SECTION VIII

FACULTY OF AGRICULTURAL ENGINEERING AND TECHNOLOGY

General information

Disciplines

• Farm Machinery and Power Engineering
• Processing and Food Engineering
• Soil Water Engineering
• Remote Sensing and GIS
• Civil Engineering
• Mechanical Engineering
• Energy Studies for Agriculture
• Electrical Engineering and Information Technology
  (A) Electrical Engineering
  (B) Computer Science and Engineering
  (C) Information Technology
The College of Agricultural Engineering and Technology (formerly the College of Agricultural Engineering) was established in 1964 as one of the constituent colleges of the Punjab Agricultural University, Ludhiana with the objectives of imparting education, to carry out multi-faceted research and to disseminate information related to technologies thus developed to the stake holders related to the area of Agricultural Engineering. The College has also played a leading role in solving the problems of farmers and industry by undertaking problem-oriented research and speedy transfer of technology. The College has maintained close liaison with different State Government departments and agencies for effective dissemination of new knowledge.

The College got international recognition when a Centre of Advanced Studies in Postgraduate Teaching and Research was established by the United Nations Development Programme (UNDP) / Indian Council of Agricultural Research (ICAR) in 1974. Subsequently, a Centre of Advanced Studies on Energy Management in Agriculture was established with major support from the Food and Agricultural Organization of the UNO (FAO)/UNDP/ICAR in 1983, and the School of Energy Studies for Agriculture was established. The ICAR also sanctioned the establishment of a Centre for Advanced Studies in the discipline of Farm Power and Machinery in 1997. The College was conferred an award by the Federation of Indian Chambers of Commerce and Industry in 1975 for its contributions. The College gets its major budgetary support from the ICAR and the Punjab Government. Several research projects are underway with the financial support from the World Bank, Department of Science and Technology, Govt. of India, Sir Rattan Tata Trust and several non-government organizations.

The College started its undergraduate programme B.Sc. (Agril. Engg. and Tech.), subsequently changed to B.Tech. (Agril. Engg.) in 1965 by following the trimester system (subsequently switching to the semester system) of instructions and the first batch was graduated in 1969. The undergraduate teaching was initially handled by the Departments of Agricultural Engineering, Civil Engineering, Electrical Engineering and Mechanical Engineering. The Department of Agricultural Engineering was trifurcated in 1974 into the Departments of Farm Power and Machinery (now Farm Machinery and Power Engineering), Soil and Water Engineering, Processing and Agril. Structures (now Processing and Food Engineering). The School of Information Technology, established in 2009 in the University, was made an integral part of the College in 2010. After merging the Department of Electrical Engineering and SIT, the School of Electrical Engineering and Information Technology has been created in 2012. The Training Unit and the Farm Machinery Testing Centre are also operational in the College which tests the manufactured machinery as per the BIS standards. The College has state of the art infrastructure and well-equipped undergraduate and postgraduate laboratories. The Placement Cell of the College has excellent track-record resulting in the employment of the students by several multi national companies and government departments. The Alumni Association of the College is highly active and its inter-active website is functional within the website of the Punjab Agricultural University, Ludhiana.

With the growth of the College the M.Tech. and Ph.D. programmes were started in different disciplines keeping in view the employment needs of the students and beneficiaries like industry and farmers of the State. The M.Tech programme in Remote Sensing and GIS has been started in collaboration with Punjab Remote Sensing Centre, Punjab from the academic session 2012-13. The B.Tech (Agril. Engg.) admission is made on the basis of JEE (Main) conducted by the CBSE, where as the postgraduate admission is made on the basis of written test conducted by PAU, interview and merit. The undergraduate and postgraduate have duly been regulated by the provisions of the regulatory bodies such as the ICAR, the University Grants Commission, the All India Council for
Technical Education and the Institution of Engineers. The revision of course curricula is a continuous process. The revised B.Tech. (Agril. Engg.) programme in the light of the recommendations of the IV Deans' Committee (ICAR) has been adopted from the session 2009-2010. The model curricula and the revised/restructured postgraduate programmes as per the recommendations of the National Core Group (ICAR) have been introduced in the academic session 2010-2011. The curricula has sufficient element of basic engineering, basic sciences, agricultural sciences, practical component, etc.

The student evaluation constitutes internal and external components and a system of Credit Point Average on a 10 point-scale is followed for grading the students. The College has several short-time student-teacher exchange programmes with two Russian universities. The Iowa State University, USA has a collaborative programme in the discipline of Soil and Water Engineering. The College of Agricultural Engineering and Technology has developed several engineering technologies which have promoted farm mechanization, efficient soil and water management, efficient post harvest handling of produce/products and adoption of renewable energy technologies in the State and country during its existence of more than four decades. The faculty of the College has distinguished itself to its contributions in the field of teaching, research and extension by winning several prestigious awards such as the Rafi Ahmed Kidwai Memorial Prize, Jawahar Lal Nehru Award, etc.
FARM MACHINERY AND POWER ENGINEERING

PROGRAMMES

M.Tech.
Ph.D.

COURSE REQUIREMENTS

M.Tech.
Field of Specialization Farm Machinery and Power Engineering

Required Courses FMP 501, FMP 502, FMP 503, FMP 504

Supporting Courses Stat 421, PGS 501 and other courses from subject matter fields (other than Minor) relating to area of special interest and research problems

Minor Field Mechanical Engineering, Energy Science and Technology, Computer Science and Engineering, Electrical Engineering, Mathematics and Statistics, Processing and Food Engineering or any other as approved by the Dean Postgraduate Studies.

Deficiency Courses As recommended by student's Advisory Committee and approved by the Dean, Postgraduate Studies

Ph.D.

Field of Specialization Farm Machinery and Power Engineering

Required Courses FMP 601, FMP 602

Supporting Courses Courses from subject matter fields (other than Minor) relating to area of special interest and research problems.

Minor Field Mechanical Engineering, Energy Science and Technology, Computer Science and Engineering, Electrical Engineering, Mathematics, Statistics, Processing and Food Engineering or any other as approved by the Dean Postgraduate Studies.

Deficiency Courses As recommended by student's Advisory Committee and approved by the Dean, Postgraduate Studies
DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

FMP 202 Farm Power and Machinery  
1+1 Sem. I 
(For students of College of Agriculture) 

FMP 206 Field Operation and Maintenance of Tractors and Farm Machinery-1  
0+1 Sem. I,II 
Introduction to various systems of a tractor viz. fuel, lubrication, cooling, electrical, transmission, hydraulic and final drive system. Familiarisation with tractor controls & learning procedure of tractor starting and stopping. Driving in forward and reverse gears. Driving safety rules and road signs. Hitching, adjustments, settings and field operation of farm machinery. Familiarisation with different makes & models of 4-wheeled tractors. Driving practice with two wheeled tractor trailer in forward and reverse. Practising the hitching and dehitching of implements; Study operation and field adjustments of common primary and secondary tillage equipment and seed drills.

FMP 303 Farm Machinery and Equipment-I  
2+1 Sem. II 
Practical: Introduction and identification of various farm machines, visit to implements shed and research hall; Field capacity and field efficiency measurement for at least two machines/implements; Draft and fuel consumption measurement under different soil conditions; Construction details, adjustments and working of M.B. plow, disc plow and disc harrow and secondary tillage tools, earth moving equipment, rotavators and other rotary tillers, measurement of speed and working width; Working of seed-cum-fertilizer drills, planters and their calibration in field; Working of transplanters and operation; Weeding equipments and their use. Sprayers and dusters, measurement of nozzle discharge, field capacity etc.

FMP 304 Farm Machinery and Equipment-II  
2+1 Sem. I 

Practical: Familiarization with various Farm machines related to harvesting, threshing, root harvesting, combine etc; Study of various types of mowers, reaper, reaper binder potato harvesters groundnut harvesters, forage harvester, sugarcane harvester and maize sheller. Study of threshing systems and thresher. Study of various types of cotton pickers and strippers, harvesting tools. Study of various types of combine harvesters, straw combines, and fruit harvesting equipment, constructional details, materials and working.

**FMP 305 Tractor and Automotive Engines**

(Pre requisite ME 105)

Sources of farm power -conventional and non-conventional energy sources. Classification of tractors and IC engines. Review of thermodynamic principles of IC (CI and SI) engines and deviation from ideal cycle. Study of engine components their construction, operating principles and functions. Engine systems: valves and valve mechanism. Fuel and air supply, cooling, lubricating, ignition, starting and electrical systems. Study of constructional details, adjustments & operating principles of these systems. IC engine fuels - their properties and combustion of fuels, gasoline tests and their significance, diesel fuel tests and their significance, detonation and knocking in IC engines, study of properties of coolants, anti freeze and anti-corrosion materials, lubricant types and study of their properties. Engine governing systems.

Practical: Introduction to different systems of an CI engine; Engine parts and functions, working principles etc; Valve system - study, construction and adjustments; Oil and Fuel - determination of physical properties; Air cleaning system; Fuel supply system of SI engine; Diesel injection system and timing; Cooling system, and fan performance, thermostat and radiator performance evaluation; Part load efficiencies and governing; Lubricating system and adjustments; Starting and electrical system; Ignition system; Tractor engine heat balance and engine performance curves; Visit to engine manufacturer/ assembler/ spare parts agency.

**FMP 306 Field Operation and Maintenance of Tractors and Farm Machinery -II**

(Pre requisite FMP 206)

Introduction to tractor maintenance procedure and trouble shooting. Scheduled maintenance after 10, 50,100, 250,500 and 1000 hrs. of operation. Safety hints. Top end overhauling. Fuel saving tips. Preparing the tractor for storage. Care and maintenance procedure of agricultural machinery during operation and off-season. Repair and maintenance and workshop requirements.

Practical: Familiarisation with tools and equipment used for maintaining and servicing of tractors and farm machines; Doing the 10-hours service jobs and Maintenance after 50- hours of operation. Conducting preventive maintenance of tractors and following service schedules. Dismantling and assembling of major engine parts; Visit to tractor/ engine repair workshop, injection pump injector repair shop; Doing minor repair of electric, mechanical and hydraulic system; Adjustment and maintenance of primary and secondary tillage equipment, seeding, planting and transplanting machines, plant protection equipment, reapers and threshers. Adjustment and maintenance of combine harvesters, straw combines, balers etc. Visit to small scale farm machinery manufacturers, repair shops, seasonal maintenance of farm machinery.

**FMP 403 Tractor Systems and Controls**

(Pre requisite FMP 206)

Study of transmission systems, clutch, gear box, differential and final drive mechanism. Familiarization of brake mechanism. Ackerman and hydraulic steering and hydraulic systems. Tractor power outlets: P.T.O., belt pulley, drawbar, etc. Tractor chassis mechanics and design for tractor stability. Ergonomic considerations and operational safety.

Practical: Introduction to transmission systems and components; Study of clutch functioning, parts and design problem on clutch system; Study of different types of gear box, calculation of speed ratios, design problems on gear box; Study on differential and final drive and planetary gears; Study of brake systems and some design problems; Steering geometry and adjustments; Study of hydraulic systems in a tractor, hydraulic trailer and some design problems; Traction performance of a tractor wheel; Finding C.G. of a tractor by weighing technique; Finding CG of a tractor using suspension/balancing techniques;
Finding moment of Inertia of a tractor; Appraisal of various controls in different makes tractors in relation to anthropometric measurements.

**FMP 404  Tractor Design and Testing**

2+1  Sem. I

(Pre requisite FMP 403)


Practical: Design problem of tractor clutch - (Single/ Multiple disc clutch), spur gears, bevel gears and helical gears. Design of gear box(synchromesh/constant mesh), variable speed constant mesh drive; Selection of tractor tires - Problem solving. Problem on design of governor. Design and selection of hydraulic pump. Engine testing as per BIS code. Drawbar performance in the lab; PTO test and measure the tractor power in the lab/field; Determining the turning space, turning radius and brake test, hydraulic pump performance test and air cleaner and noise measurement test; Visit to tractor testing centre/industry.

**Cafeteria Courses**

**FMP 405 Production Technology of Agricultural Machinery**

2+1  Sem. II


Practical: Drawings of exhaustive design plan for a machine and describe its kinematics; Part modelling of agricultural machinery by using standard software; Problem on design of cultivator and drill parts, sprayer parts including fluid flow, harvesting and threshing machinery parts; Visit to Industry. Jigs and Fixtures - study in relation to Agril Machinery. Fits, tolerances and limits; Layout planning of a small scale industry; Problems on Economics of process selection; Preparation of a project report; Case study for manufacturing of simple agricultural machinery. CNC controllers/ servo motors, CNC programming; Case studies for manufacturing of tractor through industry visit.

**FMP 406 Mechanics of Tillage and Traction**

2+1  Sem. II

Introduction to mechanics of tillage tools, engineering properties of soil, principles and concepts, stress strain relationship, design of tillage tools principles of soil cutting, design equation, force analysis, application of dimensional analysis in soil dynamics performance of tillage tools. Introduction to traction and mechanics, off road traction and mobility, traction model, traction improvement, traction prediction, tyre size, tyre lug geometry and their effects, tyre testing, soil compaction and plant growth, variability and geo statistic, application of GIS in soil dynamics.

Practical: Measurement of static and dynamic soil parameters related to tillage, soil parameters related to puddling and floatation, draft for passive rotary and oscillating tools, slip and sinkage under dry and wet soil conditions and load and fuel consumption for different farm operations; Economics of weight transfer and tractor loading including placement and traction aids; Studies on tyres, tracks and treads under different conditions, and soil compaction and number of operations.

**FMP 407 Farm Power and Machinery Management**

2+1  Sem. II

The role of mechanization and its relationship to productivity, employment, social and technological change; performance and power analysis; cost analysis of machinery: fixed cost and variable costs, effect
of inflation on cost; selection of optimum machinery and replacement criteria; break-even analysis, reliability and cash flow problems; mechanization planning; case studies of agricultural mechanization in India.

Practical: Solving problems related to various capacities, pattern efficiency, system limitation, power requirement and other operational parameters. Problems related to cost analysis and inflation and problems related to selection of equipment, replacement, break-even analysis, time value of money etc. Presentation of seminar on topic assigned related to farm machinery management. Design of farm mechanization plan for different farm size and cropping pattern.

**FMP 408 Human Engineering and Safety**  
2+1  
Sem. II

Human factors in system development - concept of systems; basic processes in system development, performance reliability, human performance. Information input process, visual displays, major types and use of displays, auditory and factual displays. Speech communications. Biomechanics of motion, types of movements, Range of movements, strength and endurance, speed and accuracy, human control of systems. Human motor activities, controls, tools and related devices. Anthropometry: arrangement and utilization of work space, atmospheric conditions, heat exchange process and performance, air pollution. Dangerous machine (Regulation) act, Rehabilitation and compensation to accident victims, Safety gadgets for spraying, threshing, Chaff cutting and tractor and trailer operation etc.

Practical: Calibration of the subject in the laboratory using bi-cycle ergo-meter as loading device, versus different physiological parameters. Study and calibration of the subject in the laboratory using mechanical treadmill as loading device versus different physiological parameters; Use of Respiration gas meter from energy point of view. Heart Rate Monitor and farm operation as a loading device. Study of general fatigue of the subject using Blink ratio method, use of electromyograph equipment, anthropometric measurements of a selected group of farm workers and its statistical analysis. Optimum work space layout and locations of controls of different factors. Familiarization with the noise and vibration equipment.

**FMP 409 Hydraulic Drives and Controls**  
2+1  
Sem. II


Practical: Introduction to hydraulic systems. Study of hydraulic pumps, hydraulic actuators. Study of hydraulic motors, hydraulic valves, hydraulic codes and circuits. Building simple hydraulic circuits, hydraulics in tractors. Introduction to pneumatics, pneumatics devices, pneumatics in agriculture; Use of hydraulics and pneumatics for robotics.

**FMP 410 Biomass Management for Fodder and Energy**  
1+1  
Sem. II

Introduction to biomass management, biomass resource assessment management techniques/supply chains, Processing of paddy straw, densification- Extrusion process, pellets, mills and cubes, Bailing-classification, uses; residue management for surface mulch and soil incorporation, Paddy Straw choppers and spreaders as an attachment to combine Harvester, Mulch seeder, Paddy Straw Chopper-cum-Loader, Baler for collection of straw; Processing of straw/ fodder for animal use; Agricultural and horticultural use, Cushioning material for fruits and vegetables, Mulching and Composting, Paper and cardboard manufacturing, Straw as a fuel.

Practical: Familiarization with different straw management techniques; on-farm and off-farm uses of straw; collection, loading and transport equipments for unbruised loose straw. Briquetting machine and preparation of briquettes. Straw baler and making of bales in the field. Straw/ fodder chopping machines, straw/mulching and incorporating machinery; machinery requirement for baling forage crops for silage.
Postgraduate Courses

FMP 501 Design of Farm Power and Machinery 3+1 Sem. II
Research and development procedure in farm equipment and agricultural tractors. Design problems and application in typical farm equipment and other organizations. Design analysis from ethical point of view. Power transmission elements. Mechanical and hydraulic, selection, design analysis, applications and limitations. Use of computer aided design in farm equipment. Analysis of linkages in farm machinery and application to few selected equipment. Application of design principles in design and analysis of selected systems and components of farm equipment such as tillage, planting/harvesting etc. Design of rotary and oscillating machines. Reliability criteria in design and its application.
Practical: Design of gears, bearings, springs, hydraulic power transmission components etc. Solving design problems on farm machines and equipment and matching power unit. Study of reliability criteria in design and its application.

FMP 502 Soil Dynamics in Tillage and Traction 2+1 Sem. I
Practical: Study of soil parameters and forces acting on tillage tools, wheel slippage, tyre selection, performance of traction devices and soil working tools.

FMP 503 Testing and Evaluation of Agricultural Equipment 2+1 Sem. I
Testing types, Procedures and various codes: National and International. Test equipment, usage and limitations. Laboratory and field testing of selected farm equipment. Tractor testing performance evaluation and interpretation. Review and interpretation of test reports. Case studies and integrated system approach to machinery evaluation.
Practical: Laboratory and field-testing of selected farm equipment viz. tiller, seed drill planter etc. and interpretation of test results. Material testing and accelerated testing of fast wearing components.

