PFE 601 TEXTURAL & RHEOLOGICAL CHARACTERISTICS 2+1 OF FOOD MATERIALS
Objective
To acquaint and equip the students with the textural & rheological properties of food materials.

Theory
UNIT I
UNIT II
Sensory methods of texture and viscosity measurements and their correlation. Rheological properties of foods.
UNIT III
Mathematical models and their application along with pipe line design and pump selection for non-Newtonian fluids. Recent advances in textural, rheological and viscoelastic characteristics of foods and their associated mathematical models.
Practical
Determination of viscosity of liquid foods, gumminess, chewiness, springiness and hardness of various fruits, vegetables and processed foods using texture profile analysis. Determination of force-distance relationship. Sensory evaluation/ subjective measurement and correlation between subjective and objective measurements of foods.

Suggested Readings
Journal of Food Science and Technology
Journal of Texture Studies

PFE 602 ADVANCES IN FOOD PROCESSING 3+0
Objective
To acquaint and equip the students with the modern and latest techniques of food engineering

Theory
UNIT I
Preservation of foods – physical and chemical methods-microbiological aspects thermo bacteriology, process calculation and selection.
UNIT II
Low temperature preservation - cooling and cold storage - freeze concentration and membrane separation process - hurdle technology - principles and applications - food irradiation - advantages and applications, microwave processing - interaction with food materials- microwave equipment - hydrostatic pressure treatment of food - equipment, processing and effect on microorganisms.
UNIT III
Application of heat energy and ultrasound - inactivation of microorganisms and enzymes -electrical resistance heating of food - heat generation, ohmic heater, heating models - pulsed electric field preservation- principles and application - influence on microorganisms and food ingredients - decontamination of microorganisms by surface treatment.
UNIT IV
Extrusion cooking - recent developments, methods, equipment, design criteria of extruders.

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

Theory

UNIT I
An overview of the modeling process. Introduction to mathematical, correlative and explanatory models. Formulation, idealization and simplification of the problems.

UNIT II
Probability models, series and linear mathematical approximation, dynamic and interacting dynamic processes.

UNIT III
Applications of mathematical modelling techniques to food processing operations like parboiling, convective drying, pasteurization, dehydration, shelf-life prediction, fermentation, aseptic processing, moisture diffusion, deep fat drying, microwave processing, infrared heating and ohmic heating. Stochastic finite element analysis of thermal food processes. Neural networks approach to modelling food processing operations.

Suggested Readings

PFE 604  ADVANCES IN DRYING OF FOOD MATERIALS  2+1

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

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

UNIT II
Air flow and resistance, principles and equipments for air movement and heating, drying methods and theory of drying, driers, classification and other allied equipment, thin layer drying of cereal grains, deep bed and continuous flow drying, drying models.

UNIT III
Heat requirements and thermal efficiency of drying system, aeration, tempering and dehydration, operation of driers and their controls, selection of driers, performance testing of grain driers, drying characteristics of cereals, pulses and oilseeds, microwave drying, radio frequency drying and tunnel drying, principles and equipment.

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

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

Suggested Readings

PFE 605  AGRICULTURAL WASTE AND BY-PRODUCTS  2+1

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

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

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

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

UNIT IV
Thermo-chemical conversions, densification, combustion and gasification, extraction, biological conversions, anaerobic digestion, biochemical digestion process, digestion systems, energy from anaerobic digestion, cellulose degradation, fermentation process.

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

Suggested Readings
USDA 1992. Agricultural Waste Management Field Handbook. USDA.
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
- Packaging India, India
- Transaction of American Society of Agricultural Engineers

Suggested Broad Topics for Master’s and Doctoral 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 - at a Glance

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<td>WATERSHED HYDROLOGY</td>
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<td>SWE 502*</td>
<td>DESIGN OF FARM IRRIGATION SYSTEMS</td>
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<td>SWE 503*</td>
<td>AGRICULTURAL DRAINAGE SYSTEMS</td>
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<td>SWE 504*</td>
<td>GROUND WATER ENGINEERING</td>
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<td>SWE 602**</td>
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<td>SWE 691</td>
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<td>SWE 699</td>
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* Compulsory for Master’s programme; ** Compulsory for Doctoral programme  
# SWE 595 – Minimum of Three Weeks Training

**Note**: Some of the identified Minor/Supporting fields are Mechanical Engineering, Processing & 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

SWE 501 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

SWE 502 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, submain 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

SWE 503 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 sub-surface drainage systems, design of filter and envelop materials.

