FACULTY OF AGRICULTURAL ENGINEERING AND TECHNOLOGY

General Information

Disciplines

- Farm Machinery and Power Engineering
- Processing and Food Engineering
- Soil and Water Engineering
- Remote Sensing and GIS
- Civil Engineering
- Mechanical Engineering
- Energy Science and Technology
- Electrical Engineering and Information Technology
  (A) Electrical Engineering
  (B) Computer Science and Engineering
  (C) Information Technology
- Course curriculum for B.Tech. (Agri. Engg.) 4 year programme
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 so developed to the stakeholders 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 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 (SIT), 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 was 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 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, M.Tech. and Ph.D. programmes were started in different disciplines keeping in view the employment needs of the students and beneficiaries like industry, public sector and farmers of the State. The M.Tech programme in Remote Sensing and GIS was 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 PG admission is made on the basis of merit list prepared through written test and interview at PAU level and ICAR PG test. The undergraduate and postgraduate programmes have duly been recognized by ICAR. The revision of course curricula is a continuous process. The revised B.Tech. (Agril. Engg.) programme in the light of the recommendations of the Vth Deans' Committee (ICAR) has been adopted from the session 2016-2017. The model curricula and the revised/restructured PG programmes as per the recommendations of the National Core Group (ICAR) was introduced in the academic session 2010-2011. The curricula have sufficient components of engineering disciplines, basic sciences, agricultural sciences, practical and hands on training. The newly included Student READY programme as per ICAR guidelines has been introduced.

The student evaluation criteria constitute internal and external components and a system of Credit Point Average on a 10 point-scale basis is followed for grading of students. The College had 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.

Required Courses

Field of Specialization

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.

Required Courses

Field of Specialization

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


Deficiency Courses

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

Undergraduate Courses

FMP 51 Farm Mechanization 2+1 Sem. I
(For students of Diploma in Agriculture)
Practical: Main parts of diesel engine (two stroke and four stroke) and their functions. Daily maintenance of prime movers and their safety aspects. Various systems of tractor. Working of bio-gas plant and solar equipment. Field measurements. Study of various parts of agricultural machines and processing equipment along with their functions. Tractor driving and operation of agricultural machines and hauling operation. Repair and maintenance of various machine, their adjustment and performance parameters.

FMP 102 Farm Machinery and Power 1+1 Sem. II
(For students of College of Agriculture)
Practical: Study of different components of IC engine. To study air cleaning and cooling system of engine, Familiarization with clutch, transmission, differential and final drive of a tractor, Familiarization with lubrication and fuel supply system of engine, Familiarization with brake, steering, hydraulic control system of engine, Learning of tractor driving, Familiarization with operation of power tiller, Implements for hill agriculture, Familiarization with different types of primary and secondary tillage implements: mould plough, disc plough and disc harrow. Familiarization with seed-cum-fertilizer drills their seed metering mechanism and calibration, planters and transplanter. Familiarization with different types of sprayers and dusters Familiarization with different inter-cultivation equipment, Familiarization with harvesting and threshing machinery.

FMP 201 Tractor and Farm Machinery Operation 0+1 Sem. I
Familiarization with different makes and models of agricultural tractors. Identification of various functional systems including air supply, fuel, cooling, transmission, steering and
hydraulic systems. Maintenance points to be checked before starting a tractor. Familiarization with controls on a tractor. Safety rules and precautions to be observed while driving a tractor. Practice of driving a tractor and with tillage tools (Primary/Secondary tillage implements) and their adjustment in the field. Field patterns while operating a tillage implement. Hitching and de-hitching of mounted and trailed type implements to the tractor. Practice for driving of a trailed type trolley: forward and in reverse direction.

FMP 203 Farm Machinery and Equipment-I 2+1 Sem. II

FMP 302 Tractor and Automotive Engines 2+1 Sem. I


**FMP 306 Farm Machinery and Equipment-II**


familiarization with the functional units and attachments. Familiarization with the working of cotton and maize harvesters. Familiarization with vegetable and fruit harvesters.

**FMP 307 Tractor Systems and Controls**  
2+1  Sem. II  

**FMP 311 Tractor and Farm Machinery Maintenance**  
0+1  Sem. II  

**Elective Courses**
FMP 411 Tractor Design and Testing


FMP 412 Farm Machinery Design and Production


FMP 413 Mechanics of Tillage and Traction


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

**FMP 414 Ergonomics 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. Introduction to biomechanics of motion, types and 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. Application of concept of ergonomics in farm machinery. Dangerous machine (Regulation) act, Rehabilitation and compensation to accident victims, safety gadgets for spraying, threshing, chaff cutting and tractor & trailer operation etc.

Practical: Calibration of the subject in the laboratory using bi-cycle ergo-meter. Study and calibration of the subject in the laboratory using mechanical treadmill. Use of respiration gas meter from human energy point of view. Use of heart rate monitor. Study of general fatigue of the subject using blink ratio method. Familiarization to electro-myograph equipment, anthropometric measurements of a selected subject. Optimum work space layout and locations of controls for different tractors. Familiarization with the noise and vibration equipment. Familiarization with safety gadgets for various farm machines.

**FMP 415 Hydraulic Drives and Controls**

2+1 Sem. II


**FMP 416 Precision Agriculture and System Management**

2+1 Sem. II

Precision Agriculture: need and functional requirements. Familiarization with issues relating to natural resources. Familiarization with equipment for precision agriculture: laser guided land levelers, precise sowing and planting machines, variable rate sprayers, yield monitoring system and moisture sensor for grain combines etc. Introduction to GIS based precision
agriculture and its applications. Introduction to different soil and plant sensors. Application of GPS based navigators and sensors for data handling in agricultural machinery management. System concept and approach in farm machinery management, problems on machinery selection, maintenance and scheduling of operations. Application to PERT and CPM for machinery system management.

Practical: Familiarization with precision agriculture problems and issues. Familiarization with various machines for resource conservation. Operation of different GIS software’s for data management. Field data collection using GPS based navigators, yield monitors, moisture sensors, soil and plant sensors etc. Solving problems related to various capacities, pattern efficiency, system limitation, etc. Problems related to cost analysis and inflation and problems related to selection of equipment, replacement, break-even analysis, time value of money etc.

**FMP 417 Machinery for Crop Residue and Fodder Management**  
2+1  
Sem. II

Introduction to biomass management, biomass resource assessment techniques, supply chains. Processing of paddy straw: densification, extrusion process, pellets, mills and cubes. Baling: machines, classification and uses. Residue management for surface mulch and incorporation: paddy straw choppers and spreaders, straw managing system as an attachment to combine harvester, mulch seeder, forage chopper cum loader etc. 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.


**FMP 418 Farm Power and Machinery Management**  
2+1  
Sem. II


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

**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 software’s software development process, Algorithm design, program composition, quality control, documentation and maintenance, software strategy. Approximation, roundoff 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 pickups, 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 Markovchain. 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
Practical: Vibration measurement equipment and measurement on different components of thresher, combine, reaper, power tiller and tractor. Modulus of elasticity, rigidity, and MI.

**FMP 508 Tractor Design**


**FMP 509 Principles of Ergonomics, Application and Safety**


**FMP 510/PFE 502 Engineering Properties of Biological Material**

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 behavior. Contact stresses between bodies, Hertz problems, firmness and hardness, mechanical, damage, deadload 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, aerodynamics 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 foodgrains, 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
Energy cycle of the earth; workflow and storage; ocean currents and tides. Energy heat flow and energy storage; photosynthesis and biomass; renewable energy sources. Thermodynamics of energy conversion; conversion of solar energy, wind energy, waterflows, heat, biomass, etc.; other conversion processes. Development and use of biogas, alcohols and plant oils, plantoilesters in I.C. engines. Study of various parameters for measuring the performance of the output. Design of bio-fuel production units: design of gasifiers, gas flow rates, biogas plants. Establishment of esterification plant, fuel blending.

FMP 513 Theory of Hydraulics and its Applications 2+1 Sem. II
Practical: Study of tractor hydraulic systems for agricultural equipment. Power steering and brake system. Performance characteristics of hydraulic components, circuit's analysis, fluid properties, analogies.

FMP 601 Advances in Farm Machinery and Power Engineering 3+0 Sem. I
Farm machinery system, its characteristics and evaluation. Identification of dynamic characteristics of related components of engine and agricultural machines. Method of dealing with engineering problems. Statement and formulation of design problems. Computer-aided design of mechanical power transmission systems. Half interval search method. Single and

**FMP 602 Mathematical Modeling in Farm Machinery and Power Engineering**


**FMP 603/EST 603 Energy Conservation and Management in Production Agriculture**


**FMP 604 Computer Aided Analysis and Design of Farm Machinery**

Introduction to CAD, the design process, modeling 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 approach to biological systems and engineering systems. Role of a system analyst in design of a system and development of computer systems. Characteristics of Agricultural systems. Tools of structured analysis. The data flow model. Object oriented approach. Feasibility study Steps in feasibility analysis cost analysis. System design process structured design. 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**

Functional design, specifications, requirements and working of farm machinery for natural resources management like rotavator, Precision sowing and planting machines, laser guided leveler, power sprayer, straw chopper cum spreader, straw bailer, combine harvester etc. Ag GPS parallel swathing option, data base management, functional systems documentation. Application of relevant software. An introduction to precision farming, GIS/GPS system for precision farming, Yield monitoring and mapping, soil sampling and analysis. Computers and Geographic information systems. Precision farming-Issues and conditions. Role of electronics in farm machinery for precision farming. Engineering fundamentals related to earth moving
Practical: Introduction to GIS and GPS, study of models - farm machinery usage. Precision farming using GIS and GPS-case study. Mechanism of power shovels, draglines, earth diggers, clamshells etc. Earthwork 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 51 Elementary Agro-Processing  
(For students of College of Agriculture)  
1+1  Sem. I  

PFE 102 Post Harvest Engineering  
(For students of College of Agriculture)  
2+1  Sem. II  
Overview of post harvest technology: Concept and science, production and post harvest losses, reasons for losses, importance of loss reduction; Water activity, water binding and its effect on enzymatic and non-enzymatic reactions and food texture, control of water activity and moisture; Post Harvest Handling operations; Cleaning: Cleaning of grains, washing of fruits and vegetables, types of cleaners, screens, types of screens, rotary screens, vibrating screens, machinery for cleaning of fruits and vegetables (air cleaners, washers), cleaning efficiency, care and maintenance; Sorting and grading: Sorting, grading, methods of grading; Grading Size grading, colour grading, specific gravity grading; screening, equipment for grading of fruits and vegetables, grading efficiency, care and maintenance; Separation: Magnetic separator, destoners, electrostatic separators, pneumatic separator; Decorticating and shelling: Principles of working, design and constructional details, operating parameters, maintenance, etc. of various decorticators/dehullers/shellers, description of groundnut decorticators, maize shellers, etc.; Grain drying theory, grain dryers; Liquid dryers; Parboiling: process, changes during parboiling, parboiling methods, advantages and disadvantages of parboiling with respect to milling, nutritional and cooking quality of grain, significance of glass transition temperature; Milling: milling, polishing, grinding, milling equipments, dehuskers, polishers (abrasion, friction, water jet), flour milling machines, pulse milling machines, grinders, cutting machines, oil expellers, machine efficiency and power requirement; Materials handling: Introduction to different conveying equipments used for handling of grains, fruits and vegetables; Scope and importance of material handling devices; Study of different material handling systems: Classification, principles of operation, conveyor system selection/design; Belt conveyor: Principle, characteristics, design, relationship between belt speed and width, capacity, inclined belt conveyors, idler spacing, belt tension, drive tension, belt tripper; Chain conveyor: Principle of operation, advantages, disadvantages, capacity and speed, conveying chain; Screw conveyor: Principle of operation, capacity, power, troughs, loading and discharge, inclined and vertical screw conveyors; Bucket elevator: Principle, classification, operation, advantages, disadvantages, capacity, speed, bucket pickup, bucket discharge, relationship between belt speed, pickup and bucket
discharge, buckets types; Pneumatic conveying system: Capacity and power requirement, types, air/product separators; Gravity conveyor design considerations, capacity and power requirement.