FMP 504 System Simulation and Computer Aided Problem Solving in Engineering 1+1 Sem. II
Concept of dimensional analysis, dimensions and units, systems of units, conversion of units of measurement, conversion of dimensional constants and equations in different units, dimensionless products, their formulation methods- the Rayleigh’s method, Buckingham’s Pi theorem and other methods. Mathematical modeling and engineering problem solving. Computers and softwares software development process, Algorithm design, program composition, quality control, documentation and maintenance, software strategy. Approximation, round off errors, truncation errors. Nature of simulations systems models and simulation, discreet event simulation, time advance mechanisms, components of discreet event simulation model. Simulation of singular server que-programme organization and logic- development of algorithm. Solving differential equation on computers- modeling engineering systems with ordinary differential equations-solution techniques using computers.
Practical: CAD Software and software development, algorithm in farm machinery. Simulation application in farm machinery like seed drill, planter, tractor etc. Simulation models.

FMP 505 Applied Instrumentation in Farm Machinery and Stress Analysis 2+1 Sem. I
Practical: Calibration of instruments, Experiment on LVDT, strain gauge transducer, inductive and capacitive pick ups, optical speed sensor, thermocouples. Vibration, measurement exercises. Application of instrument in farm machinery.

FMP 506 Farm Machinery Management and System Engineering 2+1 Sem. II
Cost analysis of farm machinery use and operations. System, definition and concept. System engineering function. System approach in farm machinery management and application of programming techniques to problems of farm power and machinery, selection, maintenance and scheduling of operations. Equipment replacement and inventory control of spare parts. Work design in agriculture. Selection of optimum mechanization systems by modeling. Application of linear programming, network theory, CPM, PERT, transportation models etc. Dynamic programming Markov chain. Man-machines-task system in farm operations, planning of work, systems in agriculture and organization of farm labour.
Practical: Field studies on farm operations and their analysis in terms of time and motion studies and resources scheduling. Computer use in solving problems of optimization, algorithm. Individual projects on system analysis of farms at different levels of mechanization.

FMP 507 Farm Machinery Dynamics, Noise and Vibrations 2+1 Sem. I

FMP 508 Tractor Design 2+1 Sem. II
Practical: Study of design aspects of tractor, and engine; tractor systems, transmission, steering, hydraulic, workplace, seat and computer aided designs.

FMP 509 Principles of Ergonomics, Application and Safety 2+1 Sem. I
Practical: Laboratory experiments in anthropometric measurements. Physiological parameter measurements of farm operators for various farm machinery operations. Human energy requirements for displays nd control of tractors and other equipment. Study of human response to noise and vibration.

FMP 510/PFE 502 Engineering Properties of Biological Material  
2+1  
Sem. I  
Physical characteristics- of different food grains, fruits and vegetables : shape, size, description of shape and size, volume and density, porosity, surface area. Rheology: ASTM standards, terms, physical states 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. 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, 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. Application of engineering properties in design and operation of agricultural equipment and structures.

Practical: Experiments for the determination of physical properties like, length, breath, 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 material.

FMP 511/EST 501 Agro-energy Audit and Management  
2+0  
Sem. II  

FMP 512/EST 502 Design and Analysis of Renewable Energy Conversion Systems  
3+0  
Sem. I  

FMP 513 Theory of Hydraulics and its Applications  
2+1  
Sem. II  

FMP 601 Advances in Farm Machinery and Power Engineering  
3+0  
Sem. I  
Farm machinery system, its characteristics and evaluation. Identification of dynamic characteristics

FMP 602 Mathematical Modeling in Farm Machinery and Power Engineering 3+0 Sem. II

FMP 603/EST 603 Energy conservation and Management in Production Agriculture 2+0 Sem. II

FMP 604 Computer Aided Analysis and Design of Farm Machinery 2+1 Sem. I
Introduction to CAD, the design process, modelling using CAD, architecture of CAD system. Geometric modeling, requirements, geometric construction methods, representation of curve desirable modeling facilities. CAD standards, Graphical Standard system; Exchange of modeling data. System analysis. Relevance of system analyst in design of a system and development of computer systems. Characteristics of Agricultural systems. Tools of structured analysis.-The data flow model. Object oriented approach. Feasibility study Steps in feasibility analysis cost analysis. System design process structured design. 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.

FMP 605 Machinery for Natural Resource Management and Precision Farming 3+1 Sem. I
Practical : Introduction to GIS and GPS, study of models - farm machinery usage. Precision farming using GIS and GPS - case study. Mechanism of power shovels, drag lines, earth diggers, clamshells etc. Earth work estimation, unit cost of operation, work scheduling, machinery maintenance, entrepreneurship.

FMP 591 Seminar
FMP 600 Master's Research
FMP 700 Doctoral Research
PROCESSING AND FOOD ENGINEERING

PROGRAMMES
M.Tech.
Ph.D.

COURSE REQUIREMENTS

M. Tech.
Field of Specialization: Processing and Food Engineering

Required Courses: PFE 501, PFE 502, PFE 503, PFE 504

Supporting Courses: Stat. 421, PGS 501 and other courses from subject matter fields (other than Minor) relating to area of special interest and research problem

Minor Field: Mechanical Engineering, Energy Science and Technology, Civil Engineering, Computer Science and Engineering, Electrical Engineering, Mathematics, Statistics, Food Science and Technology or any other as approved by the Dean Postgraduate Studies.

Deficiency Courses: As recommended by student's Advisory Committee and approved by the Dean, Postgraduate Studies.

Ph.D.

Field of Specialization: Processing and Food Engineering

Required Courses: PFE 601, PFE 602

Supporting Courses: Courses from subject matter fields (other than Minor) relating to area of special interest and research problem

Minor Field: Mechanical Engineering, Energy Science and Technology, Civil Engineering, Computer Science and Engineering, Electrical Engineering, Mathematics, Statistics, Food Science and Technology or any other as approved by the Dean Postgraduate Studies.

Deficiency Courses: As recommended by student's Advisory Committee and approved by the Dean, Postgraduate Studies.
DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

PFE 202 Engineering Properties of Biological Materials and Food Quality 2+1 Sem. I

Importance of engineering properties of biological materials and their applications in processing equipments; Study of different physical and thermal characteristics shape, size, volume, density, roundness, sphericity, surface area, specific heat, thermal conductivity, thermal diffusivity, etc. Measurement of colour, flavour, consistency, viscosity, texture and their relationship with food quality and composition. Rheological characteristics like stress, strain time effects, rheological models. Aerodynamic and frictional properties. Concept, and need of quality, quality control, Sampling; sampling techniques for liquid, powdered and granular materials, sensory quality control, panel selection methods, interpretation of sensory results in statistical quality control, Food Laws and Regulations in India. Food grades and standards.

Practical: To find the shape, size, bulk density, particle density/ true density, porosity, angle of repose, coefficient of external and internal friction, thermal conductivity, specific heat and thermal diffusivity of different crops; Study of separation behavior of a grain in a vertical wind tunnel; To determine impurities and invisible stress cracks in grains. Preparation of a ready reckoner of change in unit weight of food grains as affected by change in its moisture content (w.b.). Milling quality of paddy; Determination of hardness of food material; cooking quality of rice. Detection of adulteration in food products.

PFE 211 Food Processing Equipment - I 2+1 Sem. II

(For the College of Agriculture)


PFE 304 Protected Cultivation and Post Harvest Technology 1+1 Sem. II

(For the College of Agriculture in collaboration with Department of Vegetable Crops)


PFE 305 Crop Process Engineering 2+1 Sem. II
Scope and importance of food processing, principles and methods of food processing. Processing of farm crops; cereals, pulses, oil seeds, fruits and vegetables and their products for food and feed. Processing of animal products, Principal of size reduction, size reduction machines; crushers, grinders, cutting machines etc. - operation, efficiency and power requirement - Rittinger's, Kick's and Bond's equation, fineness modulus. Mixing, types of mixtures for dry and paste materials, rate of mixing and power requirement, mixing index. Separation, types of separators, size of screens, sieve analysis, capacity and effectiveness of screens, pneumatic separation. Filtration, different types of filters, rate of filtration, pressure drop during filtration. Scope and importance of material handling devices, different types of material handling systems; belt, chain and screw conveyor, bucket elevator, pneumatic conveying, gravity conveyor- design consideration, capacity and power requirement.

Practical: Preparation of flow and layout charts of a food processing plant; Determination of fineness modulus and uniformity index; study and performance evaluation of hammer mill; attrition mill, cleaning and grading equipment; Separation behaviour in pneumatic separator; performance evaluation of indented cylinder and screen pre-cleaner; Study of mixers; Study of conveying equipments.

PFE 306 Drying and Storage Engineering 3+1 Sem. I
Importance of moisture content and EMC and methods of their determination, EMC curve and models, principle of drying, theory of diffusion, periods of drying, thin layer, deep bed and their analysis, critical moisture content, drying models, calculation of drying air temperature and air flow rate, air pressure within the grain bed, Shred's and Hukill's curve, different methods of drying; Dryers- performance, energy utilization pattern and efficiency. Types and causes of spoilage in storage, storage of perishable products, functional requirements of storage, control of temperature and relative humidity inside storage, calculation of refrigeration load; air movement inside the storage; Storage of grains: destructive agents, respiration of grains, moisture and temperature changes in stored grains; natural ventilation inside storage, mechanical ventilation, artificial drying, traditional and modern grain storage structures; Storage of seeds, hermetically sealed and air-cooled storages-refrigerated, controlled atmosphere, modified atmospheric and frozen storages. Economic, aspects of storage.

Practical: Study of mechanics of bulk solids affecting cleaning, drying and storage of grains; Measurement of moisture content, relative humidity and air velocity during drying and aeration; Drying characteristic and determination of drying constant; Determination of EMC and ERH; Study of various types of dryers; To study the effect of relative humidity and temperature on grains stored in gunny bags; Design and layout of commercial bag and bulk storage facilities; Study of different domestic storage structures; Visits to commercial handling and storage facilities for grains.

PFE 311 Food Processing Equipment-II 2+1 Sem. I
(For students of College of Agriculture)

Practical: Lab demonstration on different states of water. Determination of equilibrium sorption isotherms, gas transmission rate and water vapour permeability of packages. Evaluation of properties of films to determine their suitability as containers for foods. Calculations for shelf life of food products. Study of freezers and CIP plant.
PFE 312 Food Plant Design and Layout

(For students of College of Agriculture)


PFE 404 Dairy and Food Engineering

Dairy development in India. Engineering, thermal and chemical properties of milk and milk products, unit operation of various dairy and food processing systems, process flow charts for product manufacture, working principles of equipment for receiving, pasteurization sterilization, homogenization, filling & packaging, butter manufacture, dairy plant design and layout, composition and proximate analysis of food products. Deterioration in products and their controls. Physical, chemical and biological methods of food preservation, changes undergone by the food components during processing, evaporation, freezing, juice extraction, filtration, membrane separation, thermal processing, plant utilities requirement.

Practical: Study of a composite pilot milk processing plant and equipments; Study of Pasteurizers, sterilizers, homogenizers, separators, butter churners, evaporators, milk dryers and freezers; Design of food processing plants and preparation of layout; Determination of physical properties of food products; Estimation of steam and refrigeration requirements in dairy & food plant; Visit to Food industry and multi-product dairy product.

PFE 405 Agricultural Structures and Environmental Control

Planning, layout, design, construction and cost estimation of farmstead. Physiological reactions of livestock environmental factors; livestock production facilities; BIS. Standards for farm structures; Design and construction of rural grain storage system; Engineering for rural living and development, rural roads, their construction cost and repair and maintenance. Sources and norms of water supply for human being and animals, drinking water standards and water treatment suitable to rural community. Site and orientation of building in regard to community sanitation system; sewage system its design, cost and maintenance; Power requirement for domestic and irrigation, sources of power supply, electrification of rural housing; Renewable and non-renewable resources; concept of eco system, biodiversity of its conservation, environmental pollution and their control, solid waste management system.

Practical: Instruments for measurements of environmental parameters; Environmental indices for your city; Harmonic analysis for sole-air temperature; Reflective and non-reflective air space in buildings; Cooling load and moisture condensation in agricultural buildings. Design and layout of a dairy farm, poultry house, sheep/goat house, biogas plant, farm fencing system, ventilation system for dairy and poultry house, feed/fodder storage structures; Familiarization with local grain storage structures. Design of grain storage structures; Cost estimation of a farm buildings.

PFE 406 Food Packaging Technology

Factors affecting shelf life of food material during storage; Spoilage mechanism during storage; Definition, requirement, importance and scope of packaging of foods; types and classification of packaging system; advantage of modern packaging system. Different types of packaging materials used. Different forms of packaging, metal container, glass container, plastic container, flexible films, shrink packaging, vacuum and gas packaging; Packaging requirement and their selection for the raw and processed foods. Advantages & disadvantages of these packaging materials; effect of these materials on packed commodities; Package testing, Printing, labeling and lamination. Economics of packaging; performance evaluation of
different methods of packaging food products; their merits and demerits; scope for improvements; disposal and recycle of packaging waste.

Practical: Identification of different types of packaging materials; determination of tear, tensile strength, compressive and burst strength of given package; To perform different destructive and non-destructive tests for glass containers; Vacuum packaging of agricultural produces; measurement of thickness of packaging materials; Determination of water-vapour transmission rate; Shrink wrapping of various horticultural produce; Testing of grease and chemical resistance of packaging materials; Determination of drop test of food package; Visit to relevant industries.

Cafeteria Courses

PFE 407 Waste and By-Product Utilization  2+1  Sem. II
Waste and byproducts generation and utilization in different food processing industries; concept scope and maintenance of waste management and effluent treatment, Temperature, pH, Oxygen demands (BOD, COD), fat, oil and grease content, metal content, forms of phosphorous and sulphur in waste waters, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues, briquetting of biomass as fuel, generation of electricity, producer gas; waste treatment and disposal, design, construction, operation and management of institutional community and family size biogas plants, concept of vermi-composting, Pre-treatment of waste: sedimentation, coagulation, flocculation and floatation, Secondary treatments: Biological and chemical oxygen demand for different food plant waste- trickling filters, oxidation ditches, activated sludge process, rotating biological contractors, lagoons, Tertiary treatments: Advanced waste water treatment process-sand, coal and activated carbon filters, phosphorous, sulphur, nitrogen and heavy metals removal.
Practical: Waste characterization; Determination of ash content and carbon in ash of agricultural waste; Briquetting of agricultural residues; Estimation of excess air for better combustion of briquettes; Study of extraction of oil from rice bran; waste treatment plant in food industry; utilization of whey; recovery of peel, germ and germ oil from by-product of cereals; Bioconversion and recycling of agro-wastes and by-products; Visits to various industries using waste and food byproducts.

PFE 408 Development of Processed Products and Equipments  2+1  Sem. II
Applications of unit operations to the food industry, analytical processing concepts with regards to mass and energy balances, equipment involved in the commercially important food processing methods and unit operations; value addition to cereals like rice, wheat etc. Parboiling of rice, quality of processed products of rice and wheat. Processing of pulses, spices and condiments; extruded food product, fermented food product, frozen and dried product, technology of meat, fish and poultry products, technology of milk and milk products. Technology of oilseeds and fat products, snack foods, Fruits and vegetables product: candy, nutraceuticals, food product development trends, food additives and labeling. Process equipment for thermal processing-evaporation, dehydration, drying, blanching, pasteurization, distillation; mechanical separation-filtration, sieving, centrifugation, sedimentation; mechanical handling-conveying and elevation; size reduction and classification-mixing; kneading, blending.
Practical: Working principle, operation and maintenance of Engleberg huller; cleaners, graders, paddy destoner-cum-cleaner, rubber roll sheller, paddy separator and vertical cone whitener; familiarization with operation and performance of Satake rice milling unit of 500 kg/hr; planning and layout of rice and roller wheat flour milling; visit to milk plant, roller flour mill, Markfed canneries, fruit/vegetable processing plants; Flow process diagram and various models of the machines used in a sugar mill.

PFE 409 Food Processing Plant Design and Layout  2+1  Sem. II
Meaning and definition of plant layout. Objectives and principles of layout. Types of layout. Salient features of processing plants for cereals, pulses oilseeds, horticultural and vegetable crops, poultry, fish and meat products, milk and milk products. Location selection criteria, selection of processes, plant capacity, project design, flow diagrams, selection of equipments, process and controls, handling equipments, plant layout, Plant elevation, requirement of plant building and its components, labour requirement, plant installation, power and power transmission, sanitation. Cost analysis, preparation of feasibility

Practical: Planning, visit and layout of flour milling plant, rice milling plant, milk plant, bakery plant, fruits and vegetable dehydration plant, beverages industry, edible of extraction plant, ice-cream plant, sugar mill plant, honey/turmeric/ chilli processing plant.

PFE 433 Engineering Principles in Food Processing 3+1 Sem. I
(For students of College of Agriculture)
Unit and Dimensions. Material and energy balances, Size reduction and related energy laws, cleaning, grading, sorting, mixing and material handling. Elementary fluid dynamics and statics, heat transfer, exchanger and psychrometrics. Principles of thermal processing, pasteurization, sterilization, refrigeration, freezing, evaporation, dehydration and centrifugal separation.


Postgraduate Courses

PFE 501 Transport Phenomena in Food Processing 2+1 Sem. I
Steady and unsteady state heat conduction, analytical and numerical solution of unsteady state heat conduction equations, Applications in food processing including freezing and thawing of foods. 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: Radiation heat transfer and its governing laws, its applications in food processing. Molecular diffusion in gases, liquids and solids; molecular diffusion in biological solutions and suspensions molecular diffusion in solids, unsteady state mass transfer and mass transfer coefficients, molecular diffusion with convection and chemical reaction, diffusion of gases in porous solids and capillaries, mass transfer applications in food processing.

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

PFE 502/FMP 510 Engineering Properties of Biological Material 2+1 Sem. 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, viscoelasticity, creep-stress relaxation, Non-Newtonian fluid and viscometry, rheological properties, force, deformation, stress, strain, elastic, plastic behaviour. 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. 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. Application of engineering properties in design and operation of agricultural equipment and structures.