**Suggested Readings**


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**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**

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 dams, silt detention tanks and check dams, visit to soil conservation structures sites.

Suggested Readings

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, evapo-transpiration 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

SWE 507  DESIGN OF PUMPS FOR IRRIGATION AND DRAINAGE  2+0

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

Suggested Readings

SWE 508  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 non-linear alignment and flow through non-prismatic channel sections.

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

Suggested Readings

SWE 509 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

SWE 510 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

SWE 511 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
SWE 512  WATERSHED MANAGEMENT AND MODELLING  2+1

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

Theory
UNIT I
Problems of desertification and degradation. Models of sediment yield
UNIT II
Survey, monitoring, reclamation and conservation of agricultural and forest lands, hill slopes and ravines
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
Modelling of flood and drought phenomenon, drought management and dry farming

Practical

Suggested Readings

SWE 513  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
UNIT III
UNIT IV
Boring machines. Different methods of boring.

Suggested Readings
SWE 601  ADVANCED HYDROLOGY  3+0

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

Theory
UNIT I
Hydrologic models, processes and systems. Uncertainty in hydrological event. Statistical homogeneity.

UNIT II

UNIT III
Time series analysis. Markov processes.

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

Suggested Readings

SWE 602  SOIL AND WATER SYSTEMS’ SIMULATION AND MODELLING  2+1

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

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

UNIT II
Rainfall-runoff models - Infiltration models, Simulation methods, structure of a water balance model.
UNIT III
Channel flow simulation - parameters and calibration - Streamflow statistics, surface water storage requirements.

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

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

Practical

Suggested Readings

SWE 603 MODELLING SOIL EROSION PROCESSES 2+1

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

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

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

UNIT III
Water and wind erosion control measures.

UNIT IV
Universal soil loss equation; stochastic models and dynamic models.

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


SWE 604 ADVANCED HYDRO-MECHANICS IN SOIL AQUIFER SYSTEMS 3+0

Objective

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

Theory

UNIT I


UNIT II

Determination of unsaturated hydraulic conductivity and models for its estimation.

UNIT III

Infiltration and exfiltration from soils in absence and presence of water table. Movement of groundwater in fractured and swelling porous media.

UNIT IV


Suggested Readings


SWE 605 HYDRO-CHEMICAL MODELLING AND POLLUTANT MANAGEMENT 3+0

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

Water quality management in lakes and reservoirs; physical characteristics; hydrologic and chemical budgets; bio-geochemical processes of pollutants; assessment methods.
UNIT IV
Classical wastewater problems; Water reclamation, reuse, water quality constraints and considerations for reuse in irrigation and industry; Biological wastewater treatment.

UNIT V

Suggested Readings

SWE 606
PLANT GROWTH MODELLING AND SIMULATION 3+0
Objective
To acquaint and equip the students with the simulation and modeling techniques in the soil, plant and water environment for crop growth.

Theory
UNIT I
Introduction to crop growth modeling. Simulation and simulation techniques. Types of models and modeling approaches.
UNIT II
Relational diagram for principal process, structures of a generalized agricultural simulator.
UNIT III
Input environment and techniques of monitoring plant environment, process and aspect of growth and development. Input yield models.
UNIT IV
Quantitative analysis of plant processes light photo-syntheses, respiration, growth, water uptake etc. and their mathematical modeling.

Suggested Readings

SWE 607
ADVANCES IN IRRIGATION AND DRAINAGE 2+0
Objective
To acquaint and equip the students with the advance application of irrigation and drainage system along with applicability of various models.

Theory
UNIT I
Advances in surface irrigation systems- surge irrigation: effect of surging on surface flow hydraulics, cablegation: water supply management.
UNIT II
Atomization in sprinkler and micro irrigation system; multipurpose and special uses of micro irrigation.

UNIT III
Synthetic materials for drainage systems. Environmental issues related to drainage. Socio-economic impacts of drainage systems.

UNIT IV
Controlled drainage for reducing agricultural non point pollution. Application of simulation models for drainage systems.