Practical: Study of cleaners for grains; Study of washers for fruits and vegetables; Study of graders for grains; Study of graders for fruits and vegetables; Study of decorticators; Study of a maize/sunflower sheller; Study of crop dryers; Study of a RF/MW/tray dryer; Study of hot air dryer; Study of vacuum dryer; Study of working principle of spray dryer and spray drying process; Study of drum dryer and liquid food dehydration using drum drying; Study of fluidized bed dryer and drying process; Study of rice milling machines; Study of pulse milling machines; Study of different components of flour mill; Study of different materials handling equipment.

PFE 201 Unit Operations in Food Processing-I
(For students of College of Agriculture)

Practical: Fineness modulus, uniformity index and power requirement in size reduction using Rittinger’s, kick’ and Bond’s law. Performance evaluation of hammer mill and attrition mill. Mixing index of feed mixer. Centrifugal separator. Osmosis in fruits, solid gain and moisture loss during osmosis, reverse osmosis process, ultra-filtration separation process.

PFE 202 Unit Operations in Food Processing-II
(For students of College of Agriculture)
Evaporation: principles, mass and energy balance, factors affecting rate of evaporation, thermodynamics of evaporation (phase change, boiling point elevation and Dühring plot), heat and mass transfer in evaporator, factors influencing the overall heat transfer coefficient and influence of feed liquor properties on evaporation. Evaporation equipment: natural circulation evaporators, horizontal/vertical short tube, natural circulation with external calandria, long tube and forced circulation. Evaporator ancillary plant, design of evaporation systems, single and multiple effect evaporators, feeding methods, preheating, vapour recompression systems. Recompression heat and mass recovery and vacuum creating devices. Fouling of evaporators and heat exchangers. Food freezing: introduction, freezing point curve for food and water, freezing points of common food materials, freezing principle,

Practical: Study of working principle, open pan, vacuum evaporator, single effect evaporator and estimation of heat/mass balance during concentration. Multiple effect evaporator and estimation of heat/mass balance during concentration. Sterilizer, design problems on freezers, numerical problem on thermo bacteriology (D, Z and F values). Freezing of foods by different methods, determination of freezing time of food material and design problems on freezers. Effect of particle size and time on solvent extraction process, temperature on crystallization rate of sugar. Study of blancher, pasteurizers, fryers, homogenizers and irradiators. Oil uptake by the food products during frying and qualitative changes in the fried food products. Visit to a sugar processing industry.

PFE 203 Food Refrigeration and Cold Chain

(For students of College of Agriculture)

Principles and importance, unit of refrigerating capacity, coefficient of performance, production of low temperatures, expansion of a liquid with flashing, reversible/irreversible adiabatic expansion of a gas/real gas, thermoelectric cooling and adiabatic demagnetization. Air refrigerators: Carnot and reversed Carnot cycle, selection of operating temperatures, Bell Coleman and reversed Brayton cycle, analysis of gas cycle, polytropic and multistage compression. Vapour Compression refrigeration system: vapour as a refrigerant in reversed Carnot cycle with p-V and T-s diagrams, limitations of reversed Carnot cycle. Modifications in reverse Carnot cycle with vapour as a refrigerant (dry vs wet compression and throttling vs isentropic expansion), representation of vapour compression cycle on pressure enthalpy diagram, super heating, sub cooling, liquid-vapour regenerative heat exchanger for vapour compression system, effect of suction vapour super heat and liquid sub cooling and actual vapour compression cycle. Azeotropes, Components of vapour compression refrigeration system, (evaporator, and compressor, condenser and expansion valve). Vapour absorption refrigeration system: process, calculations and maximum coefficient of performance.
Common refrigerants: classification, nomenclature and desirable properties (physical, chemical, safety, thermodynamic and economical). Ice manufacture: principles and systems of ice production, treatment of water for making ice, brines, freezing tanks, ice cans, air agitation and quality of ice. Cold storage: design for different categories of food resources, size and shape, construction, material, insulation, vapour barriers, floors, frost-heave, interior finish and fitting, evaporators, automated cold stores and security of operations. Refrigerated transport: handling and distribution, cold chain, refrigerated product handling, order picking, refrigerated vans and refrigerated display. Air-conditioning: factors affecting, classification, sensible heat factor air-conditioning, industrial air-conditioning, numerical problems on sensible heat factor (winter/summer/year round air-conditioning), unitary, central air-conditioning, physiological principles, air distribution and duct design methods, design of complete air-conditioning systems, humidifiers and dehumidifiers. Cooling load calculations: load sources, product cooling, conducted heat, convected heat, internal heat sources, heat of respiration and peak load.

Practical: Study of vapour compression refrigeration system. Determination of COP of vapour compression refrigeration system. Study of types of compressors, condensers, expansion valves, evaporative coils used in refrigeration systems. Study of refrigerants, their properties and charts. Study of direct and indirect contact freezing equipment, spray freezing process and cold storage for foods. Estimation of refrigeration load for cold storage of meat, poultry products, chocolate enrobing process and ice-cream. Study of refrigeration system for dairy plant, bakery and estimation of their refrigeration load. Study of refrigerated van, deep freezing and thawing of foods. Study of refrigerated display of foods and estimation of cooling load.

PFE 204 Engineering Properties of Agricultural Produce 1+1 Sem. II

Practical: Determination of shape, size, bulk density, angle of repose, true density, porosity, coefficient of external and internal friction, terminal velocity and separating behaviour in a vertical wind tunnel, thermal conductivity and specific heat of grains, fruits and vegetables. Determination of hardness of food materials and viscosity of liquid foods.

PFE 301 Food Process Equipment Design 2+1 Sem. I
(For students of College of Agriculture)
Materials and properties: materials for fabrication, mechanical properties (ductility and hardness), corrosion, protective coatings, corrosion prevention linings, equipment, choice of materials and material codes. Design considerations: stresses created due to static and dynamic loads, combined stresses, design stresses, theories of failure, safety factor, temperature and radiation effects, effects of fabrication method and economic considerations.


Practical: Design of pressure vessel, shell and tube heat exchangers, plate heat exchanger, sterilizers and retort, single and multiple effect evaporators, rising and falling film evaporators, crystallizer, fluidized bed, spray, vacuum and microwave dryer. Design of belt, chain, screw, pneumatic conveyor and bucket elevator. Design of twin screw extruder and fermenter.

PFE 302 Food Storage Engineering
(For students of College of Agriculture)
Storage: importance of scientific storage systems, post harvest physiology of semi-perishables and perishables. Climacteric and non climacteric fruits, respiration, ripening, changes during ripening, ethylene bio-synthesis. Direct and indirect damages, causes of spoilage in storage (moisture, temperature, humidity, respiration loss, heat of respiration and sprouting), destructive agents (rodents, birds and insects), sources of infestation and control. Traditional, improved, modern storage structures and farm silos (horizontal, tower, pit and trench silos), size and capacity of silos. Storage of grains: respiration, moisture and temperature changes in stored grains. Conditioning of environment inside storage through ventilation. Aeration and stored grain management: purposes, theory, system design and system operation for aeration. Storage pests and control: damage due to insects, pests and its control, seed coating and fumigation. Storage of perishables: cold, controlled, modified atmospheric, hypobaric and evaporative storage, conditions for storage, control of temperature and relative humidity. Design of storage structures: functional and structural design of grain storage structures, pressure theories, pressure distribution in the bin, grain storage loads, pressure, capacities, warehouse, silos and BIS specifications. Functional, structural and thermal design of cold stores.

Practical: Visits to traditional storage structures, FCI Godowns, cold, CA and evaporative
cooled storages. Design, sizing, capacity and drawing of traditional storage structures, FC
Godowns, cold, CA and evaporative cooled storages. Measurement of respiration of
fruits/grains. Study on fumigation. Drawing and layout of traditional storage structures, FCI
grain Godowns, cold, CA and evaporative cooled storages. Storage study in the MAP.

**PFE 303 Protected Cultivation and Secondary Agriculture**

1+1 Sem. II

(For students of College of Agriculture in collaboration with Department of Soil and Water
Engineering)

Engineering properties: physical, thermal, aero and hydrodynamic properties of cereals,
pulses and oilseeds. Application of engineering properties in postharvest technology (PHT)
equipment design and operation. Drying and dehydration: moisture measurement,
equilibrium moisture content (EMC), drying theory, drying methods, commercial grain
dryers (deep bed dryer, flat bed dryer, tray dryer, fluidized bed dryer, recirculatory dryer an
solar dryer). Material handling equipment: conveyers, elevators, principle, working and
selection. Green house technology: introduction, types of green houses, plant response to
environment, planning and design of green house structures, design criteria for cooling and
heating, equipments, materials of construction, irrigation systems and typical applications.
Passive solar green house heating/cooling systems, green house drying. Cost estimation and
economic analysis.

Practical: Study of different type of green houses based on shape. Determine the rate of air
exchange in an active summer/winter cooling/heating system. Drying rate of agricultural
products inside green house. Study of green house equipments. Visit to various post harvest
laboratories. Engineering properties (shape, size, bulk density and porosity) of bio-materials.
Determination of moisture content of various grains by oven, infrared and other moisture
meters. Field visit to seed processing plant.

**PFE 304 Agricultural Structures and Environmental Control**

2+1 Sem. I

Planning and layout of farmstead. Scope and importance and need for environmental control
of agricultural structures. Physiological reaction of livestock environmental factors,
environmental control system and their design, control of temperature, humidity and other air
constituents by ventilation and other methods. Livestock production facilities. BIS standards
for dairy, piggery, poultry and other farm structures. Design, construction and cost estimation
of farm structures, animal shelters, compost pit, fodder silo, fencing and implement shed,
barn for cows, buffalo, poultry etc. Storage of grains, causes of spoilage, water activity for
high and low moisture food and its limit for storage, moisture and temperature changes in
grain bins. Traditional and improved storage structures (CAP, hermetic storage, PUSA bin
and RCC ring bins), design consideration for grain storage godowns, bag storage structures,
shallow and deep bin, calculation of pressure in bins. Storage of seeds. Rural living and
development, rural roads, their construction cost, repair and maintenance. Sources and norms
of water supply, drinking water standards and water treatment, suitable to rural community.
Site and orientation of building in regard to sanitation, community sanitation systems,
sewage systems and its design, cost and maintenance, design of septic tank for small family.
Estimation of domestic power requirement, source of power supply and electrification of
rural housing.