Practical: Experiments for the determination of physical properties like, length, breadth, thickness, surface area, bulk density, porosity, true density, coefficient of friction, angle of repose and colour for various food grains, fruits, vegetables, spices and processed foods, aerodynamic properties like terminal velocity, lift and drag force for food grains, thermal properties like thermal conductivity, thermal diffusivity and specific heat, firmness and hardness of grain, fruits and stalk, electrical properties like dielectric constant, dielectric loss factor, loss tangent and A.C. conductivity of various food materials.
PFE 503  Advance Food Process Engineering  
Thermal processing: Death rate kinetics, thermal process calculations, methods of sterilization and equipments involved, latest trends in thermal processing. Evaporation: heat and mass balance in single effect and multiple effect evaporator, aroma recovery, Drying: Rates, equipments for solid, liquid and semi-solid material and their applications, theories of drying, novel dehydration techniques. on-thermal processing: Microwave, irradiation, ohmic heating, pulsed electric field preservation, hydrostatic pressure technique. Freezing: Freezing curves, thermodynamics, freezing time calculations, freeze drying, principle. Separation: Mechanical filtration, membrane separation, centrifugation, principles, equipments and applications. Extrusion: Theory, equipments, applications. Distillation and leaching: Phase equilibrium, multistage calculations, equipments, solvent extraction. 
Practical: Solving problems on single and multiple effect evaporator, distillation, crystallization, extraction, leaching, membrane separation and mixing, experiments on rotary flash evaporator, humidifiers, reverse osmosis and ultra filtration - design of plate and packed tower, visit to related food industry.

PFE 504 Unit Operations in Food Process Engineering
Practical: Fluid flow properties, application of psychrometric chart, determination of EMC, study of driers, elevating and conveying equipments, size reduction equipments, cleaning and sorting equipments, mixing equipments, sieve analysis, kinetics of fruits and vegetables dehydration, calculation of refrigeration load, food plant design, gas and water transmission rate, solving of numerical problems.

PFE 505 Energy Management in Food Processing Industries
Energy forms and units, energy perspective, norms and scenario; energy auditing, data collection and analysis for energy conservation in food processing industries. 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. 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. 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.

PFE 506 Processing of Cereals, Pulses and Oilseeds
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. 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. 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. Packaging of processed products, design characteristics of milling equipments; selection, installation and their performance, BIS standards for various processed products. 
Practical: Physical properties of cereals and pulses, raw and milled products quality evaluations; parboiling and drying; terminal velocities of grains and their fractions; study of paddy, wheat, pulses and oilseeds milling equipments; planning and layout of various milling plants, visit to related agro-processing industry.
PFE 507 Food Processing Equipment and Plant Design  
**Sem. II**
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.

PFE 508 Fruits and Vegetables Process Engineering  
**Sem. II**
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. Harvesting and washing, pre-cooling, preservation of fruits and vegetables, blanching, commercial canning of fruits and vegetables, minimal processing of fruits and vegetables. Cold storage, controlled atmosphere packaging of fruits and vegetables. Dehydration of fruits and vegetables, methods, osmotic dehydration, foam mat drying, freeze drying, microwave heating, applications, radiation preservation of fruits and vegetables, irradiation sources. Intermediate moisture foods, ohmic heating principle, high pressure processing of fruits and vegetables, applications, packaging technology for fruits and vegetables, general principles of quality standards and control, FPO, quality attributes.
Practical: Evaluation of washer, pre-cooler, grader and packaging equipments. Experiments on drying of fruits and vegetables, controlled atmosphere storage and quality evaluation.

PFE 509 Meat Process Engineering  
**Sem. I**
Meat and poultry products: Introduction, kinds of meat animals and poultry birds, classification of meat, composition of meat. Slaughtering: Pre slaughter operations, post slaughter operations, wholesale and retail cuts. Preservation of poultry: different methods, stuffed products, frozen products, poultry concentrates and flavours, synthetic poultry flavour. 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. 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. 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.

PFE 510/FT 511 Food Packaging  
**Sem. I**
Practical: Identification and testing of packaging materials. Determination of wax from wax paper. Measurement of tin coating weight. Sulphide stain test. Thickness, substance weight, water absorption,
PFE 511 Food Quality and Safety Engineering

Food safety, need for quality control and safety, strategy and criteria, microbiological criteria for safety and quality, biological and chemical contaminants. 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. Process equipment and machinery auditing, consideration of risk, environmental consideration, mechanical quality control. Personnel hygiene standards, preventative pest control, cleaning and disinfecting system, biological factors underlying food safety. 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.

PFE 512 Farm Structures and Environmental Control

Thermodynamic properties of moist air, psychrometric chart and computer programmes for thermodynamic properties. 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. Drying and dehumidification system, air-water contact operations and evaporation, process and product air conditioning, energy efficient environmental control practices. Instruments and measurements; codes and standards.

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

PFE 513 Storage Engineering and Handling of Agricultural Products

Storage of grains, biochemical changes during storage, production, distribution and storage capacity estimate models, storage capacity models, ecology, storage factors affecting losses, storage requirements. 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. Grain markets, cold storage, controlled and modified atmosphere storage, irradiation, storage of dehydrated products, BIS standards. Physical factors influencing flow characteristics, mechanics of bulk solids, flow through hoppers, openings and ducts; design of belt, chain, screw, roller, pneumatic conveyors and bucket elevators; principles of fluidization; recent advances in handling of food materials.

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

PFE 514 Seed Drying, Processing and Storage

Processing of different seeds and their engineering properties, principles and importance of seed processing. Performance characteristics of different unit operations such as precleaning, 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. 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 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.

**PFE 515 Biochemical and Process Engineering**  
2+1  
Sem. II

Applications of engineering principles; mass and energy balance, fluid flow principles, unit operations of process engineering. Fundamentals of growth kinetics, maintenance energy and yield concepts, principles of media sterilization, media formulations of industrial fermentation. Aerobic and agitated rheology of fermentative fluids, design and scale-up of bioreactors, enzyme reactors. 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.

**PFE 516 Milk and Milk Product Process Engineering**  
2+1  
Sem. I

National milk grid and dairy projects; heat processing of milk; filling and packaging of fruit milk; equipment for dairy products processing such as evaporated milk, cream, butter, spreads and indigenous dairy products; drying of milk and sterilization of powdery foods; modifications to the composition of milk; processing and packaging equipment for cheese, yoghurt; special and fermented milk; frozen dairy products; plant engineering and management.

Practical: Platform test of milk; determination of heat transfer characteristics of various dairy products; calculation of residence time during HTST pasteurization; rheological properties of dairy products; planning for fluid milk processing plants and composite processing plant.

**PFE 601 Textural and Rheological Characteristics of Food Materials**  
2+1  
Sem. I


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

**PFE 602 Advances in Food Processing**  
3+0  
Sem. II

Low temperature preservation - advantages and applications cooling and cold storage - freeze concentration and membrane separation process - hurdle technology - principles and applications - food irradiation-microwave processing - microwave equipment - hydrostatic pressure treatment of food - 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. extrusion cooking - equipment, design criteria of extruders.

**PFE 603 Mathematical Models in Food Processing**  
3+0  
Sem. I

PFE 604 Advances in Drying of Food Materials
2+1 Sem. II
Isotherm models, psychrometry, construction and use of psychrometric charts. Air flow and resistance, principles and equipments for air movement and heating, drying methods and theory of drying, driers, classification and other allied equipment, drying models. 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. Drying of liquid foods, spray drying, drum drying, freeze drying, foam mat drying, heat pump drying, osmotic dehydration.
Practical: Experiments on batch type thin layer drier, fluidized bed drier, continuous flow mixing type drier, continuous flow non mixing type drier, sand medium drier (conduction type drying), agricultural waste fired furnace drier, spray dryer, drum dryer, foam mat drying and osmotic dehydration, to evaluate the thermal efficiency and heat utilization factor.

PFE 605 Agricultural Waste and By-Products Utilization
2+1 Sem. II
Generation of by-products, agricultural and agro industrial byproducts/wastes, properties, on site handling, storage and processing. 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. Utilization of wastes for paper production, production of particle board, utilization, by-products from rice mill, rice husk, rice bran, utilisation. 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.

PFE 591 Seminar
PFE 600 Master’s Research
PFE 700 Doctoral Research
SOIL AND WATER ENGINEERING

A. SOIL AND WATER ENGINEERING

PROGRAMMES

M. Tech.

Ph.D.

COURSE REQUIREMENTS

M.Tech.

Field of Specialization

Soil and Water Engineering

Required Courses

SWE 501, SWE 502, SWE 503, SWE 504, SWE 505

Supporting Courses

Stat. 421, PGS 501 and other courses from subject matter fields (other than Minor) relating to area of special interest and research problem.

Minor Field

Civil Engineering, Electrical Engineering, Computer Science and Engineering, Mathematics, Soil Science or any other as approved by the Dean Postgraduate Studies.

Deficiency Courses

As recommended by the student's Advisory Committee and approved by the Dean, Postgraduates Studies

Ph.D.

Field of specialization

Soil and Water Engineering

Required courses

SWE 601, SWE 602

Supporting courses

Courses from subject matter fields (other than Minor) relating to area of special interest and research problem.

Minor Field

Civil Engineering, Electrical Engineering, Computer Science and Engineering, Soil Science, Energy Science and Technology or any other as approved by the Dean Postgraduate Studies.

Deficiency courses

As recommended by the student's Advisory Committee and approved by the Dean, Postgraduates Studies
DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

**SWE 101 Fundamentals of Soil and Water Conservation Engineering**  
2+1  
Sem. I,II  
(For the College of Agriculture in collaboration with Department of Civil Engineering)


**SWE 304 Irrigation Engineering**  
3+1  
Sem. I  


**SWE 305 Soil and Water Conservation Engineering**  
2+1  
Sem. II  
(Pre-requisite: CE 204)


SWE 306 Soil and Water Conservation Structures 2+1  Sem. I


SWE 404 Groundwater, Wells and Pumps 2+1  Sem. II


SWE 405 Drainage Engineering 1+1  Sem. I


SWE 406 Minor Irrigation and Command Area Development 2+1  Sem. I

Major, medium and minor irrigation projects. Development and utilization of water resources through different minor irrigation schemes. Basic concepts of command area. Irrigation water use efficiency and agricultural production. Land development, shaping methods and economics. Farm irrigation planning. Irrigation schedule policies. Rotational and other methods of water distribution. Water balance of a command area. Types and design of canal outlets. Conjunctive use of water. Cropping pattern for maximization of


Cafeteria Courses

SWE 407 Design and Maintenance of Greenhouse  
2+1  Sem. II

History and types of greenhouse; importance, function and features of greenhouse; scope and development of greenhouse technology. Location, Planning and various component of greenhouse; design criteria and calculation; constructional material and methods of construction; covering materials and its characteristics, solar heat transfer, solar fraction for green house, steady state analysis of greenhouse, Greenhouse heating, cooling, shading and ventilation systems; Carbon Dioxide generation and monitoring and lighting systems, instrumentation and computerized environmental Control Systems. Watering, fertilization, root substrate and its pasteurization, containers and benches, plant nutrition. Alternative cropping systems; plant tissue culture, chemical growth regulation; disease control; integrated pest management; post production quality and handling. Cost analysis of greenhouse production; Applications of greenhouse; its repair and maintenance.

Practical: Study/visit to a functional green house; planning and layout of green house and associated utilities; Material selection for the construction of green house; Measurement of temperature, humidity and air velocity inside the green house using various methods; Measurement of solar radiations inside the green house; Application of psychometric charts; estimation of cooling requirements in a green house; estimation of ventilation requirements; Thermal performance of green house; Application of data loggers for simultaneous estimation & control of different parameters like temp., RH, solar radiations etc.; Calculations of environment indices inside a green house; Structural analysis of green house; Economic analysis of green house; Visit to a commercial green house.

SWE 408 Micro Irrigation Systems Design  
2+1  Sem. II


SWE 409 Watershed Planning and Management  
2+1  Sem. II


SWE 410 Gully and Ravine Control Structures 2+1 Sem. II


SWE 411 Remote Sensing and GIS Applications 2+1 Sem. II

Practical: Familiarization with remote sensing and GIS hardware. Use of instruments for aerial photo interpretation. Interpretation of aerial photographs and satellite imagery. Basic GIS operations such as image display. Study the various features of GIS software package. Scanning and digitization of maps. Data base query and map algebra. GIS supported case studies in water resources management.

SWE 412 Reservoir and Farm Pond Design 2+1 Sem. II

Practical: Study of different types and materials of earthen dams. Determination of the position of phreatic line in earth dams. Stability analysis of earthen dams against head water pressure, foundation

Postgraduate Courses

SWE 501 Watershed Hydrology 2+1 Sem. I

SWE 502 Design of Farm Irrigation Systems 3+0 Sem. II

SWE 503 Agricultural Drainage Systems 2+0 Sem. II

SWE 504 Groundwater Engineering 3+0 Sem. I

SWE 505 Flow Through Porous Media 2+0 Sem. I
Aquifer and fluid properties and forces responsible for water movement in soils. Porosity, permeability and differential equations of saturated and Unsaturated flow, initial and boundary conditions. Dupuit and Boussinesq approximations and linearization techniques. Stream functions, potential functions and flow
net theory, Analysis or seepage from canals and ditches. Infiltration and capillary rise flux dynamics. Hydro-dynamic dispersion in soil-aquifer system

SWE 506 Crop Environmental Engineering  
2+0  Sem. II

SWE 507 Design of Pumps for Irrigation and Drainage  
2+0  Sem. II
Basic hydraulic design of centrifugal pump. Net positive suction head and cavitation, vapour pressure, water hammering problem in centrifugal pump. Principle and performance of characteristics of vertical turbine pump, submersible pump and axial flow pump and their design. Non-conventional energy sources for pumping, wind mills, micro turbines, solar pumps, hydraulic ram their selection and design criteria. Design of pumping station, techno-economic evaluation, efficient pumping system operation, flow control strategies and conservation measures for pumping systems.

SWE 508 Soil and Water Conservation Engineering  
2+1  Sem. I

SWE 509 Water Resources System Engineering  
3+0  Sem. I

2+1  Sem. II
SWE 511/RSGIS 509 Watershed Management and Modelling  2+1  Sem. II

SWE 512 Land Development and Earth Moving Machinery  2+0  Sem. I
(in collaboration with Department of Farm Machinery and Power Engineering)

SWE 513 Numerical Methods in Hydrology  2+0  Sem. II

SWE 601 Advanced Hydrology  3+0  Sem. II

SWE 602 Advanced Hydro-Mechanics in Soil Aquifer Systems  3+0  Sem. II

SWE 603 Modeling Soil Erosion Processes  3+0  Sem. I
SWE 604  Soil and Water Systems Simulation and Modelling  2+1  Sem. I

SWE 605  Hydro-Chemical Modeling  2+0  Sem. I

SWE 606  Plant Growth Modelling and Simulation  3+0  Sem. II

SWE 607  Advances in Irrigation and Drainage  2+0  Sem. II

SWE 591  Seminar
SWE 600  Master’s Research
SWE 700  Doctoral Research
B. REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM

PROGRAMMES
M. Tech.
(in collaboration with Punjab Remote Sensing Centre)

COURSE REQUIREMENTS
M.Tech.
Field of Specialization
Remote Sensing and Geographic Information System

Required Courses
RSGIS 501, RSGIS 502, RSGIS 503, RSGIS 504, RSGIS 510

Supporting Courses
Stat. 421, PGS 501 and other courses from subject matter fields (other than Minor) relating to area of special interest and research problem.

Minor Field
Computer Science and Engineering, Soil and Water Engineering, Soil Science, Forestry and Natural Resources, Agrometeorology, Agronomy, Information Technology or any other as approved by the Dean Postgraduate Studies.

Deficiency Courses
As recommended by the student's Advisory Committee and approved by the Dean, Postgraduate Studies

DESCRIPTION OF COURSE CONTENTS

RSGIS 501 Principles of Remote Sensing
2+1 Sem. I
Practical: Satellite Image Annotation and Referencing Scheme. Digital Referencing Scheme. IR Thermal Radiation Measuring Instruments and drawing of Isotherms and plotting diurnal variation curve. Understanding of Spectral Response Pattern of different Land cover objects. Ground Data collection instruments, Radiometers, Spectrometers etc. and Ground Data collection in a given area with the help of Radiometers and Spectrometers.

RSGIS 502 Geomatics, Geodesy and GPS
2+1 Sem. I
Components and functions of GIS, Data types and spatial data models, Spatial data and attribute data, their sources, Geographical data formats. Digitizing, Spatial Data quality and uncertainty. Non Spatial Database Creation, Database Design using RDBMS, Vector & raster based analysis: Single and multi-layer raster and vector analysis, map overlay, Spatial Join, Buffering analysis, network analysis, optimum


RSGIS 503 Digital Image processing 2+1 Sem. II


RSGIS 504 Introduction to Photogrammetry and Cartography 2+1 Sem. I

Practical: Preparation of Base map from topographical sheet, Orientation of stereo-model under Mirror Stereoscope and tracing of details in stereo pair, Use of Parallax Bar, determination of height from stereo pair, Exercise on map projection conversion, Exercise on DEM interpolation and DEM derivative extraction, Exercise on satellite DEM and ortho- image generation, Field exercise on interpretation.

RSGIS 505 Agri-Informatics 2+1 Sem. II
Overview and importance: Need for Agri-informatics; Spectral characteristics of crops and Spectral Vegetation Indices; Crop discrimination and acreage estimation, Crop yield modeling and condition assessment, significance of temporal satellite data; Cropping System analysis, Imaging spectroscopy, Optimum narrow bands, physiological narrow band indices, Red edge & their indices for crop stress assessment; Precision agriculture, prospects and scope in Indian agriculture; Crop parameter retrieval: Key biometric parameters. Crop discrimination, crop growth monitoring and assessment, crop parameters retrieval from microwave. Relational Agri-database information storage and retrieval, Productivity Constraints Analysis; Yield gap analysis, Early warning system. DSS in agriculture.

assessment, Crop stress assessment using hyper-spectral satellite data, SAR data analysis for crop discrimination and area estimation, SDSS for crop input optimization, ground truth data collection.

