SECTION VIII

FACULTY OF AGRICULTURAL ENGINEERING AND TECHNOLOGY

General information

Disciplines

- Farm Machinary and Power Engineering
- Processing and Food Engineering
- Soil Water Engineering
- Remote Sensing and GIS
- Civil Engineering
- Mechanical Engineering
- Energy Studies for Agriculture
- Electrical Engineering and Information Technology

  (A) Electrical Engineering
  (B) Computer Science and Engineering
  (C) Information Technology

COLLEGE OF AGRICUTLURAL ENGINEERING AND TECHNOLOGY

The College of Agricultural Engineering and Technology (formerly the College of Agricultural Engineering) was established in 1964 as one of the constituent colleges of the Punjab Agricultural University, Ludhiana with the objectives of imparting education, to carry out multi- faceted research and to disseminate information related to technologies thus developed to the stake holders related to the area of Agricultural Engineering. The College has also played a leading role in solving the problems of farmers and industry by undertaking problem-oriented research and speedy transfer of technology. The College has maintained close liaison with different State Government departments and agencies for effective dissemination of new knowledge.

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

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

With the growth of the College the M.Tech. and Ph.D. programmes were started in different disciplines keeping in view the employment needs of the students and beneficiaries like industry and farmers of the State. The M.Tech programme in Remote Sensing and GIS has been started in collaboration with Punjab Remote Sensing Centre,Punjab from the academic session 2012-13. The B.Tech (Agril. Engg.) admission is made on the basis of JEE (Main) conducted by the CBSE, where as the postgraduate admission is made on the basis of written test conducted by PAU, interview and merit. The undergraduate and postgraduate have duly been regulated by the provisions of the regulatory bodies such as the ICAR, the University Grants Commission, the All India Council for

Technical Education and the Institution of Engineers. The revision of course curricula is a continuous process. The revised B.Tech. (Agril. Engg.) programme in the light of the recommendations of the IV Deans' Committee (ICAR) has been adopted from the session 2009-2010. The model curricula and the revised/restructured postgraduate programmes as per the recommendations of the National Core Group (ICAR) have been introduced in the academic session 2010-2011. The curricula has sufficient element of basic engineering, basic sciences, agricultural sciences, practical component, etc.

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

FARM MACHINERY AND POWER ENGINEERING

PROGRAMMES

M.Tech.

Ph.D.

COURSE REQUIREMENTS

M.Tech.

Field of Specialization	Farm Machinery and Power Engineering
Required Courses	FMP 501, FMP 502, FMP 503, FMP 504
Supporting Courses	Stat 421, PGS 501 and other courses from subject matter fields (other than Minor) relating to area of special interest and research problems
Minor Field	Mechanical Engineering, Energy Science and Technology, Computer Science and Engineering, Electrical Engineering, Mathematics and Statistics, Processing and Food Engineering or any other as approved by the Dean Postgraduate Studies.
Deficiency Courses	As recommended by student's Advisory Committee and apporved by the Dean, Postgraduates Studies

Ph.D.

Field of Specialization	Farm Machinery and Power Engineering
Required Courses	FMP 601, FMP 602
Supporting Courses	Courses from subject matter fields (other than Minor) relating to area of special interest and research problems.
Minor Field	Mechanical Engineering, Energy Science and Technology, Computer Science and Engineering,Electrical Engineering, Mathematics, Statistics, Processing and Food Engineering or any other as approved by the Dean Postgraduate Studies.
Deficiency Courses	As recommended by student's Advisory Committee and apporved by the Dean, Postgraduate Studies

DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

FMP 202 Farm Power and Machinery **1+1** **Sem. I**

(For students of College of Agriculture)

Farm Power in India - Sources. Internal Combustion (IC) engines and terminology. Working principles of two stroke and four stroke engines. Different systems of tractors, types and selection. Primary and secondary tillage implements. Implements for intercultural operation, seed drills, paddy transplanters, their calibration. Plant protection, harvesting and threshing equipment. Cost of operation of tractor and machinery.