Practical: Measurement for environmental parameters and cooling load of a farm building.
Design and layout of a dairy farm, poultry house, goat house and sheep house. Design of a farm fencing system, feed and fodder storage structure, grain storage structures, commercial bag and bulk storage facilities. Performance evaluation of different domestic storage structure. Cost estimation of farm buildings.

**PFE 305 Post Harvest Engineering of Cereals, Pulses and Oil Seeds**
2+1 Sem. I


**PFE 306 Post Harvest Engineering of Horticultural Crops**
2+1 Sem. II

Importance of processing of fruits and vegetables, spices, condiments and flowers. Characteristics and properties of horticultural crops important for processing. Peeling: methods and devices (manual, mechanical, chemical, and thermal peeling). Slicing of horticultural crops: equipments for slicing, shredding and chopping. Crushing and juice extraction. Blanching: importance and objectives, blanching methods, effects on food (nutrition, colour, pigment, and texture). Chilling and freezing: requirements, thermophilic, mesophilic and psychrophilic microorganisms of fruits and vegetables, effects on food during

Practical: Performance evaluation of peeler, slicer, juicer, pulper, blanching equipment, testing adequacy of blanching, cold storage design, controlled atmosphere (CAP) and modified atmosphere packaging (MAP) storage. Minimal processing of vegetables. Preparation of value added products, Visit to fruit and vegetable processing industry and spice processing plant.

PFE 307 Dairy and Food Engineering 2+1 Sem. II


Elective courses

PFE 401 Development of Processed Products 2+1 Sem. II
Composition of food and their waste and by-products. Process flow chart with mass and

Practical: Process design and process flow chart preparation, mass and energy balance in food processing. Preparation of value added products. Visit to study operation and machinery of roller wheat flour, rice, spice grinding, sugar, dal and oil mill, fruit/vegetable, meat, poultry and fish processing and milk plants. Process flow diagram and study of various models of the machines used in sugar mill.

PFE 402 Food Quality and Control 2+1 Sem. II
Basics of food science and food analysis, concept, objectives and need of food quality. Measurement of colour, flavor, consistency, viscosity, texture and their relationship with food quality and composition. Sampling: purpose, techniques, procedures for liquid, powdered and granular materials. Quality control: tools, statistical quality control, sensory evaluation methods, panel selection methods, interpretation of sensory results, methods and instrumental method for testing quality. Food adulteration and food safety. Total quality managements (TQM), Total quality control (TQC), consumer preferences and acceptance. Food safety management systems: Good agricultural practices (GAP), Good hygiene practices (GHP), Good manufacturing practices (GMP), Hazards and HACCP (Hazard analysis and critical control point), Sanitation standards operating procedures (SSOP), Food Laws and Regulations in India, Food safety standards authority of India (FSSAI), Food grades and standards BIS, AGMARK, PFA, FPO, ISO 9000, 22000 Series. Codex Alimentarious Commission (CAC), traceability and quality assurance system in a process plant, bio safety and bioterrorism.

Practical: Examination of cereals and pulses from go-downs and market shops in relation to FPO and BIS specifications. Milling quality of food grains. Detection of adulteration and examination of milk, milk products, ghee, jams, jellies, marmalades, spices and honey for various standards of AGMARK, FPO and BIS. Measurement of quality of fresh fruits, vegetables and spices. Visit to quality control laboratory and case study of statistical process control in food processing industry. Registration process, licensing procedure and sampling techniques under FSSAI. Visit to food processing laboratory and study of records and reports.

PFE 403 Process Equipment Design 2+1 Sem. II
Introduction to process equipment design, application of engineering design for processing equipments, design parameters and general design procedure, material specification, types of material for process equipments and design codes. Design of process equipment: pressure vessel, cleaners, tubular, shell and tube and plate heat exchangers, belt, screw conveyer, bucket elevator, dryers and milling equipments. Optimization of design with respect to process efficiency, energy and cost. Computer Aided Design (CAD).
Practical: Design of pressure vessel, cleaners, milling equipments, tubular, shell and tube type, plate heat exchangers, dryer, belt, screw conveyor and bucket elevator.

**PFE 404 Food Plant Design and Management**

2+1  
Sem. II

Planning of food processing plant, feasibility study (Technical, financial and marketing). Food plant location, selection criteria, selection of processes and plant capacity. Requirements of plant building and its components. Project design, flow diagrams, selection of equipment, process and controls. Objectives and principles of food plant layout. Salient features of processing plants for cereals, pulses, oilseeds, horticultural and vegetable crops, poultry, fish, meat, milk and milk products. Introduction to finance, engineering economics, food product marketing, food business analysis and strategic planning. Introduction to marketing, Food marketing management, supply chain management for retail food products. Entrepreneurship development in food industry: SWOT analysis, generation, incubation and commercialization of ideas and innovations, new product development process, Government schemes and incentive for promotion of entrepreneurship, Govt. policy on small and medium scale food processing enterprise, export and import policies relevant to food processing sector, procedure of obtaining license and registration under FSSAI, cost analysis and preparation of feasibility report.

Practical: Preparation of project and feasibility report. Salient features and layout of pre processing house, milk and milk product plants. Salient features, design and layout of modern rice mill, bakery and related product plant. Types of records relating to production, finance and marketing. Brain storming and SWOT analysis to start a food processing business.

**PFE 405 Food Packaging Technology**

2+1  
Sem. II

defects, colour, dimensions and impact strength) and metal containers (pressure test and product compatibility).


**PFE 406 Waste and By-Product Utilization**

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 vermicomposting, 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, germand 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.

**Postgraduate Courses**

**PFE 501 Transport Phenomena in Food Processing**

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, deadload 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 2+1 Sem. II

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 2+1 Sem. II
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 2+1 Sem. I
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, oilmills, 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 2+1 Sem. I
Production and utilization of cereals and pulses, grain structure of major cereals, pulses and oilseeds and their milling fractions; grain quality standards and physico-chemical methods for evaluation of quality of flours. 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 byproducts 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**  
2+1  
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**  
2+1  
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**  
2+1  
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, desugaring 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 offish, canning of fish, visit to meat and fish processing units.

**PFE 510/FT 511 Food Packaging**  
2+1  
Sem. I  

**PFE 511 Food Quality and Safety Engineering**  
3+0  
Sem. II  
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 hygienic 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**  
1+1  
Sem. II  
Thermodynamic properties of moist air, psychorometric 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  2+1  Sem. I
Storage of grains, biochemical changes during storage, production, distribution and storage capacity estimate models, storage capacity models, ecology, storage factors affecting losses, storage requirements. 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  2+1  Sem. II
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, seedtreater, 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
operations like parboiling, convective drying, pasteurization, dehydration, shelf-life prediction, fermentation, aseptic processing, moisture diffusion, deep fat drying, microwave processing, infrared heating and ohmic heating. Stochastic finite element analysis of thermal food processes. Neural networks approach to modeling food processing operations.

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


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 particle boards 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, Postgraduate 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, Postgraduate Studies
DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

SWE 102 Soil and Water Conservation Engineering  1+1       Sem. II
(For students of College of Agriculture)

SWE 201 Irrigation Engineering  2+1       Sem. I

SWE 202 Soil and Water Conservation Engineering  2+1       Sem. II
soil loss estimation and control measures (vegetative, wind breaks, shelter belts, mechanical measures and stabilization of sand dunes).


**SWE 203 Sprinkler and Micro Irrigation Systems**  
1+1  
Sem. II


Practical: Study of different components, design and installation of sprinkler irrigation system. Determination of precipitation pattern, discharge and uniformity coefficient. Study of different components, design and installation of drip irrigation system. Determination of pressure discharge relationship and emission uniformity for emitter. Study of different types of filters and determination of filtration efficiency. Determination of rate of injection and calibration for chemigation/fertigation. Design of irrigation and fertigation schedule for crops. Field visit to micro irrigation system and evaluation of drip system. Cost economics of sprinkler and drip irrigation system.

**SWE 301 Water Harvesting and Soil Conservation Structures**  
2+1  
Sem. I

Water harvesting: principles, importance and issues. Water harvesting techniques: classification based on source, storage and use. Runoff harvesting: short-term (terracing, bunding, rock and ground catchments) and long-term harvesting techniques, purpose and design criteria. Structures: farm ponds (dug-out and embankment type reservoir), tanks and subsurface dykes. Farm pond: types, components, site selection, design criteria, capacity, embankment, mechanical and emergency spillways, cost estimation and construction. Percolation pond: site selection, design and construction details. Design considerations of nala bunds. Hydraulic jump and its application. Permanent structures for soil conservation and gully control: check dams, drop, chute and drop inlet spillway, design requirements and planning. Design procedures: hydrologic, hydraulic and structural design and stability analysis. Drop spillway: applicability, types (straight drop and box-type inlet), description, functional use, advantages and disadvantages, straight apron and stilling basin outlet, structural components and functions. Loads on head wall, variables affecting equivalent fluid pressure, triangular load
diagram for various flow conditions, creep line theory, uplift pressure estimation, safety against sliding, overturning, crushing and tension. Chute spillway: description, components, energy dissipaters, design criteria of Saint Antony Falls (SAF) stilling basin and its limitations. Drop inlet spillway: description, functional use and design criteria.


SWE 302 Drainage Engineering

Water logging: causes and impacts. Drainage: objectives and familiarization with the drainage problems of the state. Surface drainage: purpose and benefits, drainage coefficient, types of surface drainage, design of surface drains. Sub-surface drainage: purpose and benefits, investigations of design parameters (hydraulic conductivity, drainable porosity, water table), derivation of Hooghoudt’s and Ernst’s drain spacing equations, design, layout, construction and installation of subsurface drainage system including mole drains. Drainage materials, envelope, pipes and structures. Vertical drainage: multiple well point system and bio-drainage. Salt balance, reclamation of saline and alkaline soils, leaching requirements, conjunctive use of fresh and saline water.


SWE 303 Watershed Planning and Management

groups. Planning and formulation of project proposal for watershed management programme including cost-benefit analysis.


**SWE 304 Groundwater Wells and Pumps**


**Elective Courses**

**SWE 401 Floods and Control Measures**

Floods: causes of occurrence, classification (probable maximum flood, standard project flood and design flood) and estimation methods. Estimation of flood peak: rational and unit hydrograph method and empirical methods. Statistics in hydrology: flood frequency methods (log normal, Gumbel’s extreme value, log-Pearson type-III distribution) and depth-area-duration analysis. Flood forecasting. Flood routing: channel and reservoir routing, Muskingum and modified Pul’s method. Flood control: history, structural and non-structural measures, storage and detention reservoirs, levees and channel improvement. Spurs: types, functions,


SWE 402 Wasteland Development
2+1 Sem. II

SWE 403 Information Technology for Land and Water Management 2+1 Sem. II


Practical: Multimedia production. Internet applications: e-mail, voice mail, web tools and technologies. Handling and maintenance of new information technologies and exploiting their potentials. Exercise on database management using database and spreadsheet programmes. Usage of remote sensing, GIS and GPS survey in information generation and processing. Exercise on running computer software packages dealing with water balance, crop production, land development, land and water allocation and watershed analysis. Exercise on simple decision support and expert systems for management of natural resources. Multimedia production using different software’s. Exercise on development of information system on selected theme(s). Video-conferencing of scientific information.