**RSGIS 506 Application of RS and GIS for Soil Resources Management**  
2+1  
Sem. I

Physiographic analysis and their relationship with soils, soil mapping using aerial and satellite remote sensing data, kinds of soil survey, basic concept of soil profile, spectral characteristics of soils, land capability classification, land evaluation for optimal land use planning, identification and mapping of wastelands & degraded lands, mapping of soil salinity and water logging, soil moisture estimation, concept of watershed and watershed management, types of drainage and their delineation, soil erosion and erosion hazard assessment, soil conservation and management, Soil Information System and soil coding.

Practical: Study and mapping of physiography using RS data, relationship between physiography and soil types, soil mapping using aerial and satellite data, identification and delineation of soil salinity and waterlogging, sand dunes, gullied and ravenous lands, soil erosion mapping, soil-site suitability evaluation, study of drainage and their characteristics, delineation of watersheds, soil coding and soil information system in GIS.

**RSGIS 507 Application of RS and GIS for Water Resources Management**  
2+1  
Sem. I

Development of scientific hydrology, importance of water, occurrence of water, hydrological cycle, Overview of remote sensing and GIS applications in hydrology, Soil moisture at local and global scale, soil moisture retrieval using satellite data. Potential evapotranspiration and factors controlling it, Groundwater, origin and occurrence, storage, types of aquifers, groundwater movement, level. Water pollution, and use of remote sensing in water quality studies. Evaluation of surface water resources and groundwater, water supplies and utilization, problems, policies and management. GIS for surface water modeling-groundwater modeling. Concept of irrigation command area development, Snow parameter retrieval using optical and microwave data, Snowmelt runoff modeling. Hydrologic Information System.


**RSGIS 508 Application of RS and GIS for Land Resources Management**  
2+1  
Sem. I


**RSGIS 509/SWE 511 Watershed Management and Modelling**  
2+1  
Sem. II


RSGIS 510/CSE 505 Data Base Management 2+1 Sem. I
Data base concept. Sequential, indexed sequential and random access files. Storage and retrieval of data: quarry languages. Data languages. Data validation. Use of a standard data base management package.

Practical: Use of data base packages, Creation of Tables, Relationships, Queries (Views), Forms, Report Generation.

RSGIS 591 Seminar
RSGIS 600 Master's Research

Optional Courses (Course contents in the parent department)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Semester</th>
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</thead>
<tbody>
<tr>
<td>Stat. 528</td>
<td>Statistics for Image Processing</td>
<td>2+1</td>
<td>Sem. I</td>
</tr>
<tr>
<td>Soils 512</td>
<td>Environmental Soil Science</td>
<td>3+0</td>
<td>Sem. I</td>
</tr>
<tr>
<td>Forst. 511</td>
<td>Remote Sensing and GIS Applications in Forestry</td>
<td>2+1</td>
<td>Sem. I</td>
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<tr>
<td>Forst. 512</td>
<td>Land use Planning, Biometry and Forest Management</td>
<td>2+1</td>
<td>Sem. II</td>
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</tbody>
</table>
CIVIL ENGINEERING

PROGRAMMES
M. Tech.
Ph. D.

COURSE REQUIREMENTS

M. Tech.
Fields of Specialization
Hydrology and Water Resources Engineering, Structural Engineering

Required Courses
CE 501, CE 502, CE 503, CE 504 for Hydrology and Water Resources Engineering
CE 505, CE 506, CE 507, CE 508, CE 509 for Structural Engineering.

Supporting Courses
Stat. 421, PGS 501 and other courses from subject matter fields (other than Minor) relating to area of special interest and research problem.

Minor Field
Soil and Water Engineering, Computer Science and Engineering, Processing and Food Engineering, Mathematics, Statistics or any other as approved by Dean Postgraduate Studies.

Deficiency Courses
As recommended by the student's Advisory Committee and approved by the Dean, Postgraduate Studies

Ph. D.
Field of Specialization
Structural Engineering

Required Courses
CE 601, CE 602, CE 603, CE 604

Supporting Courses
Courses from subject matter fields (other than Minor) relating to area of special interest and research problem.

Minor Field
Computer Science and Engineering, Energy Science and Technology or any other as approved by Dean, Postgraduate Studies.

Deficiency Courses
As recommended by the student's Advisory Committee and approved by the Dean, Postgraduate Studies
DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

CE 104 Surveying and Leveling 1+2 Sem. II

CE 203 Engineering Mechanics 2+1 Sem. II

CE 204 Watershed Hydrology 2+1 Sem. I

CE 205 Soil Mechanics 2+1 Sem. II
Practical: Determination of water content of soil by oven drying method, specific gravity of soil by pycnometer method, field density of soil by core cutter method and sand replacement method. Grain size
analysis by sieving and by hydrometer method. Determination of plastic limit, shrinkage limit and liquid
limit. Permeability of given soil by constant head method and variable head method. Study of compaction
properties by standard proctor test. Determination of shear parameters of soil by direct shear test, unconfined
compressive strength test and triaxial test. Study of consolidation properties of soils.

CE 305 Strength of Materials 2+1 Sem. I
(Pre-requisite: CE 203)
Introduction. Slope and deflection of beams using integration techniques, moment area method and
dams. Statically indeterminate beams. Propped beams. Analysis of fixed beams. Analysis of continuous
beams using three moment theorem and moment distribution method.
Practical: Mechanical behaviour of engineering materials under loads: axial tensile, axial compressive,
bending, torsion and impact. Behaviour of closely coiled helical spring in tension and compression.
Determination of hardness of given specimens. Compressive and tensile strength of cement. Determination
of void ratio and bulk density of cement, fine aggregates and coarse aggregates. Measurement of
workability of concrete. Determination of fatigue strength of a given specimen.

CE 403 Design of Structures 2+1 Sem. II
(Pre-requisite: CE 305)
Introduction to design concepts. Different types of loads and use of BIS Codes (IS 800 and IS 456). Design
of steel connections. Design of structural steel members in tension, compression and bending. Design of
steel roof truss. Analysis and design of singly and doubly reinforced sections. Shear, Bond and Torsion.
Design of Flanged Beams, Slabs, Columns, Foundations, Retaining walls and Silos.
Practical: Design of tension members, compression members and steel beams; Design and drawing of
steel roof truss. Design of singly and doubly reinforced concrete rectangular beams and T beams.
Design of one way and two way slabs. Design of columns, isolated footing and combined foundation.
Design and drawing of a simple RCC building. Design and drawing of cantilever retaining wall.

Cafeteria Courses

CE 404 Environmental Engineering 2+1 Sem. II
Importance of safe water supply system. Domestic water requirements for urban and rural areas. Sources
of Water supply. Intakes and transportation of water. Drinking water quality. Indian Standards of
drinking water. Introduction to water treatment. Importance of sanitation. Domestic waste water: quantity,
characteristics, disposal in urban and rural areas. Sewer: types, design discharge and hydraulic design.
Introduction to domestic wastewater treatment. Design of septic tank. Solid waste: quantity, characteristics
and disposal for urban and rural areas. Introduction to air pollution. Types of pollutants properties and
their effects on living beings. ISI standards for pollutants in air and their abetments.
Practical: Determination of turbidity, pH, suspended solids, dissolved solids, total solids, temporary
hardness, permanent hardness, fluorides, chlorides, dissolved oxygen, biochemical oxygen demand,
chemical oxygen demand. Collection of air samples and their analysis. Numerical problems related to
theory. Visit to treatment plant.

CE 405 Building Technology & Construction Practices 2+1 Sem. II
concrete. Timber. Miscellaneous materials: plastics, fly ash, bitumen, plywood, corrugated sheets and
to plumbing and drainage, low cost housing/rural housing and construction practices.
Practical: Laying out of a building in the field. Construction practices in field. Detailed drawing of a small
building from measurements. Drawing of walls of various thicknesses in different bonds. Foundation drawing.
Damp proof course drawing. Drawing of floors and roofs.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Semester</th>
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<tbody>
<tr>
<td>CE 501</td>
<td>Open Channel Flow</td>
<td>3+0</td>
<td>I</td>
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<tr>
<td>CE 502</td>
<td>Dams and Reservoir Operations</td>
<td>3+1</td>
<td>II</td>
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<tr>
<td>CE 503</td>
<td>Water Quality and Pollution Control</td>
<td>3+1</td>
<td>II</td>
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<tr>
<td>CE 504</td>
<td>Fluvial Hydraulics</td>
<td>2+1</td>
<td>I</td>
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<tr>
<td>CE 505</td>
<td>Matrix - Methods of Structural Analysis</td>
<td>3+0</td>
<td>I</td>
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<tr>
<td>CE 506</td>
<td>Probabilistic Approach in Design</td>
<td>2+0</td>
<td>II</td>
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</tbody>
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**CE 501 Open Channel Flow**


**CE 502 Dams and Reservoir Operations**


**CE 503 Water Quality and Pollution Control**


**CE 504 Fluvial Hydraulics**


Practical: Problems on determination of sediment properties. Regimes of flow, resistance to flow, incipient motion, bed load, suspended load, total load transport and sediment yield from catchment.

**CE 505 Matrix - Methods of Structural Analysis**


**CE 506 Probabilistic Approach in Design**

CE 507 Structural Dynamics  3+0  Sem. II

CE 508 Inelastic Design in Structures  3+0  Sem. I

CE 509 Concrete Technology and Prestressed Concrete  3+0  Sem.I

CE 510 Experimental Stress Analysis  2+1  Sem. II

CE 511 Viscous Fluid Flow  2+0  Sem. I

CE 512 Agro Industrial Pollution Control  2+1  Sem.II
Practical: Determination of pH, total solids, suspended solids and volatile solids; dissolved oxygen, Biochemical oxygen demand, chemical oxygen demand, turbidity colour etc. Design of treatment plant.

CE 513 Control of Pollution from Solid Waste  2+0  Sem. I
Fertilizer. Fuel and food values. Sanitary landfill, composting, incineration and pyrolysis. Recycle and reuse- Materials and energy recovery operations.

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<th>Semesters</th>
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<tbody>
<tr>
<td>CE 514</td>
<td>Sub-soil and Clay Water Systems</td>
<td>3+0</td>
<td>II</td>
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<tr>
<td>CE 515</td>
<td>Foundation Engineering</td>
<td>2+1</td>
<td>I</td>
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<tr>
<td>CE 516</td>
<td>Similitude in Engineering</td>
<td>2+1</td>
<td>II</td>
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<tr>
<td>CE 517</td>
<td>Application of Finite Element Method in Structural Engineering</td>
<td>2+0</td>
<td>I</td>
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<td></td>
<td>Review of principle of virtual work. Minimum potential energy. Various types of elements. Solution procedures. Detailed study of application to structures such as dams, frame shear walls, grid floors and drafts. Application to vibration and buckling problems.</td>
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<tr>
<td>CE 518</td>
<td>Solid Mechanics and Elasticity</td>
<td>4+0</td>
<td>II</td>
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<tr>
<td>CE 519</td>
<td>Theory of Plates and Shells</td>
<td>4+0</td>
<td>II</td>
</tr>
<tr>
<td>CE 520</td>
<td>Design of R. C. C. Bridges</td>
<td>2+1</td>
<td>I</td>
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Practical: Design problem of foot bridge, slab bridge, T-beam bridge, balanced cantilever bridge, piers, bearings, piles and well foundations.

**CE 521 Applied Soil Mechanics** 2+1 Sem. II

**CE 601 Structural Response to Dynamic Loading** 3+0 Sem. II

**CE 602 Design of Industrial Building** 3+0 Sem. I

**CE 603 Design of Tall Buildings** 3+0 Sem. I

**CE 604 Random Vibrations** 3+0 Sem. II

**CE 591 Seminar**

**CE 600 Master's Research**

**CE 700 Doctoral Research**
MECHANICAL ENGINEERING

PROGRAMMES
M. Tech.
Ph. D.

COURSE REQUIREMENTS
M. Tech.

Field of Specialization
Thermal Engineering, Machine Design

Required Courses
ME 501, ME 502 for Thermal Engineering
ME 503, ME 504 for Machine Design

Supporting Courses
Stat. 421, PGS 501 and other courses from subject matter fields (other than Minor) relating to area of special interest and research problem.

Minor Field
Computer Science and Engineering, Electrical Engineering, Civil Engineering, Processing and Food Engineering, Farm Machinery and Power Engineering, Energy Science and Technology or any other as approved by the Dean Postgraduate Studies.

Deficiency Courses
As recommended by student's Advisory Committee and approved by the Dean, Postgraduate Studies

Ph. D.

Field of Specialization
Thermal Engineering

Required Courses
ME 601, ME 602, ME 603, ME 604

Supporting Courses
Courses from subject matter fields (other than Minor) relating to area of special interest and research problem.

Minor Field
Processing and Food Engineering, Energy Science & Technology or any other as approved by the Dean Postgraduate Studies.

Deficiency Courses
As recommended by the student's Advisory Committee and approved by the Dean, Postgraduate Studies
DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

ME 103 Engineering Drawing 0+2 Sem. I
Introduction of drawing scales, Principles of orthographic projections, Reference planes, Points and lines in space and traces of lines and planes, Auxiliary planes and true shapes of oblique plain surface, True length and inclination of lines, Projections of solids (Change of position method, alteration of ground lines), Section of solids and Interpenetration of solid-surfaces, Development of surfaces of geometrical solids, Isometric projection of geometrical solids.

ME 104 Workshop Practice 0+1 Sem. II
Introduction to carpentry tools, materials, woods and their characteristics. Operations in wood working; Preparation of Cross halving, Lap joint, T-Halving joint, Dovetail joint and Mortise and Tenon joint; Introduction to Smithy tools and operations; Bending, Shaping etc., Jobs on Drawing, Punching, Riveting; Introduction to tools and measuring instruments for fitting. Jobs on sawing, filing and right angle fitting of MS Flat, Complex fitting job, Operations of Drilling, Reaming, and Threading with tap and dies, Introduction to tools and operations in sheet metal work, Making different types of sheet metal joints using G.I. sheets. Practical test.

ME 105 Thermodynamics and Heat Engines 3+1 Sem. II
Thermodynamic properties, closed and open system, flow and non-flow processes, gas laws; Zeroth law of thermodynamics and temperature measurement; First law of thermodynamics- internal energy, work and heat, application in non-flow and steady flow processes; Second law, Kelvin-Planck and Clausius statements, reversible process, Carnot cycle, Carnot theorem, entropy, change of entropy in thermodynamics processes; gas and vapour, change of phase during constant pressure process, triple point and critical point, generation of steam, internal energy and entropy of steam, steam tables and Mollier chart.

ME 106 Thermodynamics 2+0 Sem. II
Thermodynamic properties, closed and open system, flow and non-flow processes, gas laws; laws of thermodynamics, internal energy. Application of first law in heating and expansion of gases in non-flow processes; First law applied to steady flow processes. Kelvin-Planck and Clausius statements. Reversible processes, Carnot cycle, Entropy, Change of entropy of gases in thermodynamics processes. Difference between gas and vapour, change of phase during constant pressure process, Generation of steam, triple point and critical point. Internal energy and entropy of steam, Use of steam tables and Mollier chart,
heating and expansion of vapour in non-flow processes, measurement of dryness fraction, Classification of steam boilers, mountings and accessories.

**ME 205 Workshop Technology**

(Pre-requisite: ME 104)


Practical: Introduction to welding equipment, processes tools, their use and precautions; ARC welding - Lap, Butt, Tee and Corner joints; Gas welding - Lap, Butt and Tee Joints; Introduction to metal casting equipment, tools and their use; Mould making using one-piece pattern, two pieces, sweep and match plate patterns; Introduction to Machine tools; Cutting tools, Measuring instruments; Jobs on simple turning, step turning, Taper turning, drilling and threading; Operations on shaper, changing a round MS rod into square section on a shaper; Demonstration of operations on a milling machine, making a slot, gear tooth forming and indexing; Any additional job.

**ME 206 Heat and Mass Transfer**

Introductory concepts, modes of heat transfer; Conduction- thermal conductivity of materials, general differential equation of conduction, one dimensional steady state conduction through plane and composite walls, tubes and spheres with and without heat generation, electrical analogy, Insulation materials, critical thickness of insulation; Fins- effectiveness, efficiency etc; Free and Forced Convection- Newton's law of cooling, heat transfer coefficient in convection, dimensional analysis of free and forced convection, useful non dimensional numbers and empirical relationships for free and forced convection, equation of laminar boundary layer on flat plate and in a tube, laminar forced convection on a flat plate and in a tube, combined free and forced convection; Radiation- introduction, absorptivity, reflectivity, transmissivity, black body and monochromatic radiation, Planck's law, Stefan-Boltzman law, Kirchoff's law, grey bodies and emissive power, solid angle, intensity of radiation, radiation exchange between black surfaces, geometric configuration factor, heat transfer analysis involving conduction, convection and radiation by networks; Heat Exchangers- types, fouling factor, log mean temperature difference, heat exchanger performance, transfer units, heat exchanger analysis restricted to parallel and counter flow heat exchangers; Diffusion-steady state molecular diffusion in fluids at rest and in laminar flow, Fick's law, mass transfer coefficients. Reynold's analogy.

**ME 207 Theory of Machines**

(Pre-requisite: ME 103)


Practical: Study of Mechanisms; Analysis of 4-bar mechanism, slider crank mechanism and their inversions; Velocity and acceleration analysis of practical mechanisms; Study of gears, gear trains and analysis-tabular method; Synthesis of gear trains for a desired speed ratio; Study of flywheel and governor action; Synthesis of cam profile for a desired follower motion; Study on the cam follower demonstration machine for follower displacement as a function of cam rotation angle and phenomenon of follower jump; Demonstration of static and dynamic balancing; Calculations on balancing a multi-rotor unbalanced system by putting masses in two different planes.
ME 303 Fluid Mechanics

Fluids- Properties, ideal and real fluid, pressure and its measurement; Pascal's law, pressure forces on plane and curved surfaces, centre of pressure; buoyancy, metacentre and metacentric height, stability of submerged and floating bodies; Kinematics - Lagrangian and Eulerian methods, continuity equation, path lines, streak lines and stream lines, stream function, velocity potential and flow net, types of fluid flow, translation, rotation, circulation and vorticity, vortex motion; Dynamics - Bernoulli's theorem, venturimeter, orifice-meter and nozzle, siphon, stress-strain relationships in laminar flow, flow between infinite parallel fixed and moving plates, laminar and turbulent flow in pipes, minor and major hydraulic losses, Moody's diagram, network of pipes, power transmission; Dimensional analysis and similitude- Rayleigh's method and Buckingham's 'Pi' theorem, similarities, dimensional analysis, dimensionless numbers; Introduction to fluid machinery.