Practical: Study of different components of IC engine, working of two stroke and four stroke engines. Various systems of tractor. Study of Mould Board (MB) plough, measurement, plough size, different parts, horizontal and vertical suction. Disc plough. Seed-cum -fertilizer drills, furrow opener, metering mechanism and calibration. Study of different inter cultivation equipment, paddy transplanters and threshing systems. Repair, adjustment and operation of sprayers and dusters. Registration procedures.

FMP 206 Field Operation and Maintenance of Tractors and Farm Machinery-1 **0+1** **Sem. I,II**

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

FMP 303 Farm Machinery and Equipment-I **2+1** **Sem. II**

Objectives of farm mechanization. Classification of farm machines. Materials of construction and heat treatment. Principles of operation and selection of machines used for production of crops. Field capacities and economics. Tillage; primary and secondary tillage equipment. Forces acting on tillage tools. Hitching systems and controls. Draft measurement of tillage equipment : Earth moving equipment - their construction and working principles viz Bulldozer, Trencher, Elevators laser land leveller etc.; Sowing, planting and transplanting equipment - their calibration and adjustments. Minimum tillage, no-tillage and straw management equipment. Fertilizer application equipment. Weed control and Plant protection equipment - sprayers, dusters and their calibration, selection, constructional features of different components and adjustments.

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

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

Principles and types of cutting mechanisms. Construction and adjustments of shear and impact-type cutting mechanisms. Crop harvesting machinery : mowers, windrowers, reapers, reaper binders and forage harvesters. Forage chopping and handling equipment. Threshing mechanics and various types of threshers. Threshers, straw combines and grain combines, maize harvesting and shelling equipment, Root crop harvesting equipment - potato, groundnut etc., Cotton picking and Sugarcane harvesting equipment. Principles of fruit harvesting tools and machines. Horticultural tools and gadgets.

Testing of farm machine. Test codes and procedure. Interpretation of test results. Selection and management of farm machines for optimum performance.

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

FMP 305 Tractor and Automotive Engines **2+1** **Sem. I**

(Pre requisite ME 105)

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

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

FMP 306 Field Operation and Maintenance of Tractors and Farm Machinery -II **1+1** **Sem. II**

(Pre requisite FMP 206)

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

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

FMP 403 Tractor Systems and Controls **2+1** **Sem. II**

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

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

Finding moment of Inertia of a tractor; Appraisal of various controls in different makes tractors in relation to anthropometeric measurements.

FMP 404 Tractor Design and Testing **2+1** **Sem. I**

(Pre requisite FMP 403)

Procedure for design and development of agricultural tractor, Study of parameters for balanced design of tractor for stability & weight distribution, hydraulic lift and hitch system design. Design of mechanical power transmission in agricultural tractors: single disc, multi disc and cone clutches. Rolling friction and anti-friction bearings. Design of Ackerman Steering and tractor hydraulic systems. Study of special design features of tractor engines and their selection. Design of seat and controls of an agricultural tractor. Tractor Testing.

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

Cafeteria Courses

FMP 405 Production Technology of Agricultural Machinery **2+1** **Sem. II**

Critical appraisal in production of Agricultural Machinery; Modelling and stress analysis of Machinery parts by using standard software; Advances in material used for tractor and Agril. Machinery. Cutting tools including CNC tools and finishing tools. Advanced manufacturing techniques like powder metallurgy, EDM (Electro-Discharge Machining), Heat Treatment of steels including pack carburizing, shot pining process, chemical vapor deposition (CVD) etc. Limits, Fits and Tolerances, Jigs and Fixtures, Microstructure Analysis. Industrial lay-out planning, Quality management,. Economics of process selection. Techno-economic feasibility of Project Report. Selection of Standard/ critical components. Case studies of manufacturing of agricultural machinery. Servo motors, drives & controllers, CNC controllers for machine tools. CNC programming. Assembly and plant automation. Storage and transportation.