SWE 404 Remote Sensing and Geographic Information System 2+1 Sem. II

Remote sensing: introduction, components, advantages and limitations. Characteristics of electromagnetic spectrum, energy interactions in the atmosphere and with the Earth’s surface, major atmospheric windows, principal applications of different wavelength regions, typical spectral reflectance curve for vegetation, soil and water, spectral signatures, different types of sensors and platforms. Contrast ratio and possible causes of low contrast. Aerial photography: types, scale, planning (end lap and side lap), stereoscopic vision, requirements of stereoscopic photographs, air-photo interpretation and its elements. Photogrammetry: measurements on a single vertical aerial photograph, measurements on a stereo-pair (vertical measurements by the parallax method), ground control for aerial photography. Satellite remote sensing: multispectral scanner (whiskbroom and push-broom scanner) and types of resolutions. Analysis of digital data: image restoration, enhancement, information extraction and classification (unsupervised and supervised). Important consideration in the identification of training areas. Vegetation indices. Microwave remote sensing. GIS: components, spatial entities, sources and components of spatial data. Map projections and their properties. Methods of data input into GIS, data editing, spatial data models and structures, attribute data management and integrating data (map overlay) in GIS. Application of remote sensing and GIS for the management of land and water resources.

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

SWE 405 Design and Management of Canal Irrigation System  
2+1  Sem. II  

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

SWE 407 Precision Farming Techniques for Protected Cultivation  
2+1  Sem. II  
Protected cultivation: introduction, components, perspective, types and cladding materials. Plant environment interactions: principles of limiting factors, solar radiation, transpiration, greenhouse effect, light, temperature, relative humidity and carbon dioxide enrichment. Design and construction of greenhouses: site selection, orientation, design, construction, design for


SWE 408 Water Quality and Management Measures 2+1 Sem. II
Water resources and quality issues in India. Natural factors affecting quality of surface and groundwater, water quality in relation to domestic, industrial and agricultural activities. Drinking water quality standards, irrigation water quality classification as per US Salinity Laboratory (USSL) and All Indian Coordinated Research Project (AICRP) criteria. Point and non-point water pollution sources. Water contamination due to inorganic, organic compounds, agricultural chemicals, food industry, hydrocarbon and synthetic organic compounds. Arsenic and fluoride contamination in groundwater and remedial measures. Water decontamination technologies, cultural and management practices for using poor quality water for irrigation. Practical: Water quality analysis and classification according to USSL and AICRP criteria. Soil chemical analysis and estimation of lime and gypsum requirements. Study of salinity development under shallow and deep-water table conditions, contaminant movement and transport in soil profile. Study of water decontamination techniques and cultural and management practices for using poor quality water for irrigation. Field visit to industrial effluent disposal sites.

SWE 409 Landscape Irrigation Design and Management 2+1 Sem. II
Conventional method of landscape irrigation: hose irrigation, quick release coupling and portable sprinkler system with hose pipes. Modern methods of landscape irrigation: pop-up and spray pop-up sprinklers, shrub adopter, drip irrigation and bubblers. Types of landscapes and
suitability of different irrigation methods, water requirement for different landscapes, segments
and main components of modern landscape irrigation systems and their selection criteria.
Merits and demerits of conventional and modern irrigation systems. Types of pipes, pressure
ratings, sizing and selection criteria. Automation system for landscape irrigation: main
components, types of controllers and their applications. Design, operation and maintenance of
modern landscape irrigation systems.
Practical: Study of irrigation equipment for landscapes. Design and installation of irrigation
system for landscape. Determination of water and power requirements for pump selection.
Irrigation scheduling of landscapes. Study of irrigation controllers and other equipment. Use of
Auto CAD in irrigation design: blocks and symbols, head layout, zoning and valves layout,
pipe sizing and pressure calculations. Visit to landscape irrigation system and its evaluation.

**SWE 410 Plastic Applications in Agriculture**

Introduction of plasticulture: types and quality of plastics used in soil and water conservation,
production agriculture and post-harvest management, quality control measures. Present status
and future prospective of plasticulture in India. Water management: use of plastics in in-situ
moisture conservation and rain water harvesting. Plastic film lining in canal, pond and
reservoir. Plastic pipes for irrigation water management, bore-well casing and subsurface
drainage. Drip and sprinkler irrigation systems. Use of polymers in control of percolation
losses in fields. Soil conditioning: soil solarisation, effects of different colour plastic mulching
in surface covered cultivation. Nursery management: use of plastics in nursery raising, nursery
bags and trays. Controlled environmental cultivation: plastics as cladding material, green/poly/shade net/net houses, wind breaks, poly tunnels and crop cover. Plastic nets for
crop protection: anti insect and bird protection nets. Plastic fencing. Plastics in drying,
preservation, handling and storage of agricultural produce, cover and plinth (CAP) storage for
food grains. Use of plastics as alternate material for manufacturing farm equipment and
machinery. Plastics for aqua cultural engineering and animal husbandry (animal shelters,
vermi-beds and inland fisheries). Silage film technique for fodder preservation. Agencies
involved in the promotion of plasticulture in agriculture at national and state level. Human
resource development in plasticulture applications.

Practical: Design, estimation and laying of plastic films in lining of canal, reservoir and water
harvesting ponds. Study of plastic components of drip and sprinkler irrigation systems, laying
and flushing of laterals. Study of different plastic mulch laying methods. Design, estimation
and installation of green/poly/shade net/net houses and low tunnels. Study on cover and plinth
(CAP) storage for food grain storage, innovative packaging solutions (leno bags, crates, bins,
boxes and vacuum packing, unit packaging, controlled atmosphere (CA) and modified
atmosphere packaging (MAP)) and cost estimation. Study on use of plastics in nursery, plant
protection, inland fisheries, animal shelters, preparation of vermi-bed and silage film for fodder
preservation. Study of plastic parts in making farm machinery. Visits to manufacturing
units/dealers of PVC pipes, drip and sprinkler irrigation systems, green/poly/shade
net/nethouse and farmers’ fields with these installations.

**Postgraduate Courses**

**SWE 501 Watershed Hydrology**

Hydrologic processes and systems. Hydrologic problems of small watersheds; Hydrologic
characteristics of watershed. Measurement and estimation of hydrologic parameters, stream
flow measurement and frequency analysis of the data. Hydrograph analysis, characteristics,
separation for simple and complex storms. Unit hydrograph theory and its application.
Derivation of unit hydrograph, synthetic hydrograph, S-hydrograph and instantaneous unit
hydrograph. Flood routing principles, channel and reservoir routing. Concept of hydraulic
flood routing. Process of sedimentation of reservoirs. Hydrologic modeling approaches,
component conceptualization of different types of watershed hydrologic models for simulation
of hydraulic problems. Choice of hydrologic models.
Practical: Delineation of watershed and study of watershed characteristics. Analysis of rainfall
and runoff data. Runoff measurement and estimation from watersheds under different land
usages. Analysis and derivation of various types of hydrographs. Flood routing, Reservoir
sedimentation, Watershed modeling. Visit to a watershed.

SWE 502 Design of Farm Irrigation Systems 3+0 Sem. II
Climate and irrigation water requirement, irrigation principles, losses, conveyance,
distribution, application, water budgeting, estimation techniques of effective rainfall. Farm
irrigation systems, irrigation efficiencies, economic feasibility, irrigation water quality and
salinity management techniques. Design of water conveyance, control and distribution
systems. Hydraulics, design and operation of border, check basin, furrow, sprinkler and trickle
irrigation systems. Flow dynamics, drop size distribution and spray losses in sprinklers.
Application of chemicals through sprinkler and drip systems. Maintenance, filtration and
flushing of drip system. Irrigation performance parameters. Evaluation of irrigation systems
and practices. Basic water management concepts and objectives. Alternative irrigation
scheduling techniques. Integrated approach to irrigation water management.

SWE 503 Agricultural Drainage Systems 2+0 Sem. II
Drainage and Crop growth under salt affected water logged soil. Methods of drainage system.
Theories and applications of surface and subsurface drainage. Design of different components
of surface and subsurface drainage systems. Theories of vertical drainage, horizontal sub surface
drainage and multiple well point system. Drainage material. Steady and unsteady state drainage
equations for layered and non-layered soils. Principle and applications of Hooghoudt, Kirkham,
Earnst, Glover Dumm, Kraijenhoff- van-de-leur equations. Drainage for salinity control. Salt
balance, leaching requirement and management practices under drained conditions. Disposal of
drainage effluents. Integrated planning, design and installation of drainage system for water
logged and saline soils.

SWE 504 Groundwater Engineering 3+0 Sem. I
Occurrence, storage and movement of ground water in alluvial and hard rock formations.
of water table beneath are charge site. Derivation of hydraulics of fully and partially
penetrating wells in confined, leaky and unconfined aquifers. Steady flow in sloping aquifers.
Analysis of multi aquifers. Flow analysis in interfering wells. Pumping tests for estimation of
aquifer parameters. Groundwater recharge. Wells near recharge and impermeable boundaries
Design of well field. Skimming well technology. Groundwater modeling for resources
planning, calibration and validation of models.
SWE 505 Flow Through Porous Media 2+0 Sem. I

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, windmills, microturbines, solar pumps, hydraulic arm - 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
Concepts and significance of optimization in water management, Model development in water management, objective functions, deterministic and stochastic inputs. Soil plant atmosphere

Practical: Familiarization with the Remote sensing instruments and satellite imagery. Aerial Photograph and scale determination with stereoscope. Interpretation of satellite imagery and aerial photograph. Determination of Parallaxes in Images. Introduction to Digital image processing software and GIS software and their working principles. Generation of Digital elevation model (DEM) for land and water resource management. Case studies on Mapping, Monitoring and management of natural resources using remote sensing and GIS.

SWE 511/RSGIS 509 Watershed Management and Modelling  

SWE 512 Land Development and Earth Moving Machinery  
(in collaboration with Department of Farm Machinery and Power Engineering)  
Objectives, methods and equipment’s for land clearing and development. Land leveling design methods, Land leveling indices. Grading of sloppy lands. Machinery selection, operating

**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
Systems engineering for water management; Complexity of resources management process, systems analysis. Rainfall-runoff models, Infiltration models, Evapotranspiration models, simulation methods, structure of a water balance model. Overland and Channel flow

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

**SWE 606 Plant Growth Modeling 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
PROGRAMME
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, Postgraduates Studies.
DESCRIPTION OF COURSE CONTENTS

RSGIS 501 Principles of Remote Sensing  2+1  Sem. I

RSGIS 502 Geomatics, Geodesy and GPS  2+1  Sem. I

RSGIS 503 Digital Image Processing  2+1  Sem. II
member analysis, Information extraction from Hyper-spectral. Digital processing of Microwave data. LiDAR data visualization and processing: Raw data to bald earth DEM processing, Filtering.