Practical: Study of manometers, pressure gauges and current meters; verification of Bernoulli's theorem; determination of coefficient of discharge of venturimeter, orifice meter, mouth piece and notches; determination of hydraulic coefficients for orifice; determination of coefficient of friction in pipeline; measurement of force exerted by water-jet on vanes; determination of metacentric height; efficiency of hydraulic ram; performance evaluation of Pelton and Francis turbines; velocity distribution in open channels and determination of Manning's roughness coefficient.

ME 304 Hands on Training in CAD/CAM and Machine Drawing

(Pre-requisite: ME 103)


ME 311 Instrumentation and Process Control

(In collaboration with Department of Computer Science and Electrical Engineering)


ME 402 Machine Design

(Pre-requisite: ME 207)

Design, phases, considerations. Mechanical properties of engineering materials. Types of loads and stresses, theories of failure, Stress concentration, fatigue and creep. Cotter, knuckle and pinned joints, turn buckle. Design of welded joints subjected to static loads. Design of threaded fasteners subjected to direct static loads, bolted joints loaded in shear or subjected to eccentric loading. Design of shafts under torsion and combined bending and torsion. Design of keys, muff/sleeve, rigid flange couplings, helical and leaf springs,
flat belt and V-belt, pulleys, gears, brackets, levers, columns, thin cylindrical and spherical shells, curved beams, crane hooks, circular rings, etc.. Design of screw motion mechanisms like screw jack, lead screw, etc. Selection of antifriction bearings.

Practical: Problems based on load/stress analysis of machine components; Problems based on practical application of theories of failure and fatigue and determination of factor of safety; Design and drawing of pin connections, Knuckle joint; Design of bolted joints cases of eccentric loading; Exercises on design of levers & rockers arm; Problems on design of shafts, keys and coupling; Problems in selection/design of belts; Selection of roller bearings - use of catalogue; Problems on design of helical and leaf spring; Problems on design of spur gears.

ME 403 Refrigeration and Air Conditioning 2+1 Sem. I
(Pre-requisite: ME 105)
Principles of refrigeration, carnot cycle, reversed carnot cycle, coefficient of performance, vapour compression system, vapour absorption system, refrigerants, desirable properties of ideal refrigerant; centrifugal, steam jet, thermolectric, vortex tube and other refrigeration systems; ultra low temperature refrigeration; cold storages, insulation material, design of cold storages, defrosting. Refrigeration in food industry; Thermodynamic properties of moist air, perfect gas relationship for approximate calculation, wet bulb temperature and its measurement, psychometric chart, elementary psychometric processes, humidifiers and dehumidifiers; Air conditioning - principles, type and functions of air conditioning, physiological principles in air conditioning, air distribution and duct design, design of complete air conditioning systems, types of air conditioners - applications.

Practical: Study of vapour compression & vapour absorption (electrolux) refrigeration systems; Determination of the coefficient of performance of the refrigeration system; Experiment on humidifier for the determination of humidifying efficiency; Experiment on dehumidifier for the determination of dehumidifying efficiency; Experiment on the COP of a domestic refrigerator; Study of a cold storage plant, Study of air conditioning unit; Determination of the coefficient of performance of air conditioning system; Estimation of refrigeration load; Estimation of cooling load for air conditioner; Estimation of humidification and dehumidification load; Design of complete cold storage system.

Postgraduate Courses

ME 501 Viscous Flow and Convective Heat Transfer 3+0 Sem. II
Derivation and general properties of Navier-Stokes equations. Exact solution of Navier-Stokes equations; parallel flow through straight channel, coquette flow, flow through pipe and flow between concentric rotating cylinders. Derivation of the conservation equations; continuity, momentum and energy equation. Laminar boundary layer equations. Boundary layer similarity parameters. Momentum and heat transfer; laminar flow inside tubes and laminar external boundary layer. Introduction to turbulent boundary layer. Free convection boundary layers. Free convection in enclosures. Influence of temperature dependent fluid properties.

ME 502 Conduction and Radiation Heat Transfer 3+0 Sem. I

ME 503 Mechanism Analysis and Synthesis 2+1 Sem. I
Kinematics of mechanisms, analysis and synthesis, mobility, systematic of mechanisms, deriving other mechanisms from linkages, Relative motion, instantaneous center method, Kennedy's theorem. Graphical

Practical: Graphical solutions of mechanisms relating to velocity and acceleration. Problems on computer-aided analysis and synthesis of mechanisms. Analysis and design problems of gear trains, cam profile design.

ME 504 Vibrations 3+0  Sem. I

ME 505 Thermal Environmental Engineering 3+0  Sem. I
Requirements of temperature and moisture in food preservation, processing, storage, animal and plant production systems, human comfort etc.; Thermodynamic properties of moist air, psychrometric chart, psychrometric processes and applications; Mass transfer and evaporation of water from free surfaces, theory of psychrometer, direct contact transfer processes between moist air and water-air washer, cooling tower, heating and cooling of moist air by extended surface coils, dehumidification using moisture absorbing materials; solar irradiations on structures, calculation of heating and cooling loads in buildings/storage structures; Design of air conditioning systems, air distribution and duct design, air flow pattern and control, equipment, components and controls. Instruments for measurement and control of temperature and moisture; Thermal insulation materials for environmental control systems, applications of environmental control in green house, dairy industry, potato storage etc.

ME 506 Thermodynamics 3+0  Sem. II
Review of basic laws. Availability; Irreversibility and availability analysis of engineering processes, Second law efficiency. Second law analysis of closed systems, steady flow systems and unsteady flow systems, Helmholt and Gibbs free energy, Maxwell relations, criteria of equilibrium. Equations of state; Vander Walls equation of state, Beattie-Bridgeman equation of state, Bertholet equation of state, Dieterici equation of state, Virial equations of state; compressibility factor, law of corresponding states and generalized compressibility chart. Properties, e.g. enthalpy, entropy, internal energy and fugacity of real gases. Chemical potential and the perfect gas mixture, P-V-T behavior of gas mixtures Clausius-Clapeyron and Gibbs Duhom equations. Reactive mixtures. Fuels and combustion, Theoretical and actual combustion processes, Enthalpy of formation and reaction, internal energy of reaction, adiabatic reaction temperature, chemical affinity, free energy and chemical equilibrium, First and Second law analysis of reactive systems. Irreversible thermodynamics and direct energy conversion systems; thermo electric systems, Thermoionic converter.

ME 507 Fatigue Design 2+1  Sem. II
Theories of failure, maximum normal stress, maximum shear stress and distortion energy theory, failure of ductile materials, failure of brittle materials. Stress concentration and its evaluation, stress concentration

Practical: Fatigue tests on testing machine(s) for specimens of different materials having different discontinuities/stress raisers and various surface conditions. Determination of correlation between fatigue limit and ultimate strength of material. Problems in fatigue design of common machine components.

ME 508 Vibration and Noise Control 3+0 Sem. I
Methods of vibration control, design of vibration absorbers, undamped dynamic absorber, centrifugal pendulum absorber, dry friction damper, untuned viscous damper. Vibration control by structural design, changing the dynamic characteristics of a structure, structural dynamics modification. Vibration and shock isolation, materials used for isolators, force transmissibility, velocity transmissibility, Application and design of isolators, design of isolators in machine foundations, balancing of rotating machinery, rotor balancing, active vibrations control. Vibration level under optimum conditions, Acoustic plane wave-governing equations, energy density, intensity and impedance, noise source identification, noise in machines, fan and flow noise, combustion noise, noise in piping systems. Wave analysis of structures and spaces, characteristics of duct and cabin noise, stationary modes, random noise, measures of a sound acoustic design, importance of reverberations time, various types of acoustic testing chambers, noise measurement and control instruments, sound intensity mapping noise isolation design, noise absorber design, design of silencers, mufflers, acoustic design of buildings.

ME 509 Bearings and Lubrication 2+0 Sem. II
Theory of lubrication, Plain (Sliding-Contact) bearings, basic types of friction in plain bearings, design of hydrodynamic bearings, fluid friction in bearings, antifriction properties of materials, bearings materials, Microgeometry of bearing surfaces, self-aligning, floating bushings, high speed and vibration-proof bearings, Lubricants and lubrication systems, types and properties of additives used in lubricants, antifriction (Rolling- elements) bearings, types of rolling element bearings, co-efficient of rolling friction, allowable peripheral speeds, load-carrying capacity and durability, selection of bearing series, high speed bearings, high temperature bearings, design of ball and roller bearings and their lubrication. Mounting of rolling bearings on shafts and installation in the housings.

ME 510 Industrial Heat Transfer 3+0 Sem. I

ME 511 Refrigeration Systems 3+0 Sem. I
Reversed Carnot cycle, Carnot, Brayton and Aircraft refrigeration systems, Vapour compression refrigeration systems; Use of p-h chart, Effect of pressure changes on COP, sub cooling of condensate on COP and capacity, super heating, Single stage, multi-stage and cascade systems. Vapour absorption systems: Theory of mixtures, temp-concentration and enthalpy concentration diagrams, Adiabatic mixing of two systems, Diabatic mixing, Throttling process, Ammonia water and water lithium bromide systems. Centrifugal and steam jet refrigeration systems. Thermoelectric refrigeration systems, its
advantages, comparison with vapour compression system, Vortex tube refrigeration system, its thermodynamic analysis. Ultra low temp refrigeration. Ejection and Centrifugal refrigeration. Water refrigeration and steam jet refrigeration, its characteristics, effect of boiler efficiency on overall COP actual steam jet system and two fluid jet refrigeration.

ME 512 Ideal Fluid Flow
3+0 Sem. I
Review of mathematical back ground. Introduction of fluid machines. Historical background and fluid kinematics. Types of fluids and motions, continuity equation in cartesian and cylindrical-polar coordinates, velocity and acceleration, free and forced vortex flow, characteristics and utility of flow nets. Derivation of equations of motion of a compressible viscous fluid (Navier-Stokes equations). General properties of Navier-Stokes equation. Integration of equation of motion and derivation of Bernoulli's theorem and energy integral relation. Potential and stream functions, properties of potential and stream functions, equipotential lines and lines of constant stream function, Relationship between potential and stream functions, Convectivity and cycle motions, boundary effects on ideal fluid motions and methods of acquiring potential solutions. Important cases of ideal fluid flow such as uniform flow, source flow, sink flow, free-vortex flow, super-imposed flow.

ME 513 Solar Energy Utilization
3+0 Sem. I

ME 514 Steam Power Engineering
2+1 Sem. II

ME 515 Computer Aided Design
2+1 Sem. I
Introduction to computer aided design, scope of computer aided machine design, design process and design environments. Geometric modeling and interactive graphic, engineering analysis, design review and automated drafting, modeling, viewing, 3-D solid modeling, boundary representation, constructive solid geometry, feature based modeling. Computer aided analysis and synthesis of common mechanical components, a bar, a beam and a shaft, comparison with analytical results. Application of numerical methods and optimization techniques to machine design problems, Computer aided selection of standard mechanical components. Introduction to FEM. FEA using two dimensional and three dimensional elements; plain strain and plain stress problems, finite element mesh, automatic meshing techniques, limitations of FEM.
Practical: Computer aided design problems for machine components, use of standard software, CAD models for other applications. Development of FEM models for analysis of a bar, beam and a shaft. Practice in using an FEM software on other real life problems like spanners, connecting rods.

ME 516 Analysis of Robot Manipulators
3+0 Sem. II
Introduction, major components of robotic systems, types of robots, classification based on mechanical configuration, motion configuration, roll, pitch and yaw angles, work space, performance measure, application of robots, controllers and actuators, control system analysis, position sensors, velocity sensors, pneumatic and hydraulic actuators, end-effectors, types, mechanical grippers, gripper force analysis,
selection of gripper and their synthesis, external sensors, tactile sensors, sensors based systems, sensors in robotics, manipulator kinematics, position representation, forward and reverse transformation of the 2-degrees of freedom, 4 degrees of freedom manipulator in three dimensions, kinematic equations using homogeneous transformations, manipulator path control, Differential relationships, dynamics of a robot, dynamic equations, real-time control and simulation, identification of load, control of a single and a multilink manipulator. Static forces, compliance, programming methods, functions and environment, robot programming languages, on-line and off-line programming languages, artificial intelligence and its techniques, application of artificial intelligence, performance capabilities, features and technical data of robots.

**ME 601 Advanced Conductive Heat Transfer**


**ME 602 Convective Heat Transfer**

Review of continuity equation, momentum equation and energy equation; differential forms and integral forms. Laminar boundary layer flow; exact solution, similarity solution and integral solutions. Laminar duct flow. Transition to turbulence. Wall turbulence; internal and external flow. Laminar natural convection. Natural convection in enclosures. Influence of temperature-dependent fluid properties. Forced convection through porous media. Special heat transfer problems; heat transfer in liquid metals and heat transfer with phase change.

**ME 603 Design of Solar Energy Systems**

Review of solar radiation intensity and solar geometry. Analysis and design of non-concentrating and concentrating solar collectors. Solar energy storage techniques, Steady and transient heat transfer analysis of solar cookers, solar ponds, solar stills and solar dryers. Design of solar thermal systems; hot water systems, space heating and cooling systems, refrigeration systems, power generation systems, solar drying system for agricultural produce, greenhouse heating and cooling systems design, thermal analysis and modeling of greenhouse system coupled with heating and cooling systems, optimum greenhouse design for crop drying applications. Design of solar photovoltaic systems, stand alone systems, Independent power generation systems, grid connected systems. Economic analysis of solar energy systems.

**ME 604 Advanced Combustion**


**ME 591 Seminar**

**ME 600 Master’s Research**

**ME 700 Doctoral Research**
ENERGY STUDIES FOR AGRICULTURE

PROGRAMME
Ph.D.

COURSE REQUIREMENTS

Field of Specialization
Energy Science and Technology

Required Courses
EST 601, EST 602, EST 603

Supporting Courses
Courses from subject matter fields (other than Minor) relating to area of special interest and research problem.

Minor Field
Farm Machinery and Power Engineering, Soil and Water Engineering, Processing and Food Engineering, or any other as approved by the Dean Postgraduate Studies.

Deficiency Courses
As recommended by the student's Advisory Committee and approved by the Dean, Postgraduate Studies

DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

EST 302 Renewable Energy
(For the students of College of Agriculture)

1+1 Sem. II


EST 303 Renewable Energy Sources
2+1 Sem. I

Classification of energy sources; Introduction to renewable energy sources; characterization of biomass; types, working principle, uses and safety/environmental aspects of different renewable energy devices like gasifiers, biogas plants, solar passive heating devices, photovoltaic cells and arrays; Brief introduction to wind energy, hydroelectric energy, ocean energy, briquetting and baling of biomass, biomass combustion, biodiesel preparation and energy conservation in agriculture.

Practical: Determination of calorific value; Estimation of ash content of biomass, moisture content of biomass, fixed carbon and volatile matter of biomass; Demonstration of down draft throat-less rice husk
gasifier, down draft gasifier with throat, working of a fixed dome type biogas plants, floating drum type biogas plants, biodiesel preparation; Measurement of basic solar parameters; Demonstration of solar water heater, photovoltaic cell and solar cooker.

Cafeteria Courses

EST 402 Renewable Energy Technologies  2+1  Sem. II
Design and operational parameters, performance evaluation and maintenance aspects of different renewable technologies like gasifiers, biogas plants, solar passive heating devices, photovoltaic cells and arrays, briquetting machines and balers; bio-diesel utilization in CI engines.
Practical: Performance evaluation of solar water heater, solar cooker; Characteristics of solar photovoltaic panel; Evaluation of solar air heater/dryer; Performance evaluation of a rice husk throat-less gasifier engine system, down draft gasifier with throat for thermal application, a fixed dome type biogas plant and floating drum type biogas plant; Estimation of calorific value of producer gas; Testing of diesel engine operation using biodiesel; Evaluation of briquette and briquetting machine using biomass material.

Postgraduate Courses

EST 501/FMP 511 Agro-energy Audit and Management  2+0  Sem.II

EST 502/FMP 512 Design and Analysis of Renewable Energy Conversion Systems  3+0  Sem.I

EST 503 Energy from Biomass  2+0  Sem.I
Biomass; fuel related properties of biomass; Biomass waste; collection, handling and pre--conditioning processes such as size reduction and densification like bailing, briquetting etc; equipments and techniques for biomass harvest, collection, handling and pre-conditioning processes such as size reduction and densification; combustion, pyrolysis and gasification of biomass: Chemistry, process description and performance analysis; alcohol production; pre-treatment of biomass, fermentation with process details and dehydration; operational performance of I.C. engines on producer gas, biogas, alcohol, and plant oils and their esters.

EST 504 Energy and Environmental Issues  2+0  Sem.II
Global Carbon Cycle: carbon reservoirs, flow and human interventions; Global warming and climate change: energy use and green house effect, green house gases, climate change impact; Energy for sustainable development: energy efficient technology, energy policies, linkage between energy use and economic growth and environment; Energy security: linkages, policies and technologies to address security problems; Energy use and acid rains; Technological options for control of SO2 and NOx; Efficient/cleaner transport options and their effects on energy use; Other options to improve energy use and environment in urban areas.

EST 601 Agricultural Energetics  2+0  Sem. II
Energy requirements for agricultural inputs like Fertilizers and manures, Pesticides, Machinery and
fuel, Irrigation, Labour, Land, Transportation, Draft animals etc.; Agricultural energetic factors, energy norms and their computations; energy analysis: methods, problems and limitations; energy analysis of household activities, crop and livestock production systems including poultry and piggery; use of alternate energy sources for agricultural purposes; Evaluation of alternate energy sources and specific practices, substitution of energetic factors amongst themselves.