Suggested Readings
SOIL AND WATER ENGINEERING
List of Journals

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

Suggested Broad Topics for Master’s and Doctoral Research

- Groundwater Modeling
- Hydrologic 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 MINOR/SUPPORTING COURSES

Civil Engineering

Some identified Monor/Supporting courses

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<tr>
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<td>OPEN CHANNEL FLOW</td>
<td>3+0</td>
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<td>DAMS &amp; RESERVOIR OPERATIONS</td>
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<td>PROBABILISTIC APPROACH IN DESIGN</td>
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<td>CE 603</td>
<td>DESIGN OF BINS AND SILOS</td>
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Civil Engineering

CE 501  OPEN CHANNEL FLOW  3+0

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

Theory
UNIT I
Open channel and their properties. Energy and momentum principles. Critical flow computations and applications.
UNIT II
Uniform flow. Its development. Formula and design computation.
UNIT III
Boundary layer concept. Surface roughness. Velocity distribution and instability of uniform flow.
UNIT IV
Gradually varied flow theory and analysis. Method of computations.
UNIT V
Hydraulic jump and its use as levelling energy dissipation
UNIT VI
Spatially varied flow. Unsteady flow. Rapidly varied flow.

Suggested Readings
CE 502  DAMS & RESERVOIR OPERATIONS  3+1

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

Theory
UNIT I
UNIT II
UNIT III
UNIT IV
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

CE 503  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
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

CE 504   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

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

UNIT V

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

CE 505   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

CE 506 SIMILITUDE IN ENGINEERING 2+1

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

Theory

UNIT I
Dimensions and units.

UNIT II
Dimensional and similarity analysis. Theory of models.

UNIT III
True, distorted and dissimilar models.

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

Practical

Suggested Readings

CE 507 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

CE 601 PROBABILISTIC APPROACH IN DESIGN 2+0
Objective
To acquaint and equip the students with different probabilistic methods for dynamic loading design.

Theory

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

UNIT II

UNIT III

UNIT IV

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

Suggested Readings

CE 602 RANDOM VIBRATIONS 2+0
Objective
To acquaint and equip the students with design by linear and nonlinear random loading analysis.
Theory
UNIT I
Response to linear single and multi-degree of freedom system to stationary and non-stationary random excitation.
UNIT II
Response of continuous systems. Normal mode method.
UNIT III
UNIT IV
Applications to mechanical, aero, civil, ocean and agricultural engineering systems.

Suggested Readings

CE 603  DESIGN OF BINS AND SILOS  2+1

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

Theory
UNIT I
Computer aided design manuals. Rankine’s and Coulomb’s theories of active and passive pressures.
UNIT II
Janssen’s and Airy’s theories grain pressure theories for design of deep and shallow silos. Reimbert’s theory of silo design.
UNIT III
Comparison of Australian (AS) and Indian (BIS) design criteria for bins and silos.
UNIT IV
Computer aided design of grain silos by developing flowcharts and programs for underground and over ground silos.

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

Suggested Readings
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

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
rotating unbalance, Energy dissipated by damping. Forced vibration with damping, Vibration isolation and force and motion transmissibility.

UNIT II

UNIT III

Suggested Readings
Marie Dillon Dahleh Amazon Co.

**Computer Science & Electrical Engineering**

**EE 501  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

UNIT II

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

EE 502 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
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.
CSE 501  COMPUTER GRAPHICS  2+1

Objective
To acquaint and equip the students with the underlined 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
UNIT IV
Orthogonal Projection and multiple views, Isometric projection, Perspective projection, 3D Clipping
UNIT V

Practical
Practical problems on above topics.

Suggested Readings

CSE 502  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, Generalisation of learning algorithm.
UNIT III
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
COMPULSORY NON-CREDIT COURSES
(Compulsory for Master’s programme in all disciplines; Optional for Ph.D. scholars)

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<tr>
<th>CODE</th>
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<tr>
<td>PGS 501</td>
<td>LIBRARY AND INFORMATION SERVICES</td>
<td>0+1</td>
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<tr>
<td>PGS 502</td>
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<td>INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE</td>
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<td>PGS 504</td>
<td>BASIC CONCEPTS IN LABORATORY TECHNIQUES</td>
<td>0+1</td>
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<td>PGS 505</td>
<td>AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES</td>
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<tr>
<td>PGS 506</td>
<td>DISASTER MANAGEMENT</td>
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Course Contents

PGS 501 LIBRARY AND INFORMATION SERVICES 0+1

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

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

PGS 502 TECHNICAL WRITING AND COMMUNICATIONS SKILLS 0+1

Objective
To equip the students/scholars with skills to write dissertations, research papers, etc.
To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

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


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

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**


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**PGS 504**

**BASIC CONCEPTS IN LABORATORY TECHNIQUES**

**Objective**

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

**Practical**

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; washing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; Electric wiring and earthing. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy.

**Suggested Readings**


Objective

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

Theory

UNIT I
History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

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

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

Suggested Readings

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