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

RSGIS 505 Agri-Informatics 2+1 Sem. II

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

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 water logging, 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, Snow melt 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: query languages. Data languages. Data validation. Use of a standard database management package.
Practical: Use of database packages, Creation of Tables, Relationships, Queries (Views), Forms, Report Generation.

RSGIS 591 Seminar

RSGIS 600 Master's Research
CIVIL ENGINEERING

PROGRAMMES
M. Tech.
Ph.D.

COURSE REQUIREMENTS

M.Tech.

Fields of Specialization  Hydrology and Water Resources Engineering, 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, Postgraduates 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, Postgraduates Studies
DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

CE 105 Soil Mechanics  
2+1  Sem. I

Introduction of soil mechanics, phase diagram, physical and index properties of soil, classification of soils, effective and neutral stress, total stress, simple numerical problems related to stresses, Seepage Analysis, Quick condition, numerical problems related to Quick sand condition, Permeability, Factors affecting permeability, Numerical problems related to permeability, Constant Head and Variable head permeability test. Flow parallel and perpendicular to planes of stratification. Shear strength, Mohr stress circle, theoretical relationship between principle stresses and shear stresses, Mohr-coulomb failure theory, effective stress principle. Determination of shear parameters by direct shear test, Unconfined compressive strength test, tri-axial test and vane shear test. Numerical exercise based on various types of tests. Compaction of soils, standard and modified proctor test, Jodhpur mini compaction test, field compaction method and control. Numerical problems related to Compaction. Consolidation of soils, one dimensional consolidation spring analogy, Terzaghi’s theory, Laboratory consolidation test, determination of coefficient of consolidation by calculation of void ratio and coefficient of volume change. Earth pressure: plastic equilibrium in soils, active and passive states, Rankine’s theory of earth pressure, active and passive earth pressure for cohesive soils, simple numerical exercises. Introduction to bearing capacity and stability analysis.

Practical: Determination of water content of soil; Determination of specific gravity of soil; Determination of field density of soil by core cutter method; Grain size analysis by hydrometer method; Determination of field density by sand replacement method; Grain size analysis by sieving (Dry sieve analysis); Determination of liquid limit by Casagrande’s method, cone penetrometer; Determination of plastic limit; Determination of shrinkage limit; Determination of permeability by constant head method; Determination of permeability by variable head method; Determination of compaction properties by standard proctor test; Determination of shear parameters by Direct shear test; Determination of unconfined compressive strength of soil; Determination of shear parameters by Tri-axial test; Determination of consolidation properties of soils.

CE 106 Surveying and Levelling  
1+2  Sem. II


**CE 108 Engineering Mechanics** 2+1 Sem. II

**CE 207 Watershed Hydrology** 1+1 Sem. I
Practical: Visit to meteorological observatory and study of different instruments. Design of rain gauge network. Exercise on intensity duration frequency curve. Exercise on depth area duration and double mass curve. Analysis of rainfall data and estimation of mean rainfall by different methods. Exercise on frequency analysis of hydrologic data and

**CE 208 Strength of Materials**  
2+1  
Sem. I


Practical: To perform the tension test on metal specimen (mild steel, cast iron), to observe the behaviour of materials under load, to calculate the value of E, ultimate stress, permissible stress, percentage elongation and to study their fracture. To perform the compression test on concrete cylinders, cubes, mild steel, cast iron, wood specimen and to determine various physical and mechanical properties. To perform the bending test on the specimens: mild steel girder, wooden beam, plain concrete beams, reinforced cement concrete beam and to determine the various physical and mechanical properties. To determine Young’s modulus of elasticity of beam with the help of deflection produced at center due to loads placed at center and quarter points. To study the behaviour of materials (galvanized iron, mild steel, cast iron pipes) under torsion and to evaluate various elastic constants. To study load deflection and other physical properties of closely coiled helical spring in tension and compression. To perform the Rockwell, Vickers and Brinell Hardness tests on the given specimens. To perform the Drop Hammer Test, Izod Test and Charpy’s impact test on the given specimens. To determine compressive and tensile strength of cement after making cubes and briquettes. To measure workability of concrete (slump test, compaction factor test). To determine void ratio and bulk density of cement, fine aggregates and coarse aggregates. To determine fatigue strength of a given specimen. To write detailed report emphasizing engineering importance of performing tension, compression, bending, torsion, impact and hardness tests on the materials.

**CE 306 Building Construction and Cost Estimation**  
2+0  
Sem. I

Brick Bond: English Bond, Single Flemish Bond, Double Flemish Bond. Procedure for
design of a building. Types of agricultural buildings. Sloped and flat roof buildings and
their construction economics. Preliminary estimates, detailed estimates of buildings,
source of cost information, cost analysis, factors affecting building costs, cost evaluation
of building and planning for state development. Measurement and measurement book.
Economic methods for evaluating investment in buildings and building systems: cost in
use, benefit to cost and savings to investment ratios, rate of return, net benefits, payback
period.

CE 307 Design of Structures 2+1 Sem. II
Introduction to various types of loads: dead load, wind load, live load and earthquake
load. Use of Bureau of Indian Standard codes. Introduction to design philosophies.
Design of riveted, welded and bolted connections. Design of structural steel members in
tension, compression and bending. Introduction to trusses, analysis of truss for dead load,
live load and wind load. Design of truss elements. Introduction to reinforced cement
concrete. Balanced, under reinforced and over reinforced sections. Design of singly and
doubly reinforced sections. Shear, Bond and Torsion. Design of flanged beams. Design of
one way and two-way slabs. Design of axially loaded columns. Design of wall footing,
isolated footing and combined footing. Introduction to cantilever and counter fort
retaining walls. Design of cantilever retaining wall. Introduction to silos and theories
related to their analysis.
Practical: Design and drawing of steel roof truss. Design and drawing of singly reinforced
beam, doubly reinforced beam. Design and drawing of one way and two-way slabs. Design
and drawing of RCC building. Design and drawing of retaining wall.

Postgraduate Courses

CE 501 Open Channel Flow 3+0 Sem. I
Open channel and their properties. Energy and momentum principles. Critical flow
computations and applications. Uniform flow. Its development. Formula and design
computation. Boundary layer concept. Surface roughness. Velocity distribution and
instability of uniform flow. Gradually varied flow theory and analysis. Method of
computations. Hydraulic jump and its use as energy dissipater. Spatially varied flow.
Unsteady flow. Rapidly varied flow.

CE 502 Dams and Reservoir Operations 3+1 Sem. II
Dams classification. Suitable site selection for dams and reservoirs. Survey and planning
of storage projects. Types of concrete dams. Forces acting on concrete dams. Stability
analysis. Methods of design of gravity dams. Concrete cooling and temperature control
for dams. Earth dams and their types. Methods of construction. Causes of failure and
remedial measure. Seepage and stability analysis of earth dams. Foundation treatment
and Abutment grouting. Instrumentation in dams. Spillway and spillway capacities.
Spillway Gates. Reservoir planning. Storage, sedimentation and losses. Reservoir
economics. Flood routing. Practical: Stability analysis of gravity dam, Design of concrete
dams, Stability analysis of earth dams, Design criteria of earth dam, Phreatic line
determination in earth dams, Seepage analysis through earth dams, Reservoir design,
Reservoir capacity determination, Flood routing through reservoir. Design of spillway.

**CE 503 Water Quality and Pollution Control**  
3+1  Sem. II  
Impurities in water. Water analysis (Physical, Chemical and Bacteriological). Indices of
water quality for domestic and industrial uses. Standards of water quality. Monitoring of
water quality from various sources. Sampling of water. Sources of water pollution.
Pollution of surface water and ground water. Purification of water supplies. Wastewater
characteristics and disposal methods. Wastewater treatment. Mathematical modeling on
pollution control. Environmental legislation on water pollution in India and abroad.
Practical: Determination of pH, total solids, dissolved and suspended solids, Chlorides,
Sulphates, turbidity, dissolved oxygen, hardness, BOD, COD, Nitrogen (Ammonical,
nitrate, nitrite), MPN, Total count of bacteria in water/sewage samples.

**CE 504 Fluvial Hydraulics**  
2+1  Sem. I  
Sediment properties. Sediment problems. Incipient motion of sediment particles. Regimes
for computing bed load, suspended load and total load transport. Alluvial streams and
their hydraulic geometry. Bed level variations in alluvial streams. Sediment samples and
sampling. Sediment yield from catchment. Methods for computing sediment yield from
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**  
3+0  Sem. I  
Fundamentals of FORTRAN programming, Basic concepts of structural analysis. Energy
principles. Introduction to flexibility and stiffness matrix method. Application of
flexibility and stiffness matrix methods to statically indeterminate structures. Computer
oriented direct stiffness method. Additional topics for the stiffness method.

**CE 506 Probabilistic Approach in Design**  
2+0  Sem. II  
Review of various approaches in engineering design and introduction of probabilistic
approach. Random variables. Probability distribution and density functions. Expected
values Mean Variance, Conditional probability. Characteristic functions. Function of
random variable. Concepts of stationary, ergodic and non-stationary processes. Auto
density functions and their determination from experimental data. Broad-band and
narrow-band random processes, White noise. Application in various disciplines of
engineering.
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

CE 513 Control of Pollution from Solid Waste 2+0 Sem. I

CE 514 Sub-soil and Clay Water Systems 3+0 Sem. II

CE 515 Foundation Engineering 2+1 Sem. I
CE 516 Similitude in Engineering  

CE 517 Application of Finite Element Method in Structural Engineering  
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.

CE 518 Solid Mechanics and Elasticity  

CE 519 Theory of Plates and Shells  

CE 520 Design of R. C. C. Bridges  
bridge and balanced cantilever bridges. Design of piers, bearings, piles and well foundations.

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
Random variables. Probability distribution and density functions. Concepts of stationary, ergodic & non-stationary processes. Free and Forced vibration of single degree of

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| 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, Postgraduates 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, Postgraduates Studies
DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

**ME 101 Workshop Technology**  
(For students of College of Agriculture)  
1+2  
Sem. I

Introduction to basic materials: Ferrous and non-ferrous materials and important engineering materials such as timber, abrasive materials, silica, ceramics, glasses, graphite, diamond, plastic polymers and composite materials, their properties and applications; Safety measures in workshop; Heat treatment processes: Introduction to hardening, tempering, annealing, normalizing, etc.; Welding: Introduction, types of welding, types of electrodes, types of flames, types of welding joints, edge preparation, welding techniques and equipments; Gas welding and gas cutting, arc welding; Introduction to soldering and brazing and their uses; Smithying and forging: Introduction to different tools and their uses; Different forging operations, defects of forging; Carpentry: Introduction to various carpentry tools and materials; Type of woods and their characteristics, brief ideas about band saw, wooden lathe circular saw, wood planner, etc.; Machinery: Introduction to various workshop machines (1) Lathe, (2) Milling machine, (3) Shaper and planner, (4) Drilling and boring machine, (5) Grinder and (6) CNC machines; Length of cut, feed, depth of cut, RPM, cutting speed, time, work holding and tool holding devices; Sheet-metal: Introduction, different operations, sheet metal joints; Allowances for sheet metal, operations and joints, estimate of cost.