**EST 602 Biomass Energy Conversion**  
2+1 Sem.I

Biomass fuel characterization: physical, thermal and chemical properties; thermo chemical processes: operation parameters, types of biomass gasifiers, gasifier design, producer gas cleaning systems, application of producer gas for thermal application and electricity generation; biochemical processes: biogas production, process parameters of bio-methanation; Combustion: types of combustion furnaces, operating parameters and performance evaluation; Methods for production of biodiesel, fuel characteristics of biodiesel, use of biodiesel in stationary and mobile applications.

Practical: Determination of fuel related properties of biomass, Producer gas analysis, Biogas analysis, Determination of properties of bio-diesel.

**EST 603/FMP 603 Energy Conservation and Management in Production Agriculture**  
2+0 Sem. II

Energy requirement of different operations in agricultural production systems viz. crop, livestock and aquaculture: limits of conservation: planning and management of agricultural production systems for energy conservation and energy returns assessment. Development of computer program for efficient energy management in a given agricultural production system. Energy use planning and forecasting for a given system.

**EST 604 Advances in Biochemical Conversion of Biomass**  
2+1 Sem. I

Biomass formation, characteristics and classification; Biogas Production: Biochemistry, Microbiology, process parameters of biomethanation, biogas digester type, digesters design, biogas utilization and slurry management, chemical kinetics and mathematical modeling of biomethanation process, Economics of plant, environmental and social impact; Bioconversion of biomass into alcohol - types and pretreatment of biomass, production process, biochemical and microbiology, fermentor design and process parameters; Economics of alcohol production from biomass, Biohydrogen for algae/biomass, Environmental benefits of bioconversion processes.

Practical: Biomass characterization using CHNO analyzer, Kinetics of biogas production from Biomass-Parameters affecting the methane production, Effect of physic-chemical parameters on biogas yield, gas quality etc., Biogas plant designing and evaluation, Biogas storage, Biogas purification, Pretreatment strategies for alcohol production from biomass, Alcohol production through biochemical routes, Optimization of process parameters for alcohol production, Fermentor designing and evaluation, Alcohol purification, Economic calculations of biogas and alcohol generation from biomass.

**EST 605 Computer-based Energy Management**  
3+0 Sem.II

Energy management activities and approaches, Trends in computer based energy management, Philosophy of control for energy processes, Design procedure for an advanced control system, Applying optimization techniques, Example of an advanced control system, Examples of energy conservation control, A survey of optimization techniques, Review of experimental search methods, The pattern search method, Three optimization techniques commonly used in energy management solutions, General philosophy of selecting a computer system, A typical system specification generated by a user, A typical quotation generated by a supplier, Software specification, Systems engineering services available from manufacturers, energy management in production agriculture and agro-industry systems.

**EST 591 Seminar**

**EST 700 Doctoral Research**
ELECTRICAL ENGINEERING AND INFORMATION TECHNOLOGY

A. ELECTRICAL ENGINEERING PROGRAMMES

M. Tech.

Ph. D.

COURSE REQUIREMENTS

M. Tech.

Field of Specialization

Electrical Engineering

Required Courses

EE 501, EE 502, EE 503, EE 504

Supporting Courses

Stat.421, PGS 501 and other courses as recommended by the student's Advisory Committee

Minor Field

Computer Science and Engineering or any other as recommended by the student's Advisory Committee and approved by the Dean, Postgraduates Studies

Deficiency Courses

As recommended by the student's Advisory Committee and approved by the Dean, Postgraduates Studies

Ph. D.

Field of Specialization

Electrical Engineering

Required Courses

EE 601

Supporting Courses

MGT 511 or as recommended by the student's Advisory Committee

Minor Field

Computer Science and Engineering or any other appropriate field as recommended by the student's Advisory Committee

Deficiency Courses

As recommended by the student's Advisory Committee and approved by the Dean, Postgraduates Studies
DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

EE 203 Electrical Circuits 2+1 Sem. I

Average and effective value of sinusoidal and linear periodic waveforms. Independent and dependent sources, loop current and loop equations (Mesh current method), node voltage and node equations (Nodal voltage method), Network theorems: Thevenin's, Norton's, Superposition, Reciprocity and Maximum power transfer, Star- Delta conversion solution of DC circuit by Network theorems, Sinusoidal steady state response of circuits, Instantaneous and average power, power factor, reactive and apparent power, Concept and analysis of balanced polyphase circuits, Laplace transform method of finding step response of DC circuits, Series and parallel resonance, Simple Low, High, Band Pass, Band Reject filter.

Practical: Familiarization with the components and equipments used in Laboratory; verification of Kirchhoff's current laws; Kirchhoff's voltage laws; Thevenin theorems; Norton's theorems; Superposition theorem; reciprocity theorem. Studying the sinusoidal response of RL series circuit; sinusoidal response of RC series circuit; step response of RL series circuit; step response of RC series circuit; response of Low, High, Band Pass, Band Reject filter and power consumed in a three-phase circuit.

EE 204 Electrical Machines 2+1 Sem. I

(Pre-requisite EE-203)

Electro motive force, reluctance, laws of magnetic circuits, determination of ampere-turns for series and parallel magnetic circuits, hysteresis and eddy current losses, Transformer: principle of working, construction of single phase transformer, EMF equation, phasor diagram on load, leakage reactance, transformer on load, equivalent circuit, voltage regulation, power and energy efficiency, open circuit and short circuit tests, principles, operation and performance of DC machine (generator and motor), EMF and torque equations, armature reaction, commutation, excitation of DC generator and their characteristics, DC motor characteristics, starting of shunt and series motor, starters, speed control methods-field and armature control, polyphase induction motor: construction, operation, equivalent circuit, phasor diagram, effect of rotor resistance, torque equation, starting and speed control methods, single phase induction motor: double field revolving theory, equivalent circuit, characteristics, phase split, shaded pole motors.

Practical: Performing open circuit and short circuit tests on a single phase transformer; load characteristics of d.c. shunt /series /compound generator; characteristics of DC shunt/ series motors; no load test, blocked rotor test and load-test on 3-phase induction motor and plotting the torque v/s speed characteristics; no load and blocked -rotor test, load test on 1-phase induction motor. Parameters of equivalent circuit. and torque -speed characteristics.

EE 302 Electronics and Instrumentation 2+1 Sem. II

(Pre-requisite EE-204)

Diode as a circuit element, rectifier, clipper, clamper, voltage multiplier, capacitive filter, bipolar junction transistor: operating point, various biasing methods (fixed, self, potential divider), h-parameter model of a transistor, analysis of small signal, CE amplifier, Timer IC and its application, analysis of differential amplifier using transistor, ideal OP-AMP characteristics, linear and non-linear applications of OP-AMP (adder, subtractor, integrator, active rectifier, comparator, differentiator, differential, instrumentation amplifier and oscillator), zener diode voltage regulator, transistor series regulator, current limiting, Basic theorem of Boolean algebra, Combinational logic circuits(basic gates, SOP rule and K-map), binary ladder D/A converter, successive approximation A/D converter, generalized instrumentation, measurement of displacement, temperature, velocity, force and pressure using potentiometer, resistance thermometer, thermocouples, bourdon tube, LVDT, strain gauge and tacho-generator.

Practical: The p-n junction diode; and its application circuits, transistor characteristics, biasing and its application circuits, IC555 and its application circuits, IC741 and its application circuits, zener regulator circuit and familiarization with various types of transducers.
Postgraduate Courses

EE 501 Applied Electronics 2+1 Sem. II
Review of semiconductor devices and their characteristics; Rectifiers, Voltage Regulators, Bipolar Junction Transistor, biasing techniques & stability, amplifier circuits, amplifier characteristics such as Gain, Impedance, Bandwidth etc. Oscillator Circuits, Special solid-state devices like UJT, FET, MOSFET, DIAC, TRIAC, SCR, and their applications. 555 Timer, Operational amplifiers & their Applications, Filters and their characteristics, Design of electronic systems and their analysis using linear and Digital Integrated circuits.

EE 502 Design and Application of Transducers 2+1 Sem. II
Introduction to functional elements of an instrument, active and passive transducers, analog and digital modes, null and deflection methods, performance characteristics of instruments including static and dynamic characteristics. Measuring devices for force, torque and shaft power, strain gauge type devices and their design and application in two and three dimensional force measurement. Design and analysis of strain gauge type tillage torque dynamometers. Devices for measurement of temperature, pressure, sound, vibration, flow. Measuring instruments for calorific values of solid, liquid and gaseous fuels. Measurement of gas composition using GLC. Computer based data acquisition system.
Practical: Calibration of instruments, measurement of strain, making of thermocouples and their testing, flow measurement in a pipe, humidity measurement, data acquisition analysis and interpretation, signal conditioning circuits, testing of pressure transducers.

EE 503 Instrumentation Engineering 2+1 Sem. II
Practical: Application of instrumentation amplifiers, filters and other signal processing circuits. Applications of A/D and D/A convertors, Study of Modulation Techniques, Experiments on interfacing transducers to microcomputers/ Microcontroller/ Microprocessors.

EE 504 Process Control System 2+1 Sem. II
Practical: Study of performance of thermister, LVDT, thermocouple, strain gauge; open loop control systems, feedback control system; PI, PD, PID Controller; Simulation of typical control systems; use of microprocessors in process control.

EE 505 Applied Instrumentation 2+1 Sem. I
measurement, Soil and Grain moisture transducers. Pressure measurement - Manometers, Bourdon Tube, Diaphragm, high pressure and vacuum sensing techniques. Flow transducers- Venturiometer, Rotameter, Drag force, Ultrasonic, Electromagnetic, Hot wire anemometers. Time, Frequency, Level measurement, Optical Density and pH measurement, pCO2 and grain quality measurement. Biomedical measurement - BP, Heart Rate, ECG, Ultrasonic flaw detection. Spectroscopy.

Practical: Laboratory exercises to demonstrate applications of displacement, pressure, velocity temperature, moisture, humidity, heat flux, flow, ultrasonic and biomedical transducers.

EE 506 / CSE 506 Operating Systems and Utilities 3+0 Sem. II

EE 507 / CSE 507 Design of Micro-computer Systems 2+1 Sem. II
Digital logic families. Microcomputer organization. Software program planning, programming in high level and symbolic languages. Interfaces and peripheral devices. Microprocessor-based system development aids. Design methodology and applications. Microprocessors with advanced architecture. Technology assessment.

Practical: Hands-on experience in the use of microcomputer system and design of peripheral controllers and interfaces along with construction and debugging of IC circuits.

EE 508 Linear System Analysis 2+0 Sem. I

EE 509 Methods of Optimization 3+0 Sem. I

EE 510 Optimal Control 3+0 Sem. I
Introduction to classical and modern control: optimization, optimal control; calculus of variations and optimal control: basic concepts, optimum of a function and a functional, the basic variational problem, the second variation, extrema of functions and functionals with conditions, variational approach to optimal systems; linear quadratic optimal control systems: problem formulation, finite-time linear quadratic regulator(LQR), analytical solution to the matrix differential Riccati equation, infinite-time lqr system, linear quadratic tracking system: finite-time case, lqt system: infinite-time case, fixed-end-point regulator system, frequency-domain interpretation; discrete-time optimal control systems: variational calculus for discrete-time systems, discrete-time optimal control systems, discrete-time linear state regulator systems, steady-state regulator system, discrete-time linear quadratic tracking system, frequency-domain interpretation; pontryagin minimum principle: constrained systems, pontryagin minimum principle, dynamic programming, the hamilton- jacobi-bellman equation; constrained optimal control systems: constrained optimal control, toc of a double integral system, lti system, energy-optimal control systems, optimal control systems with state constraints.
EE 511 Maintenance Management  2+0  Sem. I

EE 512 Direct Energy Conversion  2+0  Sem. I
Solar energy and its utilization. Solar cells. Thermo-electric and thermo ionic devices. Fuel cells. Magneto-
Hydrodynamic energy conversion.

EE 513 Systems Analysis in Agriculture  2+0  Sem. II

EE 601 Analysis and Design of Instrumentation Systems  2+1  Sem. II
Practical: Determination of dynamic characteristics of instrumentation systems.

EE 602 Non-linear and Time Varying Systems  3+0  Sem. I

EE 603 Large Scale Systems  3+0  Sem. II
Review of graph theory - Graph, weighted Graph or network, Cyclic Graph, Drag, Warshall's Algorithm, Shortest path Algorithm, Link Representation of Graph, Dijkstra's Algorithm, Graph Traversal: Depth First and Breadth First; Spanning Forests, Symmetrical Directed, Connected Graphs, Minimum Spanning Trees. Large scale system modelling. Mass energy based economic models. Hierarchical systems. Simulation exercises of agricultural energy and other socio-economic systems. Case studies.

EE 604 Optimization of Engineering Systems  3+0  Sem. II

EE 591 Seminar
EE 600 Master's Research
EE 700 Doctoral Research
B. COMPUTER SCIENCE AND ENGINEERING

PROGRAMMES

M. Tech.

COURSE REQUIREMENTS

M. Tech.

Field of Specialization  
Computer Science and Engineering

Required Courses  
CSE 501, CSE 502, CSE 503, CSE 504

Supporting Courses  
Stat.421, PGS 501 and other courses as recommended by the student's Advisory Committee

Minor field  
Electrical Engineering or any other as recommended by the student's Advisory Committee and approved by the Dean, Postgraduates Studies

Deficiency Courses  
As recommended by the student's Advisory Committee and approved by the Dean, Postgraduates Studies

DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

CSE 101 Introduction to Computer Applications  
0+2  
Sem. I & II

Introduction: Components & classification of computer system - CPU, input and output devices and memory, units of memory, hardware and software, peripheral devices, booting of computer, computer viruses, worms and vaccines. Operating system - WINDOWS: Graphical User Interface (GUI), desktop, taskbar and its elements. Windows Explorer, anatomy of a window, title bar, minimum, maximum and close buttons, scroll bars, menus and toolbars. Applications - MS WORD: Word processing, features of word- processing packages. Creating, editing, formatting and saving a document in Ms Word, creating Headers/Footers and tables, using Insert menu options, using tools like Macro, Mail Merge, Spelling, Grammar and track changes. MS EXCEL: electronic spreadsheet concepts, creating, editing and saving a spreadsheet, using basic in-built statistical and other functions and writing expressions, use of data analysis tools, correlation and regression, t-test for two-samples with one-way classification, creating graphs. MS POWERPOINT: creating and running presentations in PowerPoint. MSACCESS: concept of databases, creating database, primary key, query, simple forms and reports, illustration through examples. Internet: Worldwide web (WWW) concepts, web browsing and electronic mail.

CSE 103 Introduction to Computer Use  
0+2  
Sem. I

Parts of Computers, working with windows commands, copy & Moving Files into folders, use of windows explorer, Word processing with notepad, wordpad use of paint brush, Introduction to BASIC language and programming

CSE 104 IT Applications in Food Industry  
1+1  
Sem. II

Importance of computerization and IT in food industries, role of computers in optimization, introduction to operations research, linear programming problems, modeling of food technology systems and operations, graphical solution, simplex method, degeneracy and duality in linear programming, transportation problems, assignment problems, project management using PERT/CPM.
Practical: Applications of IT to solve the problems of food technology: use solution to linear programming problems using graphical, simplex, Big M and two phase methods, degeneracy, transportation and assignment solution in food industry. Computation of critical path, slacks and floats in PERT/CPM. Visit to Industry and knowledge of computer.

CSE 204 Computer Programming and Data Structures 0+3 Sem. I
Introduction to high level languages, Primary data types and user defined data types, Variables, typecasting, Operators, Building and evaluating Expressions, Standard library functions, Managing Input and Output, Familiarizing with Turbo C IDE, Building an executable version of C program, Debugging a C program, Developing and executing simple programs, using decision making statements and looping statements, Using nested control structures, Familiarizing with one and two dimensional arrays, Using string functions, Developing structures and union, Creating user defined functions, passing arguments and returning values, recursion, Using local, global & external variables, scope and visibility of a variable, Using pointers, Implementing Stacks, Implementing push/pop functions, Creating Queues, Developing linked lists in C language, Insertion/Deletion in data structures.

CSE 302 Systems Engineering 2+1 Sem. II
Practical: Solving the Linear programming Problems using Graphical method, Simplex method. Practice with transportation problems, Assignment problems and PERT/CPM. Crashing the networks problems.

CSE 303 Practical Training in Web Applications 0+2 Sem. II
Basic database concepts, introduction to RDBMS & data types, SQL Commands: CREATE, DROP, ALTER, SELECT, UPDATE, INSERT, DELETE; query SQL Data, modify SQL Data, data constraints, Joins, Set operations, working with date and time, using string, logical, mathematical and group functions; creating simple forms and reports, basics of HTML, developing web pages, generating dynamic web pages; connectivity of web page with RDBMS, project.

Postgraduate Courses

CSE 501 Computer Engineering 2+1 Sem. I
Practical: Application of logic gates in half and full - adders. Code converters and display devices. Study of computer systems with logic analyzer.

CSE 502 Computer Graphics 2+1 Sem. I
CSE 503  Software Engineering  3+0  Sem. II

CSE 504  Computer Networks  2+0  Sem. I

CSE 505/RSGIS 510  Data Base Management  2+1  Sem. I

CSE 506/EE 506  Operating Systems and Utilities  3+0  Sem. II

CSE 507/EE 507  Design of Micro-computer Systems  2+1  Sem. II
Digital logic families. Microcomputer organization. Software program planning, programming in high level and symbolic languages. Interfaces and peripheral devices. Microprocessor-based system development aids. Design methodology and applications. Microprocessors with advanced architecture. Technology assessment.
Practical: Hands-on experience in the use of microcomputer system and design of peripheral controllers and interfaces along with construction and debugging of IC circuits.

CSE 508  Information Management  2+1  Sem. I
Practical: Data base design for simple problems.

CSE 509  Principles of Data Base Systems  3+0  Sem. I

CSE 510  Introduction to Computer Science  2+1  Sem. I
Computer organization: Instruction sets, buses, I/O channels, Interrupt processing, associative memories. System programming: Assemblers, linkers, loaders, editors, command processors, system call interface.
Operating systems: Scheduling, process management. Data base structures: filter organization (ISAM, sequential, direct, B-trees.), Database models (relational, hierarchical, network).
Practical: Application of compilers, assemblers, linkers, loaders, editors and command processors.