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

FMP 406 Mechanics of Tillage and Traction **2+1** **Sem. II**

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

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

FMP 407 Farm Power and Machinery Management **2+1** **Sem. II**

The role of mechanization and its relationship to productivity, employment, social and technological change; performance and power analysis; cost analysis of machinery: fixed cost and variable costs, effect

of inflation on cost; selection of optimum machinery and replacement criteria; Break-even analysis, reliability and cash flow problems; mechanization planning; case studies of agricultural mechanization in India.

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

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

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

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

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

Hydraulic Basics: Pascal's Law, Flow, Energy, Work, and Power. Hydraulic Systems, Color Coding, Reservoirs, Strainers and Filters, Filtering Material and Elements. Accumulators, Pressure Gauges and Volume Meters, Hydraulic Circuit, Fittings and Connectors. Pumps, Pump Classifications, Performance, Displacement, Designs, Gear Pumps, Vane Pumps, Piston Pumps, Pump Operation. Hydraulic Actuators, Cylinders, Construction and Applications, Maintenance, Hydraulic Motors. Valves, Pressure-Control Valves, Directional- Control Valves, Flow-Control Valves, Valve. Installation, Valve Failures and Remedies, Valve Assembly, Troubleshooting Valves Hydraulic Circuit Diagrams and Troubleshooting, United States of American Standards Institute USASI Graphical Symbols Tractor hydraulics, nudging system, ADDC. Pneumatics: Air services, logic units, Fail safe and safety systems Robotics: Application of Hydraulics and Pneumatics drives in agricultural systems, Programmable Logic Controls (PLCs).

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

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

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

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

Postgraduate Courses

FMP 501 Design of Farm Power and Machinery 3+1 Sem. II

Research and development procedure in farm equipment and agricultural tractors. Design problems and application in typical farm equipment and other organizations. Design analysis from ethical point of view. Power transmission elements. Mechanical and hydraulic, selection, design analysis, applications and limitations. Use of computer aided design in farm equipment. Analysis of linkages in farm machinery and application to few selected equipment. Application of design principles in design and analysis of selected systems and components of farm equipment such as tillage, planting/harvesting etc. Design of rotary and oscillating machines Reliability criteria in design and its application.

Practical: Design of gears, bearings, springs, hydraulic power transmission components etc. Solving design problems on farm machines and equipment and matching power unit. Study of reliability criteria in design and its application.

FMP 502 Soil Dynamics in Tillage and Traction 2+1 Sem. I

Dynamic properties of soil related to tillage and traction. Tillage edaphic environmental relationship. Design, considerations for tillage tools. Soil compaction due to machine traffic. Traction and Transport mechanism. Tyre size, type, selection, deflection. Dimensional analysis and design of traction and transport devices. Soil vehicle models, prediction of performance and finite element approach.

Practical: Study of soil parameters and forces acting on tillage tools, wheel slippage, tyre selection, performance of traction devices and soil working tools.

FMP 503 Testing and Evaluation of Agricultural Equipment 2+1 Sem. I

Testing types, Procedures and various codes: National and International. Test equipment, usage and limitations. Laboratory and field testing of selected farm equipment Tractor testing performance evaluation and interpretation. Review and interpretation of test reports. Case studies and integrated system approach to machinery evaluation.

Practical: Laboratory and field-testing of selected farm equipment viz. tiller, seed drill planter etc. and interpretation of test results. Material testing and accelerated testing of fast wearing components.

FMP 504 System Simulation and Computer Aided Problem Solving in Engineering 1+1 Sem. II

Concept of dimensional analysis, dimensions and units, systems of units, conversion of units of measurement, conversion of dimensional constants and equations in different units, dimensionless products, their formulation methods- the Rayleigh's method, Buckingham's Pi theorem and other methods. Mathematical modeling and engineering problem solving. Computers and softwares software development process, Algorithm design, program composition, quality control, documentation and maintenance ,software strategy. Approximation, round off errors, truncation errors. Nature of simulations systems models and simulation, discreet event simulation, time advance mechanisms, components of discreet event simulation model. Simulation of singular server que-programme organization and logic- development of algorithm. Solving differential equation on computers- modeling engineering systems with ordinary differential equations-solution techniques using computers.