Practical: Identification of different materials of manufacture; Demonstration of different measuring instruments and measurement technique; Identification of various hand tools; Demonstration of various power tools and machine tools; Simple exercises in filing, fitting, chipping, hack sawing, chiseling, tapping, etc.; Introduction to welding machine, processes, tools, their use and precautions; Simple exercises on arc welding; Simple exercises in gas welding; Demonstration of various casting processes and equipments, tools and their use; Exercises on mould making using one piece pattern and two piece pattern; Demonstration of mould making using sweep pattern and match plate pattern; Simple exercises on turning: Step turning, taper turning, drilling and threading; Introduction to shaper and planner machine and preparations of various jobs on them; Introduction to drilling machines and preparation of a related jobs; Demonstration of other important operations and preparation of additional jobs.

**ME 102 Engineering Drawing and Graphics**  
(For students of College of Agriculture)  
0+3  
Sem. II

Introduction of drawing scales; Principles of orthographic projections (First and third angle methods of projection); Different methods of dimensioning; References planes; Points and lines in space and traces of lines and planes; True length and inclination of lines; Projections of solids: Change of position method, alteration of ground lines; Concept of sectioning; Section of solids; Development of surfaces of geometrical solids; Isometric projection of geometrical solids; Preparation of manual drawings from models and isometric views of objects and machine components/food equipment; Nomenclature,
thread profiles, multi start threads, left and right hand threads. Square headed and hexagonal nuts and bolts. Conventional representation of threads. Different types of lock nuts, studs, machine screws. Design process, application of computers for design, definition of CAD, benefits of CAD, CAD system components; Computer hardware for CAD. Demonstration on computer graphics and computer aided drafting use of standard software; Practice in the use of basic and drawing commands on AutoCAD; Generating simple 2-D drawings with dimensioning using AutoCAD; Small Projects on food equipment and components using CAD.

ME 103 Engineering Drawing

0+2 Sem. I

Introduction of drawing scales; First and third angle methods of projection. Principles of orthographic projections; Different methods of dimensioning; References planes; Points and lines in space and traces of lines and planes; True length and inclination of lines; Projections of solids (Change of position method, alteration of ground lines); Concept of sectioning; Section of solids; Development of surfaces of geometrical solids; Isometric projection of geometrical solids. Preparation of working drawing from models and isometric views. Nomenclature, thread profiles, multi start threads, left and right hand threads. Square headed and hexagonal nuts and bolts. Conventional representation of threads. Different types of lock nuts, studs, machine screws.

ME 104 Workshop Technology and Practice

1+2 Sem. II


Practical: Introduction to various carpentry tools, materials, types of wood and their characteristics and processes or operations in wood working. Preparation of simple joints: Cross half Lap joint and T-Halving joint, preparation of Dovetail joint, mortise and tenon joint. Introduction to smithy tools and operations. Jobs on bending, shaping, drawing, punching, riveting. Introduction to tools and measuring instruments for fitting, jobs on sawing, filing and right angle fitting of MS flat, practical in more 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. Introduction to welding equipment, processes tools, their use and precautions. Jobs on arc welding: Lap, butt, T-Joint and corner joint in arc welding, Gas welding practice: Lap, butt and T-Joints. Introduction to metal casting equipment, tools and their use, mould making using one-piece pattern and two-piece pattern, demonstration of mould making using sweep pattern and match plate patterns. Introduction to machine shop machines and tools, demonstration on processes in machining and use of measuring instruments. Practical jobs on simple turning, step turning, taper turning, drilling and
threading. Operations on shaper and planer, changing a round MS rod into square section on a shaper, demonstration of important operations on a milling machine, making a plot, gear tooth forming and indexing. Any additional job.

ME 106 Food Thermodynamics
(For students of College of Agriculture)

ME 108 Heat and Mass Transfer
flow heat exchangers. Steady state molecular diffusion in fluids at rest and in laminar flow, Flick’s law, mass transfer coefficients. Reynold’s analogy.

ME 201 Heat and Mass Transfer in Food Processing 2+1 Sem. I
(For students of College of Agriculture) (Practical part to be taught by Department of Processing and Food Engineering)
Basic heat transfer processes, coefficients and related properties. One-dimensional steady state conduction: theory of heat conduction, Fourier’s law and its derivation, concept of electrical analogy and its application for thermal circuits, heat transfer through composite walls and insulated pipelines. One-dimensional steady state heat conduction with heat generation: heat flow through slab, hollow sphere and cylinder with linear heat transfer, uniform and non-uniform heat generation, temperature distribution equations with different boundary conditions. Steady-state heat conduction with heat dissipation to environment: introduction to extended surfaces (fins) of uniform area of cross-section and with equation of temperature distribution with different boundary conditions, effectiveness and efficiency of the fins. Introduction to unsteady state heat conduction: system with negligible internal resistance and in various geometries. Convection: forced and free convection, use of dimensional analysis for correlating variables affecting convection heat transfer, concept of Nusselt number, Prandtl number, Reynolds number, Grashoff number, important empirical relations used for determination of heat transfer coefficient, heat transfer to flowing fluids. Radiation: heat radiation, emissivity, absorptivity, transmissivity, radiation through black and grey surfaces, determination of shape factors. Introduction to condensation and boiling heat transfer: film and drop-wise condensation, effect of non-condensable gases, boiling heat transfer. Heat exchangers: introduction, fouling factors, jacketed kettles, LMTD, parallel and counter flow heat exchangers, shell and tube and plate heat exchangers, heat exchanger design, application of different types of heat exchangers in dairy and food industry. Mass transfer: Fick’s law of diffusion, steady state diffusion of gases and liquids through solids, equimolal diffusion, isothermal evaporation of water into air, mass transfer coefficient, application in dairy and food industry.

ME 202 Fluid Mechanics and Open Channel Hydraulics 2+1 Sem. II
Properties of fluids: 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, condition of floatation, stability of submerged and floating


**ME 207 Theory of Machines**

ME 208 Thermodynamics, Refrigeration and Air Conditioning 2+1 Sem. I
Practical: Study and numerical on thermodynamic air cycles (Otto, diesel and dual cycles), Study and application of P-V, T-s and P-h chart in refrigeration. Numerical on air refrigeration cycle (reverse Carnot cycle and Bell Coleman cycle), Numerical on vapour compression cycle refrigeration. Study of domestic water cooler, domestic household refrigeration, absorption type solar refrigeration system. Study of cold storage for fruit and vegetables, Freezing load and time calculations for food materials, Determination of refrigeration parameters using refrigeration tutor–II test rig, Numerical on design of air conditioning systems, Study of window air conditioner, Study on repair and maintenance of refrigeration and air-conditioning systems. Visit to chilling or ice making and cold storage plants.

ME 302 Machine Design 2+0 Sem. I

ME 305 Fluid Mechanics 2+1 Sem. II
(For students of College of Agriculture)
Fluid properties, compressible and non-compressible fluids, flow behavior of viscous
foods. Surface tension, capillarity. Static pressure of liquids: hydraulic pressure, absolute and gauge pressure, pressure head of a liquid, pressure on vertical rectangular surfaces. Pressure measuring devices: simple, differential, micro-manometer, inclined manometer, mechanical gauges, piezometer. Floating bodies: Archimedes’ principle, stability and equilibrium of floating bodies, metacentric height. Fluid flow: classification, steady, uniform and non-uniform, laminar and turbulent, continuity equation, Bernoulli’s theorem and its applications. Navier-Stokes equations in cylindrical co-ordinates, boundary conditions, simple application of Navier-Stokes equation. Laminar flow between two straight parallel boundaries. Flow past through the immersed solids, packed and fluidized beds. Flow through pipes: loss of head, determination of pipe diameter, discharge, friction factor, critical velocity. Flow through orifices, mouthpieces, notches and weirs, vena-contracta, hydraulic coefficients, discharge losses, time for emptying a tank, loss of head due to contraction, enlargement at entrance and exit of pipe, external and internal mouthpieces. Types of notches, rectangular and triangular notches, rectangular weirs. Venturimeters, pitot tube, rotameter, water level point gauge, hook gauge. Dimensional analysis: Buckingham’s pi-theorem application to fluid flow phenomena, Froude Number, Reynolds number, Weber number and hydraulic similitude. Turbines and pumps: classification, centrifugal, submersible, reciprocating and positive displacement pumps. Centrifugal pumps: pumps in series and parallel, basic equations applied to centrifugal pump, loss of head due to changed discharge, static head, total head, manometric head, manometric efficiency, operating characteristics of centrifugal pumps, submersible pumps. Reciprocating pumps: working of single and double-acting pumps, instantaneous rate of discharge, acceleration of piston and water. Gear pump: pressure variation, work efficiency. Pressure requirements for viscous foods to lift them to different heights and selection of pumps. Open channel hydraulics: classification of open channel and definitions, most economical sections of regular cross-sections, specific energy concept, critical depth, energy diagrams, velocity and pressure profiles in open channels, hydraulic jumps and types.


Elective Course

ME 404 Mechatronics

(In collaboration with School of Electrical Engineering and Information Technology)

Definition of mechatronics, measurement system, control systems, microprocessor based controllers, mechatronics approach. Sensors and transducers, performance terminology, displacement, position & proximity sensors, photo-electric transducers, flow transducers,

Practical: Selection of sensor for a particular application from catalogue/internet. Design a mechatronics product/system and incorporate application of mechatronics for enhancing product values. To study the hardware and software of mechatronics kit. To move a table in X-direction within the range of proximity sensors using Control-X software. To run a motor with PLC. To run a conveyor with computer. To study the movement of actuating cylinders and sensors.

Postgraduate Courses

ME 501 Viscous Flow and Convective Heat Transfer  
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  
Unidirectional heat conduction with heat convection; generalized equation for fins. Unidirectional heat conduction with heat generation; heat generation function of position/temperature and viscous heat generation and applications. Two-dimensional heat conduction; numerical analysis and other methods. Unsteady state unidirectional heat conduction; Newtonian heating/cooling, one dimensional system with convective surface conditions. Two dimensional solutions; finite and semi infinite bodies. Periodic heat conduction. Insulation; types and optimization of insulation thickness. Radiation exchange between diffuse-gray surfaces in an enclosure. Gas radiation. Radiation exchange with specular surfaces. Radiation network; absorbing and transmitting media, transmitting, reflecting and absorbing media, absorbing, emitting and scattering media. Numerical solutions. Combined heat exchange; convection and radiation, conduction and...
radiation. Effect of radiation on temperature measurements.

**ME 503 Mechanism Analysis and Synthesis** 2+1 Sem. I
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, Helm-holt 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 mixtures. Irreversible thermodynamics and direct energy conversion systems; thermoelectric systems, Thermoionic converter.

**ME 507 Fatigue Design**  
2+1  Sem. II  
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 waves- 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, Micro geometry 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, subcooling 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. Centrifugal and steam jet refrigeration systems: 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 background. 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
of turbo-generator set.

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 3+0 Sem. I
heat source, Periodic heat conduction with moving boundaries.