**CSE 511 Computer Architecture**  
2+0  
Sem. II  
Review of basic computer organization, impact of operating systems and programming languages on computer architecture. CPU design, computer arithmetic, memory management, bit-slice architectures, interconnection, networks, data flow machines, RISC architecture, special purpose architectures.

**CSE 512 System Programming**  
3+0  
Sem. II  
Machine structure; Machine language; Assembly languages; Design of assemblers, Symbol table organization, pacing and segmentation; stock and multiple register; machine code and storage optimization; Input and output control systems and debugging tools. Design of macro assemblers. Micro assembly systems, Macro as generalized string processor; Algebraic expression-translation and interpretation. Design of loaders and linkage editors. Design and direct linking and relocatable loaders; core image builder, overlay structure and dynamic loading, Interpreters, compilers and supervisors.

**CSE 513 Artificial Intelligence**  
3+0  
Sem. II  
Introduction of AI languages (LISP and PROLOG); Basic problem solving techniques, State space and/or graph and game tree search; Predicate logic and theorem proving; Knowledge representation, Predicate logic, semantic networks, Frames, scripts; Expert Systems, Machine learning: Natural languages processing; Elements of computer vision.

**CSE 514 Expert System Design**  
3+0  
Sem. II  
Introduction to expert system: Types of expert systems; Nature of expertise and knowledge acquisition; Preparation/interview analysis cycle. Knowledge analysis techniques - epistemic nets, analysis and structures, Interpretation model technique. Project management for expert systems: Case Studies.

**CSE 515 Computer Methods in Engineering**  
0+3  
Sem. II  
Introduction to computer hardware and operations, operating system, introduction to programming and numerical techniques, spreadsheet based application, simulation, modeling and optimization, data base management, graphics application, computer based instrumentation for data acquisition and control.

**CSE 516 Neural Network and its Applications**  
2+1  
Sem. II  
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.

**CSE 591 Seminar**

**CSE 600 Master's Research**
C. INFORMATION TECHNOLOGY

PROGRAMMES
MCA
PGDCA

COURSE REQUIREMENTS
MCA
Field of Specialization: Information Technology

Required Courses: IT 501, IT 502, IT 503, IT 504

Supporting Courses: PGS 501 or any other as recommended by the student's Advisory Committee

Minor Field: Computer Science and Engineering, Biotechnology, or any other as approved by Dean, Postgraduate Studies.

Deficiency Courses: As recommended by the student's Advisory Committee and approved by the Dean, Postgraduate Studies

PGDCA*
Fields of Specialization: Information Technology

Required Courses: IT 501, IT 502

Supporting Courses: MGT 511 or any other as recommended by the student's Advisory Committee

Minor Field: –

Deficiency Courses: –

*Requirements
i) Major field courses: 21
ii) Supporting courses: 03
iii) Project research: 08
Total: 32
DESCRIPTION OF COURSE CONTENTS

IT 501 Computer Fundamentals and Programming 2+1 Sem. I

Computer fundamentals, number systems, decimal, octal, binary and hexadecimal, representation of integers, fixed and floating point numbers, character representation, American Standard Code for Information Interchange (ASCII), Extended Binary Coded Decimal Interchange Code (EBCDIC). Functional units of computer, I/O devices, primary and secondary memories. Programming fundamentals with C, techniques of problem solving, flowcharting, stepwise refinement, representation of integer, character, real numbers, data types in C, constants and variables, arithmetic expressions, assignment statement, logical expression. Sequencing, alteration and iteration, arrays, string processing. Sub-programs, recursion, pointers and files. Program correctness, debugging and testing of programs.

Practical: Conversion of different number types, creation of flow chart, conversion of algorithm/flowchart to program, mathematical operators, operator precedence, sequence, Implementing subprograms and recursion. Debugging and testing, Control statements, looping and decision making statements, arrays and string processing, pointers and file processing.

IT 502 Operating System 3+1 Sem. I

Operating system overview, operating system as an extended machine and resource manager, operating system classifications, operating system modes and system calls. Operating system architecture. Process, process model, process scheduling, operations on process, inter process communication. Process synchronization, critical section problem, producer consumer problem, bounded buffer problem, semaphores, monitors, CPU scheduling, long term schedulers, middle term schedulers, short term schedulers, basic concepts, scheduling criteria, scheduling algorithms, First come first serve, shortest job first, priority scheduling, round robin, multilevel queue, multilevel feedback, deadlocks, system model, race condition, deadlock prevention, deadlock avoidance, deadlock detection. Memory management, base register and limit register, contiguous memory allocation, swapping, paging, segmentation, virtual memory, fragmentation, demand paging, page replacement, first in first out, least recently used, optimal algorithm, thrashing, shared segment. Device management system, dedicated share and virtual devices, spooling channels, multiplexer and selector, control units, traffic controllers and device handlers.

Practical: Windows and Linux installation, managing files and folders in windows. Dos commands, user account settings, add and remove hardware and software's, group policies, user policies, administrator policies, services, disk formatting and partitioning, disk management and defragmentation, managing files and folders, synchronization, user profiles, windows components, event viewer, desktop settings, folder properties.

IT 503 Internet and Web Technologies 3+1 Sem. I

Practical: Designing static website with features like tables, hyperlink among pages, pictures, frames, client side scripts for user interface validation, arrays, methods, branching and iterations, server side scripting for database interaction, database creation, retrieving and accessing databases, filters, and designing of an information system.

**IT 504 Dynamic Web Development**
3+1Sem. IIT
Dynamic Hyper Text Markup Language, using text formatting tags, tables, lists, images and image map, frames and frameset and forms for user input. Form elements, textbox, checkbox, radio buttons, selection lists, dropdown list, multiple selection, text area, field set, legend, hidden fields, uploading files, mailto information, get and post method, Types of dynamic scripting languages, overview of dynamic scripting languages, features of dynamic scripting languages. Client side and server side scripting, dynamic scripting language constructs, variables, loops and decisions, functions and procedures. Dynamic language features, introspection, mobility, instrumentation, garbage collection, importance and need, factors affecting garbage collection algorithms, mark and sweep garbage collection algorithm, Typing, static versus dynamic typing, manifest versus inferential typing. Implementing client side validations and database interaction using server side scripts. Latest trends in programming on the emerging technologies relating to web based software development.

Practical: Developing tables, frames, DHTML tags in dynamic WebPages in JavaScripts/VB scripts. Creating dynamic WebPages using different form elements, textbox, checkbox, radio buttons, selection lists, dropdown list, multiple selection, text area, field set, legend, hidden fields, uploading files, mailto information, get and post method.

**IT 505 Multimedia and Applications**
2+1Sem. I
Introduction to multimedia technology, use of computers in communications and entertainment. Framework for multimedia systems. Multimedia devices, presentation devices and the user interface. Digital representation of sound and transmission, speech recognition and generation, digital video and image compression, JPEG image compression standard, MPEG motion video compression. Presentation and multimedia authoring, implementing layouts, designing of visuals, applying animations and transitions, creating hyperlinks and actions, templates, wizards and views, inserting pictures, charts, tables, objects, movies and sounds, customizing a show, using a standard presentation software. Introduction to Adobe Photoshop, basic color models, CMYK, RGB, bitmap graphics, vector graphics, images and image editing. Filters and layers.

Practical: Layouts and designing of visuals, basics of colors, working with text, presentations, charts and putting animations, views, graphics, adding audio and videos, creating interactive presentations. Adobe Photoshop, introduction, working with images, image editing and cleaning. Panning and zooming, cropping images, morphing, building layers and adding filters, effects.

**IT 506 Relational Data Base Management System**
2+2Sem. IIT
Overview of DBMS, basic DBMS terminology, advantages and disadvantages of DBMS, file approach and its limitations, DBMS approach, advantages of DBMS, DBMS components. Design, logical and physical data independence, three level architecture of DBMS, entities and types of entities, relationships, entity relationship model. Data models, relational model, network model, hierarchical model, comparison of data models. Relational model, storage organizations for relations, primary, secondary, candidate, alternate keys, relational algebra & relational calculus, functional dependencies and normalization. Functional relational query language, SQL commands, DCL, DDL, DML and TCL. PL/SQL, variables, control structures, decisions and loops, functions and procedures, cursors and triggers.

Practical: E-R diagram construction, SQL, version of SQL, commands syntax, data types, DDL statements, DML statements, DCL statements, TCL statements, having clauses, order by and where clause, wild cards, operators, integrity constraints, primary key, reference key, check, unique, not null, index and views, sequences, functions, aggregate functions, numerical, string, date and time, sub queries, nesting of queries, normalization of database and case study on a database design and implementation. PL/SQL, variables, control structures, decisions and loops, exception handling, creating functions and procedures, cursors, implicit and explicit cursors, triggers.
IT 507 Visual Programming  
1+2  Sem. II
Visual fundamentals, building your first application, developing applications in visual programming, working in the visual programming environment, using the intrinsic controls, working with projects, working with properties, deploying visual applications, advanced programming, debugging, creating controls, using active x controls, your applications, database programming, database basics and the data control. Making reports, enhancing the programming using the advanced data controls.
Practical: Programs for loops, typecasting. Developing user friendly programs in visual environment / platform on Linux/windows, methods and events, programming using data types, constants and variables, making statements in a program, working with conditional statements, working with loops, working with arrays, working with strings and typecasting, the elements of visual environment, creating menus, forms and dialog boxes, handling keyboard and mouse input, working with time and timers, adding graphics, writing reusable code with subs and functions, saving and retrieving data. Accessing Databases using advance Data control.

IT 508 Programming in C++  
2+2  Sem. II
Introduction to C++, character set, constants, variables and keywords and their types. Operators, type conversion. Control statements, conditional expression. Declaration of variables, statements, simple C++ program, manipulator functions, I/O stream flags. Functions, types of functions, local and global variables, default arguments, multifunction program. Storage class specifiers, pre-processor, header files and standard functions. Arrays, declaration, initialization, processing with array, array with functions, strings and their functions. Overview of classes and objects, definition, structures and classes, member functions, defining object, accessing a member, array of class objects, classes within classes. The I/O library and file handling, operations on files.
Practical: Programs on use of decision making statements in C++, using iterations and arrays, multidimensional array, input output manipulators, predefined manipulators and user defined manipulators, formatted and unformatted input output functions, set precision, user defined objects, defining function, return statement, Classes and Objects, using constructors and destructors in classes, object as a member, Member Functions, call and return values, passing parameters, actual and formal arguments, recursion, I/O library files, macros, stream buffers, istream, ostream and fstream, file handling, saving files on disk, reading contents from files, editing files, apply file modes, type of files.

IT 509 Data Structures and Algorithms  
3+1  Sem. I
Overview of data structures, basic concepts, data organization, description of various data structures. Programming design and development. Algorithms, programming constructs algorithm complexity, big O notation, and concept of recursion. Arrays and matrices, stack, stack insertion and deletion, queue, circular queues, priority queues, link list, Representation and processing of linear linked lists, multiple linked structures, creating link list, inserting and deleting link nodes from a list, circular link list, doubly link list, Trees, traversing a tree, traversal methods, depth, level and height of a tree, binary tree, BST, AVL tree, threaded binary trees, M-Way search trees, B-Tree, heaps, multi way trees. Graphs, demonstrating graphs in memory, operations on graphs, applications of graphs. Searching and sorting, searching, linear search and binary search algorithm, hash list searches, collision resolution. Bubble sort, selection sort, insertion sort, radix sort, merge sort algorithm, quick sort, heap sort, shell sort.
Practical: Implementation of various types of structures, programs for array and multidimensional arrays, linked lists, doubly linked lists, circular linked lists, queue, de-queue, stack and tree, in-order, preorder and post-order tree traversals, string processing, searching and sorting techniques, graph and geometric algorithms and case studies.

IT 510 Core Java  
1+2  Sem. I
Features of java, java and internet, java and www, hardware and software requirements, java support systems, java environment, java classes, access modifiers, managing classes and calling methods, inheritance, overloading, packages & interfaces, exception handling, multiple catch statements, finally statement, creating user defined exceptions, multithreading, thread control methods, thread life cycle.
Practical: Programs on java classes, methods, string class, decision making control statements, looping control statements, jumping statements, vectors, operators, arrays, multidimensional arrays, passing arrays to functions, array of objects, string handling in java, string functions, inheritance, types of inheritance, inheritance accessing modes, runtime and compile time binding, packages, importing classes and packages, interfaces, runnable interfaces, exception handling, types of exceptions, throwing exceptions, catch and try block, multiple catch blocks, finally keyword, multi threading, prioritizing the threads, Designing applets in WebPages, Extending applet class, I/O applets, importing classes and packages, extending applet class.

**IT 511 Data Communication and Networks** 2+0  Sem. II

Definition of a communication network, simplex, duplex and half duplex systems, concept of node nodes connected by links to create networks, names & addresses, the idea of "address resolution". Types of network, point-to-point connections, circuit-switched networks, message-switched networks, packet-switched networks, datagram networks. Types of equipment, packet-switched network, types of communication-broadcast, unicast and multicast modes. Open system interconnection, layers, responsibilities of each layer, TCP/IP model, transmission media, magnetic, twisted, coaxial cables and optical fiber, multiplexing, switching, terminal handling, telephone system, modems, connections, transmission media.

**IT 512 Linux System Administration** 1+2  Sem. II

Linux basics, script command and utilities, booting process, HTTPD, CDI and PERL. Linux protocols, configuring TCP/IP, DNS, NFS and NIS, mailing, security, proxy server, network management in Linux, shell programming. X-windows, principles, X programming model, calling motif functions, widget basics, text and list widgets etc., color basics. Practical: Linux commands, Assign multiple IP's, Assign second IP, Trace Route, Trace Path, Disable network card, Enable network card, View current routing table, Assign IP/Subnet, Display Current Configuration for all NIC's, static IP address, Implementation of sever settings, administration commands, process related commands, network commands, IP Address Management, Installation of server using Network File System (NFS), mount system drives and fetching data using NFS, Managing network problems, script writing based on Linux using vi editors / emacs editors, constructs of shell programming.

**IT 513 Concepts of Object Oriented Programming** 3+1  Sem. I

Introduction to object orientation, history and evolution of object oriented languages, Object Oriented Programming (OOP) languages (e.g. C++/Java etc.), abstract data types, classes, parameterized classes, objects, object/message paradigm, data encapsulation, concepts of modules and interfaces, data abstraction and types, constructors and destructors, types of constructors, data hiding, overloading, operator overloading, binary and unary operator overloading, function overloading, constructor overloading, virtual class, pure virtual class, dynamic binding, polymorphism, virtual classes, inheritance, class hierarchies, relationships, inheritance and dynamic binding, single level inheritance, multiple inheritance, multilevel inheritance, hierarchical inheritance and hybrid inheritance, procedural abstraction, functional procedures, object oriented software design, concept of modeling objects, object oriented analysis and design, importance, object oriented analysis landscape, object oriented design landscape, unified modeling language, structure diagrams, classes and states, object diagrams, class diagrams, interaction diagram, activity diagram, use case diagram, state machine diagrams, sequence diagram, behavior diagram, meta modeling.

Practical: Case studies using Object Oriented Analysis And Design (OOAD), creation of classes with features, overloading, programs using inheritance, multilevel and multiple inheritance, hybrid and hierarchical inheritance, data abstraction, polymorphism, programs for binary and unary operator overloading, function overloading, and implementation of a case study.

**IT 514 Design and Analysis of Algorithms** 3+0  Sem. I

Elementary algorithmic, problem and instances, the efficiency of algorithms, average and worst case analyses, some examples, asymptotic notation, analysis of algorithms, greedy algorithms, general
characteristics of greedy algorithms, Set and disjoint set union, Stassen’s matrix multiplication graphs, minimum spanning trees, Kruskal's algorithms, Prim's algorithms, graphs, adjacency matrix, cost adjacency matrix, shortest paths, traversing graphs, the knapsack problem, scheduling, minimizing time in the system, scheduling with deadlines, divide and conquer, dynamic programming, exploring graphs, graphs and games, traversing trees, depth-first search, undirected graphs, articulation points, depth-first search, directed graphs, acyclic graphs, topological sorting, breadth-first search, backtracking, the knapsack problem, computational complexity, information-theoretic argument, adversary argument, linear reductions, introduction to NP-completeness, Classes NP-Hard and NP-Hard Graph Problems (CNDP, DHC, TSP and AOG). Case Studies using divide and conquer searching and complexities. Algebraic General Method, Evaluation and Interpolation, Fast Fourier Transformation, Modular Arithmetic. Introduction to Absolute Approximation.

**IT 515 Information and Network Security**


**IT 516 Soft Computing**


**IT 517 System Software**

Introduction to software processors, elements of assembly language programming, assembly scheme, single pass and two pass assembler, general design procedure of a two pass assembler, macros and macro processor, macro definition, macro expansion, and features of macro facility, design of macro processor, overview of compilers, memory allocation, compilation of expressions, compilation of control structures, use of interpreters, pure and impure interpreter, Compile and go loader, Absolute loader, Relocating loader, and direct linking loader. lexical analysis, syntax analysis, intermediate code generation and optimization, local and global optimization, assembly and output. Loaders and linkage editors. Translated linked and load time addresses, relocation and linking concepts. Design of a linker, self relocating programs. Introduction to loading, linking and relocation, program linking, linkage editors, dynamic linking, bootstrap loader. Other system software, database systems, functions and structure of text editor. Processor management, Scheduler, traffic controller, race condition, Information management.

**IT 518 Computer Organization and Architecture**

Number systems, boolean algebra, minimization of boolean function using karnaugh map, logic gates, combinational circuits, MUX, DEMUX, encoder, decoder, sequential circuits, flip-flops, half and full adder, shift register, counters. Organization of CPU, control unit, instruction and execution cycle in CPU,
register organization, the instruction cycle, instruction pipelining. Memory organization, internal memory, semiconductor main memory (RAM, ROM, EPROM), cache memory, advanced DRAM organization, external memory, magnetic disks, RAID, optical memory, magnetic tape. Basic structure of computer hardware and system software, addressing methods and machine program sequencing, input-output organizations, accessing I/O devices, Direct Memory Access (DMA), interrupts. CISC and RISC architecture, study of functional units of microprocessors.