Practical: CAD Software and software development, algorithm in farm machinery. Simulation application in farm machinery like seed drill, planter, tractor etc. Simulation models.

FMP 505 Applied Instrumentation in Farm Machinery and Stress Analysis 2+1 Sem. I

Strain -stress, strain relationship, strain gauges - mechanical, optical, electrical acoustical and pneumatic etc. and their use. Experimental method of measuring strain/stress. Measuring devices for displacement, velocity, force, torque and power. Strain gauges: types and their application in 2D, 3D force measurement. Design and analysis of strain gauges. Introduction to functional elements of instruments, Active and passive transducers. Analog and digital modes. Performance characteristics- static and dynamic of instruments . Devices for measurement of temperature, relative humidity, pressure, sound, vibration, flow etc. Recording devices and their type. Measuring instruments for calorific value of solid, liquid and gaseous fuels. Measurement of gas composition using GLC.Basic signal conditioning devices. Data acquisition system, micro computers. Data storage and their application.

Practical: Calibration of instruments, Experiment on LVDT, strain gauge transducer, inductive and capacitive pick ups, optical speed sensor, thermocouples . Vibration, measurement exercises. Application of instrument in farm machinery.

FMP 506 Farm Machinery Management and System Engineering 2+1 Sem. II

Cost analysis of farm machinery use and operations. System, definition and concept. System engineering function. System approach in farm machinery management and application of programming techniques to problems of farm power and machinery, selection, maintenance and scheduling of operations. Equipment replacement and inventory control of spare parts. Work design in agriculture. Selection of optimum mechanization systems by modeling. Application of linear programming, network theory, CPM, PERT, transportation models etc. Dynamic programming Markov chain. Man- machines-task system in farm operations, planning of work, systems in agriculture and organization of farm labour .

Practical: Field studies on farm operations and their analysis in terms of time and motion studies and resources scheduling. Computer use in solving problems of optimization , algorithm. Individual projects on system analysis of farms at different levels of mechanization.

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

Principles of soil working tools: shares, discs, shovels, etc. Metering of seeds and granular fertilizers with various mechanism, effect of various parameters on distribution of seed and fertilizer in seed cum fertilizer drills and planters, flow of seeds and fertilizers through tubes and boots. Kinematics of transplanters. Theory of atomization, specific energy for atomization, electrostatic spraying and dusting, spray distribution patterns. Kinematics of reapers/harvesting machines. Theory of mechanical separation of grains from ear heads/pods. Parameters affecting performance of threshers, aerodynamic properties of straw and grain mixture, theory of root crop harvesters, power requirement of various components of field machines. Noise and vibration theory- Definition, units , measurement and their importance. Types of vibrations, analysis of one , two and multiple degree of freedom, their solution using different methods. Lagrange equation. Introduction of transient vibration in systems, vibration of continuous media. Balancing of single rotating weight and number of weights in same plane and different planes. Complete balancing of reciprocating parts of engine.

Practical : Vibration measurement equipment and measurement on different components of thresher, combine, reaper,power tiller and tractor. Modulus of elasticity, rigidity, and MI . Evaluation of logarithmic decrement and damping factor. Whirling of shaft. Heat motion in two pendulum system. Analysis of multi-degree of freedom system.

FMP 508 Tractor Design 2+1 Sem. II

Technical specifications of tractors available in India, modern trends in tractor design and development, special design features of tractor in relation to Indian agriculture. Parameters affecting design of tractor engine and their selection. Design of fuel efficient engine components and tractor systems like transmission, steering, front suspension, hydraulic system and hitching, chassis, driver's seat, work place area and controls. Tire selection Mechanics of tractor. Computer aided design and its application in agricultural tractors.