**ME 602 Convective Heat Transfer**

3+0 Sem. II

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 ductflow. 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**

3+0 Sem. I

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**

3+0 Sem. II


**ME 591 Seminar**

**ME 600 Master’s Research**

**ME 700 Doctoral Research**

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SCHOOL OF RENEWABLE ENERGY ENGINEERING

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, Postgraduates Studies.
DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

EST 201 Fundamentals of Renewable Energy Sources 2+1 Sem. I

EST 202 Renewable Energy and Green Technology 1+1 Sem. II
(For students of Agriculture Students)
EST 301 Renewable Power Sources  
Practical: Performance evaluation of solar water heater, solar cooker and solar air heater/dryer. Solar photovoltaic system and its characteristics. Effect of shading on photovoltaic panel. Diesel engine operation using dual fuel (diesel and biogas) and biogas alone. Visit to commercial/ institutional power generation biogas plant and biogas bottling plant.

EST 302 Bio-Energy Systems: Design and Applications  
Practical: Study of anaerobic fermentation system for industrial application, gasification for industrial process heat, biodiesel production system, biomass densification techniques (briquetting, pelletization and cubing), integral bio-energy system for industrial application and bio-energy efficiency in industry and commercial buildings. Study and demonstration of energy efficiency in building. Measuring efficiency of different insulation techniques. Study of Brayton, Striling and Rankine cycles.

Postgraduate Courses

EST 501/FMP 511 Agro-energy Audit and Management  
Energy resources on the farm: conventional and non-conventional forms of energy and their use. Heat equivalents and energy coefficients for different agricultural inputs and products. Pattern of energy consumption and their constraints in production of

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 bio methanation, biogas digester type, digesters design, biogas utilization and slurry management, chemical kinetics and mathematical modelling of bio methanation process, Economics of plant, environmental and social impact; Bioconversion of biomass into alcohol - types and pre treatment of biomass, production process, biochemistry and microbiology, fermentor design and process parameters; Economics of alcohol production from biomass, Bio-hydrogen 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 physico-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

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 101 Electrical Engineering**  
(For students in College of Agriculture)  
2+1  
Sem. I  
Practical: Study of voltage resonance in L.C.R. circuits at constant frequency: (a) Star connection study of voltage and current relation. (b) Delta connection study of voltage and current relation. Measurement of Power in 3 phase circuit by wattmeter and energy meter: (a) for balanced loads, (b) for unbalanced loads. Polarity test, no-load test, efficiency and regulation test of single-phase transformer, Starting of induction motors by; (a) D.O.L. (b) Manual star delta (c) Automatic star delta starts. Starting of slip ring induction motors by normal and automatic rotor resistance starters. Test on 3 phase induction motor- determination of efficiency, line current, speed slip and power factor at various outputs. Determination of relation between the induced armature voltage and speed of separately excited D.C. generator. Magnetization characteristics of D.C. generator. Study the starter connection and starting reversing and adjusting speed of a D.C. motor.

**EE 204 Electrical Machines and Power Utilization**  
2+1  
Sem. I  
Various methods of three phase power measurement. Power factor, reactive and apparent power, Concept and analysis of balanced poly-phase circuits. Series and parallel resonance. Electromotive 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, voltage regulation, power and

Practical: To obtain load characteristics of DC shunt, series, compound generator. To study characteristics of DC shunt/series motors. To study DC motor starters. To perform load-test on 3-phase induction motor and plot torque-speed characteristics. To perform no-load and blocked–rotor tests on 3-phase induction motor to obtain equivalent circuit parameters & to draw circle diagram. To study the speed control of 3-phase induction motor by cascading of two induction motors, i.e. by feeding the slip power of one motor into the other motor. To study star-delta starters physically and (a) to draw electrical connection diagram (b) to start the 3-phase induction motor using it (c) to reverse the direction of 3-phase induction motor. To start a 3-phase slip–ring induction motor by inserting different levels of resistance in the rotor circuit and plot its torque–speed characteristics. To perform no load & blocked–rotor test on single phase induction motor and determine the parameters of equivalent circuit drawn on the basis of double revolving field theory. To perform load–test on single phase induction motor and plot torque-speed characteristics. To study power consumed in a 3-phase circuit. Two lamps in series controlled by one switch. Two lamps in parallel controlled by one switch.

**EE 206 Electronics and Instrumentation**  
(For students in College of Agriculture Engineering & Technology and College of Agriculture)


EE 304 Instrumentation and Process Control in Food Industry 2+1 Sem. II
(For students in College of Agriculture)
Practical: Study on instrumentation symbols; Determination of relative humidity by wet and dry bulb thermometer; Measurement of wind velocity by anemometer; Measurement of intensity of sun shine by sunshine recorders; Study of characteristics of pressure transducers, characteristics of IC temperature sensor, characteristics of platinum RTD, temperature controlled alarm system; Study of water level to current conversion; Study of characteristics of capacitive transducer.

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 till 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

circuits used to implement Proportional, Integral, Derivative and Composite Modes. Introduction to computer control of process. Applications and design.
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  
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  

EE 507 / CSE 507 Design of Micro-computer Systems  
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  

EE 509 Methods of Optimization

EE 510 Optimal Control
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, to a double integral system, lti system, energy-optimal control systems, optimal control systems with state constraints.

EE 511 Maintenance Management

EE 512 Direct Energy Conversion
EE 513 Systems Analysis in Agriculture 2+0 Sem. II

EE 601 Analysis and Design of Instrumentation Systems 2+1 Sem. II

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 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 3+0 Sem. II

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

### PROGRAMME

M. Tech.

### COURSE REQUIREMENTS

#### M. Tech.

<table>
<thead>
<tr>
<th>Field of Specialization</th>
<th>Computer Science and Engineering</th>
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<tbody>
<tr>
<td>Required Courses</td>
<td>CSE 501, CSE 502, CSE 503, CSE 504</td>
</tr>
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<td>Supporting Courses</td>
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<td>As recommended by the student's Advisory Committee and approved by the Dean, Postgraduates Studies.</td>
</tr>
</tbody>
</table>
DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

CSE 101 Information and Communication Technology in Agriculture  1+2  Sem. I & II
(All degree programmes except B.Tech-Agril. Engg.)
IT and its importance. IT tools, IT-enabled services and their impact on society; Introduction to Computers, hardware and software; input and output devices; word and character representation; features of machine language, assembly language, high-level language and their advantages and disadvantages; Operating Systems, definition and types, Applications of Word Processing /Spreadsheet /Presentation /Databases for document creation & Editing, Data presentation, interpretation and graph creation, statistical analysis, mathematical expressions, Database concepts and types, uses of DBMS in Agriculture; Introduction to Local area network (LAN), Wide area network(WAN), Internet and World Wide Web, HTML and IP and Video conferencing, Introduction to e- Agriculture, concepts and applications, Use of ICT in Agriculture.

Practical: Practice with latest operating system for Creating, Files & Folders, File Management. Use of Word Processing / Spreadsheet / Presentation / Databases with latest software packages; Creating a spreadsheet, use of statistical tools, writing expressions, creating graphs, analysis of scientific data. Creating Database, preparing queries and reports, Creation and operation of Email account; demonstration of Agri-information system using Mobile Apps. Internet applications: Web Browsing, Creation and operation of Email account; handling of audio visual equipments. Planning, preparation, presentation of posters, charts. Introduction of Geospatial Technology for generating valuable information for Agriculture. Hands on Decision Support System. Preparation of contingent crop planning.

CSE 204 Computer Programming & Data Structures  1+2  Sem. I & II
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, Decision making, Branching, Looping, Arrays, User defined functions, passing arguments and returning values, recursion, scope and visibility of a variable, String functions, Structures and union, Pointers, Stacks, Push/Pop operations, Queues, Insertion and deletion operations, Linked lists.

Practical: Familiarizing with Turbo C IDE; Building an executable version of C program; Debugging a C program; Developing and executing simple programs; Creating programs using decision making statements such as if, go to & switch; Developing program using loop statements while, do & for; Using nested control structures; Familiarizing with one and two dimensional arrays; Using string functions; Developing structures and union; Creating user defined functions; Using local, global & external variables; Using pointers; Implementing Stacks; Implementing push/pop functions; Creating queues; Developing linked lists in C language; Insertion/Deletion in data structures.
CSE 205 Web Designing and Internet Applications  1+1  Sem. II

CSE 102 Basics of Computer Science and Bio-informatics in Agriculture  1+2  Sem. I
Information Technology (IT) and its importance. IT Tools. IT-enabled services and their impact on society: Introduction to computers, hardware and software, input and output devices, word and character representation: features of machine language, assembly language, high-level language and their advantages and disadvantages: Operating System, definitions and types. Applications of word processing/Spreadsheet/Presentation: document creation and editing, data presentation, interpretation and graph creation, statistical analysis, mathematical expressions. Introduction to Local area network (LAN), Wide area network (WAN), Internet and World Wide Web, HTL and IP and Video Conferencing, Introduction to e-Agriculture concepts and applications, Use of ICT in Agriculture.
Practical: Practice with latest operating system for creating Files and Folders, File Management, Use of Word Processing/Spreadsheet/Presentation with latest software packages: Creating spreadsheet, use of statistical tools, writing expressions, creating graphs, analysis of scientific data. Creation and operation of Email account: demonstration of Agri-information system using Mobile Apps, Internet Applications: Web Browsing, Creation and operation of Email account: handling of audio-visual equipment’s. Planning preparation, presentation of Posters, charts, Searching and retrieval of information from biological databases, Sequence alignment using BLAST.
Postgraduate Courses

CSE 501 Computer Engineering  2+1  Sem. I

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
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.

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

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

CSE 510 Introduction to Computer Science 2+1 Sem. I
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, Postgraduates Studies.