**IT 519 Cyber Law in India**


**IT 520 Network Programming**

Introduction to networking and internet protocols via programming, TCP/IP, user datagram protocol, multicasting, standard internet services and protocol usage by common internet applications. Sockets programming, client/server, peer-to-peer, internet addressing, TCP sockets, UDP sockets, raw sockets, multithreading and exception handling. Finger, Domain Name System, HTTP, and ping clients and servers. Routers and architectures, routing protocols. Router and switch configurations, internet operating systems. Internetwork setup, wireless internetworking. Network protocol analyzers, Types of protocols, remote terminal access, types of servers, transaction based, inherent concurrency, strict turn-taking, stateless servers, traffic generation.

Practical: Handling TCP/IP protocol, programming TCP/IP parameters, Implementation of remote terminal access, commands of HTTP, handling UDP, programming of UDP parameters. Network programming under Linux / windows, implementing socket programming, configuring peer to peer networks, routers and switch configuration in Linux and Windows.

**IT 521 Design and Management of Web Portals**

Web portals, definition, history, types of web portals, web portal services, search engine, indexing, FAQ, RSS feeds, E-mail alerts, live chat, blog, web portal design, management, security issues. XML. Introduction, features of XML, XML protocols, XML documents. Structure of XML, logical structure, physical structure. XML markup, element markup, attributes markup naming rules, elements, attributes, descriptors, comments, entity. Unrestricted elements, element content models, element sequences, element choices, combined sequences and choices. Viewing, xml in internet explorer, viewing xml using the xml data source object. XSL (Extensible Style Sheet Language) or CSS (Cascading Style Sheet).


**IT 522 Content Management**

Strategy, scope, structure, skeleton, surface review. Compare and contrast OS-CMS options. Defining a successful online community, setting up a Joomla site, sections, categories, content, menu, wire framing, Joomla templates, evaluating Joomla extensions for community functionality and technical features, installing and configuring Joomla extensions, forming, storming, norming, and conforming.

Practical: Use of open source software tools for content management, create, update, and delete articles, display a list of articles, create a navigation menu and display articles in the front-end, auto-archive articles older, Create a Website template, use of File System Object, use the VBScript function Replace() Create a Database for the Content developing e-learning modules. Templates, content languages, meta data, mail, stats, search engine friendly URL’s, calendar, content items, native support for file types, multiple file transfer, file conversion tools, currency conversion, source editor, spell checker, XML editor, role management, media asset repository (Images, sound, flash, video etc).
IT 523 Data Warehousing & Data Mining  
Concepts and principles of data warehousing, data warehousing architecture. System process and process architecture, data warehousing design, database schema. Partitioning strategy, aggregations, data marts, meta data management, and data warehouse process. Query management, data warehouse security, backup, backup schedule, backup media, backup format, backup file format, restoring points, restoring backup files and recovery, recovery from deleted database, recover from damage disk, capacity planning, testing the warehouse. Introduction to data mining, neural networks, fuzzy logic. Visualization techniques, decision trees, association rules, statistical and clustering models.

Practical: Data warehouse design, selection of schema, normalization and renormalization, query plan strategy, performance tuning, backup, backup scheduling, restoring database and recovery of data warehouse, dynamic reporting and OLAP cubes, data mining techniques, neural networks, fuzzy logic, visualization techniques and decision trees.

IT 524 System Analysis And Design  
System, concept, elements of a system and types of system, system development life cycle, role of system analyst, initial investigation, feasibility study, technical, economic and behavioral feasibility, cost and benefit analysis. System analysis, problem definition, information requirements, information gathering tools, tools of structured analysis, data flow diagrams, data dictionary, decision tree, decision tables and structured English, system design, structured design, input design, and output design, form design, file organization, sequential, indexed sequential, chaining and inverted list organization, system testing, test plan and test data, types of system test, system implementation, implementation plan, activity network for conversion, combating resistance to change. Hardware/software selection, procedure for selection, major phases in selection, make v/s buy decision, criteria for software selection.

IT 525 Object Oriented Software Engineering  
Software engineering, software related problems, software engineering, concepts, and development activities. Modeling, modeling with UML. Project communications, project communication modes, mechanisms and activities. Requirements requirements elicitation, concepts & managing requirements elicitation. Analysis, analysis overview, activities and managing analysis. Design, design overview, fundamental concepts of system design, activities and managing system, design. Object design, object design overview, activities and managing object design. Rationale management, rationale overview, concepts, activities and managing rationale. Software documentation procedures, Software reliability and quality assurance. Quality Metrics and software models. Testing, testing overview, testing fundamentals, activities and managing testing. Software configuration management, configuration management overview, concepts, activities and managing configuration management. Project management, project management overview, activities and managing project management models and activities. Software engineering tools and environment, International software engineering standards and their relevance. Case studies in software engineering. Software Agents, Definition, Applications, Types and Classes, Multi-Agent systems, Characteristics & Properties Agents.

IT 526 Network Management  

Practical: Basic Networking Concepts, Installing and configuring network server for window based and linux based systems, configuration protocols & bindings, network adapters, peripherals & devices, create users, managing users, managing group accounts, create policies, profiles, system policies, user policies, Managing resources, disk resources, working with window resources, UNC, configure IP addresses in windows and linux, set up LAN network, managing network with respect to their
topologies, ring topology set up wi-fi networks, managing E-mail, DHCP Practice of latest protocol/ network services on Linux / windows server.

**IT 527 Parallel and Distributed Computing**

3+0 Sem. I,II

Basic concepts of parallel computers and computation, parallelism and computing, von Neumann computer architecture, Flynn's classical taxonomy, general parallel technology, parallel computer memory architecture, Shared Memory, Distributed Memory, Hybrid Distributed-Shared Memory, Parallel Programming Models, Shared Memory Model, Threads Model, Message Passing Model, Data Parallel Model, Other Models, Designing Parallel Programs, Automatic vs. Manual Parallelization, Understand the Problem and the Program, Synchronization, Data Dependencies, Load Balancing, Granularity, I/O, Limits and Costs of Parallel Programming, Performance Analysis and Tuning, PI Calculation, Simple Heat Equation, 1-D Wave Equation, Distributed system models, cloud computing, Distributed System Challenges, connecting users and resources / concurrency, parallel machine model, parallel algorithm, designing parallel algorithms, methodical design, partitioning, communication, agglomeration, mapping, quantitative basis, performance evaluation, scalability analysis, communication model, communication libraries, basics of PVM, MPI, BSP, clustering, grids types, computational grids, data grids. Grid computing, layered grid architecture, volunteer grid computing.

**IT 528 Server Programming with Java**

2+1 Sem. I,II


**IT 529 Trends in Internet Technology**

2+1 Sem. I,II

Evolution of internet. Internet protocol, IP addressing, routing, bridges, switches, hubs, Internet applications, FTP, TELNET, Email, chat. WWW, HTTP protocol. E-commerce, types of Ecommerce, business to business Ecommerce, Customer to business, business to customer, government to business, E-business, M-commerce, requirements for Ecommerce, Ecommerce and web security issues including symmetric and asymmetric key, encryption and digital signature, authentication. Emerging trends, internet telephony, Voice over internet protocol (VOIP), virtual reality over the web, intranet, extranet, firewall security, firewall types, configuration of firewall, firewalls design issues, firewall architecture and implementation.

Practical: Configuring FTP, TELNET, Mail Server, Designing / formatting dynamic WebPages, usages of servlets, PHP and CGI programming, applications of VOIP.

**IT 591 Seminar**

**IT 599 Project for PGDCA IT**

600 Project Research
### COURSE CURRICULUM FOR B.Tech.(Agri. Engg.) 4 YEAR PROGRAMME

#### CORE COURSES

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Cr. Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chem. 205</td>
<td>Engineering Chemistry</td>
<td>2+1</td>
</tr>
<tr>
<td>Eng. 102</td>
<td>Comprehension and Communication Skills in English</td>
<td>1+2</td>
</tr>
<tr>
<td>Math. 211</td>
<td>Engineering Mathematics-I</td>
<td>2+1</td>
</tr>
<tr>
<td>Math. 212</td>
<td>Engineering Mathematics-II</td>
<td>2+1</td>
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<tr>
<td>Math. 311</td>
<td>Engineering Mathematics-III</td>
<td>2+1</td>
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<td>Mgt. 422</td>
<td>Agribusiness Management and Trade</td>
<td>3+0</td>
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<tr>
<td>Mgt. 423</td>
<td>Introduction to Entrepreneurship and Marketing</td>
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<tr>
<td>Pbi. 101</td>
<td>Basic Punjabi</td>
<td>0+2(NC)</td>
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<tr>
<td>Pbi. Cul. 101</td>
<td>Punjabi Culture</td>
<td>2+0(NC)</td>
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<td>Phy. 203</td>
<td>Engineering Physics</td>
<td>2+1</td>
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<tr>
<td>Agron. 105</td>
<td>Agriculture for Engineers</td>
<td>3+1</td>
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<tr>
<td>Env. 301</td>
<td>Environmental Science</td>
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<tr>
<td>HD 106</td>
<td>Human Values in Education</td>
<td>1+1</td>
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<tr>
<td>CE 104</td>
<td>Surveying and Levelling</td>
<td>1+2</td>
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<tr>
<td>CE 203</td>
<td>Engineering Mechanics</td>
<td>2+1</td>
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<tr>
<td>CE 204</td>
<td>Watershed Hydrology</td>
<td>2+1</td>
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<tr>
<td>CE 205</td>
<td>Soil Mechanics</td>
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<tr>
<td>CE 305</td>
<td>Strength of Materials</td>
<td>2+1</td>
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<tr>
<td>CE 403</td>
<td>Design of structures</td>
<td>2+1</td>
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<tr>
<td>CSE 204</td>
<td>Computer Programming and Data Structures</td>
<td>0+3</td>
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<tr>
<td>EE 203</td>
<td>Electric Circuits</td>
<td>2+1</td>
</tr>
<tr>
<td>EE 204</td>
<td>Electrical Machines</td>
<td>2+1</td>
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<tr>
<td>EE 302</td>
<td>Electronics and Instrumentation</td>
<td>2+1</td>
</tr>
<tr>
<td>EST 303</td>
<td>Renewable Energy Sources</td>
<td>2+1</td>
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<tr>
<td>FMP 206</td>
<td>Field Operation and Maintenance of Tractors and Farm Machinery-I</td>
<td>0+1</td>
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<tr>
<td>FMP 303</td>
<td>Farm Machinery and Equipment-I</td>
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<tr>
<td>FMP 304</td>
<td>Farm Machinery and Equipment-II</td>
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<tr>
<td>FMP 305</td>
<td>Tractors and Automotive Engines</td>
<td>2+1</td>
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<td>FMP 306</td>
<td>Field Operation and Maintenance of Tractors and Farm Machinery-II</td>
<td>1+1</td>
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<tr>
<td>FMP 403</td>
<td>Tractor Systems and Controls</td>
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<td>FMP 404</td>
<td>Tractor Design and Testing</td>
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<tr>
<td>ME 103</td>
<td>Engineering Drawing</td>
<td>0+2</td>
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<td>ME 104</td>
<td>Workshop Practice</td>
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<tr>
<td>ME 105</td>
<td>Thermodynamics and Heat Engines</td>
<td>3+1</td>
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<tr>
<td>ME 205</td>
<td>Workshop Technology</td>
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</table>
ME 206  Heat and Mass Transfer  2+0
ME 207  Theory of Machines  2+1
ME 303  Fluid Mechanics  2+1
ME 402  Machine Design  2+1
ME 403  Refrigeration and Air Conditioning  2+1
PFE 202  Engineering Properties of Biological Materials and Food Quality  2+1
PFE 305  Crop Process Engineering  2+1
PFE 306  Drying and Storage Engineering  3+1
PFE 404  Dairy and Food Engineering  2+1
PFE 405  Agricultural Structures and Environmental Control  2+1
PFE 406  Food Packaging Technology  2+1
SWE 304  Irrigation Engineering  3+1
SWE 305  Soil and Water Conservation Engineering  2+1
SWE 306  Soil and Water Conservation Structures  2+1
SWE 404  Groundwater, Wells and Pumps  2+1
SWE 405  Drainage Engineering  1+1
SWE 406  Minor Irrigation and Command Area  2+1

Project and Practical Training Courses
CSE 303  Practical Training in Web Application  0+2
Econ. 428  Practices in Project Planning and Evaluation  0+3
ME 304  Hands on Training in CAD/CAM and machine Drawing  0+3
Industrial Training (one month)  0+6( NC)
In-House Training (15 days)  0+3( NC)
In-House Training (15 days)  0+3( NC)
Proj. I  B.Tech. Project  0+3
Proj. II  B.Tech. Project  0+3
Seminar  B.Tech. Seminar  0+1

Cafeteria Courses
Each student has to register for two cafeteria courses out of the courses listed below:

CE 404  Environmental Engineering  2+1
CE 405  Building Technology and Construction Practices  2+1
CSE 302  Systems Engineering  2+1
EST 402  Renewable Energy Technologies  2+1
FMP 405  Production Technology of Agricultural Machinery  2+1
FMP 406  Mechanics of Tillage and Traction  2+1
FMP 407  Farm power and Machinery Management  2+1
FMP 408  Human Engineering and Safety  2+1
FMP 409  Hydraulic Drives and Controls  2+1
FMP 410  Biomass Management for Fodder and Energy  1+1
PFE 407  Waste and By-Product Utilization  2+1
PFE 408  Development of Processed Products and Equipments  2+1
Pre-requisites for courses

<table>
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<tr>
<th>Sr No.</th>
<th>Course No.</th>
<th>Pre-requisites</th>
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<tbody>
<tr>
<td>1.</td>
<td>EE 204</td>
<td>EE 203</td>
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<td>14.</td>
<td>FMP 404</td>
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SEMESTER-WISE STUDY PROGRAMME OF B.Tech (Agril. Engg.)

FIRST YEAR

<table>
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<tr>
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<td>211</td>
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<td>Env.</td>
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<td>Phy.</td>
<td>203</td>
<td>2+1</td>
<td>CE</td>
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<tr>
<td>Chem.</td>
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<td>2+1</td>
<td>ME</td>
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<td>204</td>
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<td>CE</td>
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<td>ME</td>
<td>103</td>
<td>0+2</td>
<td>Math.</td>
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<tr>
<td>Agron.</td>
<td>105</td>
<td>3+1</td>
<td>ME</td>
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<tr>
<td>EE</td>
<td>203</td>
<td>2+1</td>
<td>Eng.</td>
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<td>0+1(NC)</td>
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21(11+10)+3(NC)   22(13+9)+1(NC)
## SECOND YEAR

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<tr>
<th>Semester III</th>
<th>Semester IV</th>
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<tbody>
<tr>
<td><strong>CE</strong> 204 2+1</td>
<td><strong>ME</strong> 207 2+1</td>
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<tr>
<td><strong>EE</strong> 204 2+1</td>
<td><strong>ME</strong> 206 2+0</td>
</tr>
<tr>
<td><strong>Math.</strong> 311 2+1</td>
<td><strong>EE</strong> 302 2+1</td>
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<td><strong>ME</strong> 205 2+1</td>
<td><strong>SWE</strong> 305 2+1</td>
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<tr>
<td><strong>FMP</strong> 206 0+1</td>
<td><strong>FMP</strong> 303 2+1</td>
</tr>
<tr>
<td><strong>SWE</strong> 304 3+1</td>
<td><strong>PFE</strong> 305 2+1</td>
</tr>
<tr>
<td><strong>PFE</strong> 202 2+1</td>
<td><strong>CE</strong> 205 2+1</td>
</tr>
<tr>
<td><strong>NSS/NSO/NCC</strong> 0+1</td>
<td>Edu. Tour 0+1</td>
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</table>

| 20(13+7)+1(NC) | 20(14+6)+2(NC) |

## Third Year

<table>
<thead>
<tr>
<th>Semester V</th>
<th>Semester VI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ME</strong> 303 2+1</td>
<td><strong>ME</strong> 402 2+1</td>
</tr>
<tr>
<td><strong>CE</strong> 305 2+1</td>
<td><strong>CE</strong> 403 2+1</td>
</tr>
<tr>
<td><strong>SWE</strong> 306 2+1</td>
<td><strong>PFE</strong> 405 2+1</td>
</tr>
<tr>
<td><strong>FMP</strong> 304 2+1</td>
<td><strong>SWE</strong> 404 2+1</td>
</tr>
<tr>
<td><strong>FMP</strong> 305 2+1</td>
<td><strong>FMP</strong> 306 1+1</td>
</tr>
<tr>
<td><strong>PFE</strong> 306 3+1</td>
<td><strong>PFE</strong> 404 2+1</td>
</tr>
<tr>
<td><strong>Mgt.</strong> 422 3+0</td>
<td><strong>FMP</strong> 403 2+1</td>
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</tbody>
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| 22(16+6) | 20(13+7) |

## Fourth Year

<table>
<thead>
<tr>
<th>Semester VII</th>
<th>Semester VIII</th>
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<tbody>
<tr>
<td><strong>ME</strong> 403 2+1</td>
<td>Proj. II 0+3</td>
</tr>
<tr>
<td><strong>EST</strong> 303 2+1</td>
<td>Seminar 0+1</td>
</tr>
<tr>
<td><strong>Mgt.</strong> 423 2+1</td>
<td>Econ. 428 0+3</td>
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<tr>
<td><strong>SWE</strong> 405 1+1</td>
<td>ME 304 0+3</td>
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<tr>
<td><strong>SWE</strong> 406 2+1</td>
<td>CSE 303 0+2</td>
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<tr>
<td><strong>PFE</strong> 406 2+1</td>
<td>Cafeteria course I 4+2</td>
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<tr>
<td><strong>FMP</strong> 404 2+1</td>
<td>Cafeteria course II</td>
</tr>
<tr>
<td><strong>Proj. I</strong> 0+3</td>
<td>Industrial training 0+6(NC)</td>
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<tr>
<td>23(13+10)</td>
<td>In-house training-I 0+3(NC)</td>
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<tr>
<td></td>
<td>In-house training-II 0+3(NC)</td>
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</tbody>
</table>

| 18(4+14)+12(NC) |

Total Credit Hours requirement for B.Tech. (Agri. Engg.) Programme 166+19(NC)