Practical: Study of design aspects of tractor, and engine; tractor systems, transmission, steering, hydraulic, workplace, seat and computer aided designs.

FMP 509 Principles of Ergonomics, Application and Safety 2+1 Sem. I

Human factors in system development. Energy liberation and mechanical efficiency of human body. Anthropemetry and Biomechanics: Anthropemetry and its applications, joint movement and method of measurement, analysis. Biomechanics of motion controls and related devices and their design considerations. Man-Machine system concept, human behavior models, thermal and non-thermal factors and their influence on human performance. Safety standards at workplace and natural hazards at farm. Case studies on ergonomics in agricultural machines. viz design aspects of foot and hand controls in tractors and farm equipments, operator's seat and agricultural equipment.

Practical: Laboratory experiments in anthropometric measurements. Physiological parameter measurements of farm operators for various farm machinery operations. Human energy requirements for displays nd control of tractors and other equipment. Study of human response to noise and vibration.

FMP 510/PFE 502 Engineering Properties of Biological Material 2+1 Sem. I

Physical characteristics- of different food grains, fruits and vegetables : shape, size, description of shape and size, volume and density, porosity, surface area. Rehology : ASTM standards , terms, physical states of materials, classical ideal material, rheological models and equations, viscoelasticity, creep stress relaxation, Non- Newtonian fluid and viscometry, rhelogical properties, force, deformation , stress, strain, elastic, plastic behaviour. Contact stresses between bodies, Hertz problems, firmness and hardness, mechanical, damage, dead load and impact damage, vibration damage, friction, effect of load, sliding velocity, temperature, water film and surface roughness, Friction in agricultural materials, rolling resistance, angle of internal friction, angle of repose, flow of bulk granular materials, aero dynamics of agricultural products, drag coefficients, terminal velocity, Thermal properties : Specific heat, thermal conductivity, thermal diffusivity, methods of determination, Steady state and transient heat flow. Electrical properties Dielectric loss factor, loss tangent, A.C conductivity and dielectric constant, method of determination, energy absorption from high frequency electric field. Application of engineering properties in design and operation of agricultural equipment and structures.

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

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

Energy resources on the farm: conventional and non-conventional forms of energy and their use. Heat equivalents and energy coefficients for different agricultural inputs and products. Pattern of energy consumption and their constraints in production of agriculture. Direct and indirect energy. Energy audit of production agriculture, and rural living and scope of conservation. Identification of energy efficient machinery systems, energy losses and their management. Energy analysis techniques and methods: energy balance, output and input ratio, resource utilization, conservation of energy sources. Energy conservation planning and practices. Energy orecasting, Energy economics, Energy pricing and incentives for energy conservation, factors effecting energy economics. Energy modelling.

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

Energy cycle of the earth; water flow and storage; ocean currents and tides. Energy heat flow and energy storage; photosynthesis and biomass; renewable energy sources. Thermodynamics of energy conversion; conversion of solar energy, wind energy, water flows, heat, biomass, etc.; other conversion processes. Development and use of biogas, alcohols and plant oils, plant oil esters in I.C. engines. Study of various parameters for measuring the performance of the output. 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

Fluid power and its advantages, properties of hydraulic fluids, viscosity, bulk modulus and density. Concepts of energy in hydraulic systems, laws of fluid flow. Pressure distribution system of tubing and hoses coupling etc. Basics of hydraulic flow and hydraulic circuit analysis. Types of pump and theory of operation. Fluid power actuators, hydraulic rams, hydraulic motors, piston motors and their performance characteristics. Electro hydraulic gear motors and hydro transmissions control components, directional, safety and servo valves, hydraulic circuits design, pump unloading. Tractor hydraulic systems, tractor power steering and brake system. Logic elements in fluidies-sensing and logic circuit. Electrical control for fluid power circuits.

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 double-tie-rod steering systems, development of mathematical models and its computer-aided solutions. Force analysis in tractor-implement combination. Vibration transmissibility and damping in various farm machines. Tractor dynamics, development of the model and computer-aided design. Checking, interpretation and statistical analysis of results.