PGDCA

Field 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  
-
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**

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**

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**

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**

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++**

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**

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**

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,
grahs 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, informa-
tion-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**

3+0      Sem. I

General introduction to security, the OSI security architecture, security trends, security
attacks, security services. Model for network security. Classical encryption techniques,
symmetric cipher model, substitution techniques, transpositions techniques, rotor
machines, steganography. Advanced encryption standard, evaluation criteria for
advanced encryption standard, the advanced encryption standard cipher, block cipher and
data encryption standards, block cipher principles, block cipher design principles,
strength of des, single and triple des. Public key cryptography and RSA, principles of
public key cryptosystems, RSA algorithm. Digital signatures and authentications, digital
signatures, digital signature standards authentication protocols, Network attack and

IT 516 Soft Computing
2+0 Sem. I

IT 517 System Software
3+0 Sem. I,II
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
2+0 Sem. I,II
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 2+1 Sem. I,II
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 2+0 Sem. I,II
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 3+0 Sem. I,II
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**

1+2 Sem. I,II


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>College of Agriculture</th>
<th>Cr. Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agron. 102 Principles of Agronomy</td>
<td>1+1</td>
</tr>
<tr>
<td>ENV 101 Environmental studies and Disaster Management</td>
<td>2+0</td>
</tr>
<tr>
<td>Soils 102 Principles of Soil Science</td>
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<tr>
<td>Hort. 203 Principles of Horticultural Crops and Plant Protection</td>
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<tr>
<th>College of Basic Sciences &amp; Humanities</th>
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<tr>
<td>Eng. 101 General English</td>
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<td>Eng. 201 Communication Skills and Personality Development</td>
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<td>Phys. 203 Engineering Physics</td>
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<td>Mgt. 201 Entrepreneurship Development and Business Management</td>
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<td>CE 105 Soil Mechanics</td>
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<tr>
<td>CE 106 Surveying and Levelling</td>
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<tr>
<td>CE 108 Engineering Mechanics</td>
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<tr>
<td>CE 207 Watershed Hydrology</td>
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<tr>
<td>CE 208 Strength of Materials</td>
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<td>CE 306 Building Construction and Cost Estimation</td>
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<td>FMP 203 Farm Machinery and Equipment- I</td>
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<td>FMP 302 Tractor and Automotive Engines</td>
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<tr>
<td>FMP 306 Farm Machinery and Equipment-II</td>
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<td>ME 103 Engineering Drawing</td>
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<td>ME 104 Workshop Technology and Practice</td>
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<td>ME 108 Heat and Mass Transfer</td>
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<td>ME 202 Fluid Mechanics and Open Channel Hydraulics</td>
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<td>ME 302 Machine Design</td>
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PFE 204  Engineering Properties of Agricultural Produce  1+1
PFE 304  Agricultural Structures and Environmental Control  2+1
PFE 305  Post Harvest Engineering of Cereals, Pulses and Oil Seeds  2+1
PFE 306  Post Harvest Engineering of Horticultural Crops  2+1
PFE 307  Dairy and Food Engineering  2+1
CSE 204  Computer Programming and Data Structures  1+2
CSE 205  Web Designing and Internet Applications  1+1
EE 204  Electrical Machines and Power Utilization  2+1
EE 206  Electronics and Instrumentation  2+1
EST 201  Fundamentals of Renewable Energy Sources  2+1
EST 301  Renewable Power Sources  2+1
EST 302  Bio-energy Systems: Design and Applications  2+1
SWE 201  Irrigation Engineering  2+1
SWE 202  Soil and Water Conservation Engineering  2+1
SWE 203  Sprinkler and Micro Irrigation Systems  1+1
SWE 301  Water Harvesting and Soil Conservation Structures  2+1
SWE 302  Drainage Engineering  1+1
SWE 303  Watershed Planning and Management  2+1
SWE 304  Groundwater, Wells and Pumps  2+1

Project and Practical Training Courses
EDT 391  Educational Tour  0+2
IAP 491  Industrial Attachment for Agricultural Engineering  0+10
SDT 491  Skill Development Training in Agricultural Engineering  0+10
ELP 491  Experiential Learning Program in Agricultural Engineering  0+10
PPR 491  Project Planning & Report Writing  0+10

Elective Courses
Each student has to register three elective courses out of the courses listed below:
FMP 411  Tractor Design and Testing  2+1
FMP 412  Farm Machinery Design and Production  2+1
FMP 413  Mechanics of Tillage and Traction  2+1
FMP 414  Ergonomics and Safety  2+1
FMP 415  Hydraulic Drives and Controls  2+1
FMP 416  Precision Agriculture and System Management  2+1
FMP 417  Machinery for Crop Residue and Fodder Management  2+1
FMP 418  Farm Power and Machinery Management  2+1
PFE 401  Development of Processed Products  2+1
PFE 402  Food Quality and Control  2+1
PFE 403  Process Equipment Design  2+1
PFE 404  Food Plant Design and Management  2+1
PFE 405  Food Packaging Technology  2+1
PFE 406  Waste and By-Product Utilization  2+1
SWE 401  Floods and Control Measures  2+1
SWE 402  Wasteland Development  2+1
SWE 403  Information Technology for Land and Water Management  2+1
SWE 404  Remote Sensing and Geographic Information System  2+1
SWE 405  Design and Management of Canal Irrigation System  2+1
### SEMESTER-WISE STUDY PROGRAMME OF B.Tech. (Agri. Engg.)

#### FIRST YEAR

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Title of the Course</th>
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<th>Course No.</th>
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<td>Entrepreneurship Development and Business Management</td>
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<td>Engineering Properties of Agricultural Produce</td>
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### THIRD YEAR

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<td>SWE 303</td>
<td>Watershed Planning and Management</td>
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<td>CE 306</td>
<td>Building Construction and Cost Estimation</td>
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<td>SWE 304</td>
<td>Groundwater, Wells and Pumps</td>
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<td>Agricultural Structures and Environmental Control</td>
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<td>Tractor Systems and Controls</td>
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<td>EST 302</td>
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<td>Educational Tour</td>
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</table>

| Total       | 26(17+9)                                                                     |                           | Total       | 24(15+9)                                                                     |                           |

*The students will register for Educational Tour in the V semester and will go on educational tour at the end of V semester during semester break.

**The students will register for Industrial Attachment in VII semester but the industrial attachment will start during the semester break at the end of VI semester and will carry on into the VII semester till 10 weeks are completed.
### FOURTH YEAR

<table>
<thead>
<tr>
<th>Semester VII</th>
<th>Student READY</th>
<th>Semester VIII</th>
<th>Student READY</th>
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<td>IAP 491*</td>
<td>Industrial Attachment for Agricultural Engineering</td>
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<tr>
<td>SDT 491**</td>
<td>Skill Development Training in Agricultural Engineering</td>
<td>10(0+10)</td>
<td>II</td>
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<tr>
<td>ELP 491***</td>
<td>Experiential Learning Program in Agricultural Engineering</td>
<td>10(0+10)</td>
<td>III</td>
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</table>

| PPR 491        | Project Planning and Report Writing | 10(0+10)       |

| Total          | 30(0+30)       | Total          | 19(6+13)       |

* Industrial training will start in the summer break after VI semester and will continue in the VII semester either in one organization or multiple organisations as all organizations do not absorb trainees for 8 weeks.

**Four compulsory modules for all the students SDT-1, SDT-2, SDT-3, SDT-4

***Each student will choose one out of four modules ELP-1, ELP-2, ELP-3, ELP-4
Skill Development Training in Agricultural Engineering (SDT 491)
Four Modules (all are compulsory for every student)

SDT-1  Geotechnical analysis of site for business establishment (1 week) –
Department of Civil Engineering

Site investigation and its importance in agricultural engineering, soil sampling,
types of sampling techniques and types of samplers, standard penetration test, field tests and
determination of moisture content etc, laboratory tests on samples, local laws, pollution norms,
effluent treatment, construction details etc.

SDT-2  Computer Aided Design & Applications (3 weeks) - Department of
Mechanical Engineering

Application of computers for design, Overview of CAD window: explanation of
various options on drawing screen, study and practice of draw and dimension tool bar, study of
OSNAP, line thickness and format tool bar, practice on OSNAP, line thickness and format tool
bar, practice on mirror, offset and array commands, practice on trim, extend, chamfer and fillet
commands, practice on copy, move, scale and rotate commands. Drawing of 2-D views: drawing
using draw tool bar, practice on creating boundary, region, hatch and gradient commands,
practice on editing polyline using PEDIT and explode commands, setting of view ports for
sketched drawings, printing of selected view ports in various paper sizes. 2-D drawing of
machine parts with all dimensions and allowances: drawing of foot step bearing and knuckle
joint, sectioning of foot step bearing and stuffing box, drawing of hexagonal nut and bolt and
other machine parts. Practice on 3-D commands: extrusion, loft, sweep, press pull, revolving,
joining and other commands. Demonstration on CNC machine with simple operations, Machine
drawing examples.

SDT-3  Design and Development of Website for Engineering Entrepreneurs (2
weeks) – Department of Electrical Engineering and Information Technology

Basic Concepts: An introduction to domain names, web servers, and website
hosting, Building your first web page: The structure of an HTML page, HTML tags, HTML code
examples, Introduction to website, Absolute vs Relative URL, basic layout, basic color scheme
and fonts. An Introduction to CSS: Tags used in this CSS based layout, Basic concepts in Java
Script programming.
SDT-4 Campus to Corporate (1 week) – Training Unit and Placement

Interpersonal skills, decision making, information management system, conflict management, organisational behaviour, mentoring by industry experts, market analysis, team working and leadership qualities.

On Campus Experiential Learning program in Agricultural Engineering (ELP 491)

Each student will choose one of the following

ELP-1 Production of agricultural machinery using advanced techniques (7 weeks) - Department of Farm Machinery and Power Engineering

Selection of machine (REC approved machine or machine in demand), CAD based drawings, Visit to concerned industry for an overview of manufacturing processes, Fabrication of parts using Advanced tools available in the department or in industry, assembling of the different parts, testing of the machine in the field, Visit to the customer hiring centers to check the potential of machine/product, seminar, presentation and evaluation.

ELP-2 Agro processing and value addition of agricultural produce (7 weeks) - Department of Processing and Food Engineering

Agricultural raw material characteristics, its procurement and storage, Site selection, plant layout, Machinery selection, Detailed project report, Unit operations in processing of wheat, paddy, pulses, oilseeds, turmeric and honey. Performance evaluation of various machines used for cleaning, grading and sorting of agricultural commodities. Quality norms/regulations. Record keeping and maintenance of machinery. Exposure of agro processing complex, Hands on training on Agro Processing Unit, packaging and marketing of developed products from different agricultural produce from APC, Economic viability. Pre & post-harvest factors affecting quality of horticultural produce, storage methods, refrigeration, modified atmospheric. Drying of fruits and vegetables, Seminars, presentation and evaluation.

ELP-3 Design and operation of micro irrigation systems and protected cultivation structures (7 weeks) - Department of Soil and Water Engineering

Design, installation and operation of micro irrigation system: orientation, components, design of main, sub main, and lateral, selection of pipe and emitter, material
requirements, layout, installation and operation of system. Fertigation system: fertilizers solubility, precautions while mixing fertilizers, frequency, duration and injection rate. Design and installation of protected cultivation structures: Technical standards for the construction of green/poly house structures, site selection, orientation, selection of covering material, shade net including thermal net, fogging system, profile, zig-zag spring and air circulating fans. Equipments used for installation of green, poly and shade net houses, low tunnels etc. Remote Sensing and GIS application.

**ELP-4 Entrepreneurship Opportunities in Renewable Energy Sector (7 weeks) - Department of Renewable Energy Engineering**

## Semester-wise Breakup of Credit Hours for B.Tech. (Agricultural Engineering)

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<tr>
<th>Semester</th>
<th>Credit Hours including NC</th>
<th>Theory</th>
<th>Practical</th>
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*Students who do not opt Basic Punjabi and Punjabi Culture

## Credit Load of Students with Basic Punjabi

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<th>Theory</th>
<th>Practical</th>
<th>NC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sem 1</td>
<td>22</td>
<td>10</td>
<td>12</td>
<td>3 NC</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>191</strong></td>
<td><strong>90</strong></td>
<td><strong>101</strong></td>
<td><strong>18 NC</strong></td>
</tr>
</tbody>
</table>

## Credit Load of Students with Punjabi Culture

<table>
<thead>
<tr>
<th>Semester</th>
<th>Credit hours including NC</th>
<th>Theory</th>
<th>Practical</th>
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