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

Mathematical modeling, its classifications, characteristics and approach and limitations. Dimensional homogeneity, Buckingham pi-theorem. Simulation for system modeling. Similitude in tillage tool studies, prediction models for traction devices. Review of probability theory, analysis of random data, formulation and analysis of models: deterministic and stochastic application of modeling in farm machinery: case studies.

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

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

FMP 604 Computer Aided Analysis and Design of Farm Machinery 2+1 Sem. I

Introduction to CAD, the design process,modelling using CAD, architecture of CAD system. Geometric modeling, requirements, geometric construction methods, representation of curve desirable modeling facilities. CAD standards, Graphical Standard system Exchange of modeling data. System analysis. Relevance of system 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 3+1 Sem. I

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 machinery: Swell, shrinkage and compaction measurements. Use of tractors and Crawlers and effects of altitude & temperature on their performance. Grade resistance and gradability. Land cleaning, reclamation and leveling equipment. Power shovels, drag lines, cam shells. Rubber tire for earth moving machinery. Trenching machineries and wagons. Economic analysis of land development machinery. Application of PERT and CPM to the problems related to land development.

Practical : Introduction to GIS and GPS, study of models - farm machinery usage. Precision farming using GIS and GPS - case study. Mechanism of power shovels, drag lines, earth diggers, clamshells etc. Earth work estimation, unit cost of operation, work scheduling, machinery maintenance, entrepreneurship

FMP 591 Seminar

FMP 600 Master's Research

FMP 700 Doctoral Research

PROCESSING AND FOOD ENGINEERING

PROGRAMMES

M.Tech.

Ph.D.

COURSE REQUIREMENTS

M. Tech.

Field of Specialization	Processing and Food Engineering
Required Courses	PFE 501, PFE 502, PFE 503, PFE 504
Supporting Courses	Stat. 421, PGS 501 and other courses from subject matter fields (other than Minor) relating to area of special interest and research problem
Minor Field	Mechanical Engineering, Energy Science and Technology, Civil Engineering, Computer Science and Engineering, Electrical Engineering, Mathematics, Statistics, Food Science and Technology or any other as approved by the Dean Postgraduate Studies.
Deficiency Courses	As recommended by student's Advisory Committee and apporved by the Dean, Postgraduates 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 apporved by the Dean, Postgraduates Studies

DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

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

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

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

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

(For the College of Agriculture)

Material handling - machines and conveyors. Pre-treatment unit operations - cleaning, dehulling, dehusking, sorting, grading, peeling, mixing and forming. Size reduction and separation. Agitation and mixing. Bread moulders, pie and biscuit formers, confectionery moulders. Extrusion - extrusion cookers, cold extrusion, single and twin screw extrusion, low and high pressure extrusion. Engineering properties of food materials. Hygienic design of food processing equipment. Rheology and texture of food materials. Application to separation, pneumatic handling and conveying. Evaporation - principle, types and selection of evaporators. Drying - principle, drying rate kinetics, classification. Thermal processing - blanching, pasteurizations and sterilization

Practical: Study of instron texture analyzer and its working. Determination of electric conductance of a given food sample. Study of evaporator, dryer, sterilizer. Design problems on equipments.

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

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

Introduction, planning, design and application of green houses. Plant response to greenhouse environment. Green house equipment. Materials of construction for traditional and low cost green houses. Irrigation systems used in greenhouses. Cost estimation and economic analysis. Winnowing. Groundnut decorticators. Maize and castor shellers. Drying- grain drying, types of drying, types of dryers. Storage- grain storage, types of storage structures. Cleaning and grading equipment for fruits and vegetables. Size reduction equipment. Evaporation- principle and types. Quality standards. Crops selection and constraints of greenhouse cultivation. Growing media, drainage, flooding and leaching, soil pasteurization, nutrient film technique (NFT) / hydroponics.

Practical: Study of different types of green houses. Calculation of air rate exchange system. Estimation of drying rate of agricultural products. Testing of soil and water suitability and fertigation requirements for greenhouses. Study of threshers, Winnowers, groundnut decorticator and maize and castor shellers - their components, operation and adjustments. Improved grain storage structures. Study of dryers, cleaners and graders. Visit to commercial greenhouses. Growing media - their preparation and pasteurization/sterilization.

PFE 305 Crop Process Engineering **2+1** **Sem. II**

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

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

PFE 306 Drying and Storage Engineering **3+1** **Sem. I**

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

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

PFE 311 Food Processing Equipment-II **2+1** **Sem. I**

(For students of College of Agriculture)

Mechanical separators - centrifugation, clarifiers, desludging and decanting machines. Filtration and expression: batch and continuous type. Baking, roasting and frying equipment. Extraction and leaching, crystallization and distillation - Basic principles. Water activity and states - Renault's Law. Water sorption isotherms - hysterisis. Water activity measurement. Water binding and its effect on enzymatic and non-enzymatic reactions and food texture. Control of water activity and moisture. Permeability and shelf life - calculation of shelf life. shelf life requirements, deteriorative reactions. Accelerated testing. Transport properties of barriers. Shelf life simulation for moisture, oxygen, and light sensitive products. Freezing of Foods - freezing concentration and freeze drying. Freezing curves, phase diagrams, methods of freezing concentration, washing, cleaning in place (CIP) and cleaning out place (COP) cleaning. Microwave, dielectric and infrared heating

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

PFE 312 Food Plant Design and Layout **1+2** **Sem. II**

(For students of College of Agriculture)

Plant design, sales planning for plant design. Plant location, levels of plant location. Location of layout - location factors, plant site selection. Location theory and models, industrial buildings and grounds. Classification of Dairy and Food Plants. Development of the pilot layout, constructing the detailed layout: Functional design: Sitting of different sections in a plant, Layout installations. Quantitative analysis for Plant Layout: engineering economy. Common Problems in Plant Layout and Process scheduling. Practical Layout. Common materials of construction of Food plant, building. Maintenance of Food Plant Building, Cleaning and sanitization.

Practical: Preparation of project report. Preparation of feasibility report. Layout of Food storage wares and godowns. Layout and design of cold storage. Layout of pre-processing house. Layout of Milk and Milk product plants. Low shelf life product plan. Bakery and related product plant. Fruits processing plants. Vegetable processing plants. Layout of multi product and composite food Plants Evaluation of given layout. Waste treatment and management of food plant.

PFE 404 Dairy and Food Engineering **2+1** **Sem. II**

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

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

PFE 405 Agricultural Structures and Environmental Control **2+1** **Sem. II**

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

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

PFE 406 Food Packaging Technology **2+1** **Sem. II**

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

different methods of packaging food products; their merits and demerits; scope for improvements; disposal and recycle of packaging waste.

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

Cafeteria Courses

PFE 407 Waste and By-Product Utilization **2+1** **Sem. II**

Waste and byproducts generation and utilization in different food processing industries; concept scope and maintenance of waste management and effluent treatment, Temperature, pH, Oxygen demands (BOD, COD), fat, oil and grease content, metal content, forms of phosphorous and sulphur in waste waters, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues, briquetting of biomass as fuel, generation of electricity, producer gas; waste treatment and disposal, design, construction, operation and management of institutional community and family size biogas plants, concept of vermi-composting, Pre-treatment of waste: sedimentation, coagulation, flocculation and floatation, Secondary treatments: Biological and chemical oxygen demand for different food plant waste- trickling filters, oxidation ditches, activated sludge process, rotating biological contractors, lagoons, Tertiary treatments: Advanced waste water treatment process-sand, coal and activated carbon filters, phosphorous, sulphur, nitrogen and heavy metals removal.

Practical: Waste characterization; Determination of ash content and carbon in ash of agricultural waste; Briquetting of agricultural residues; Estimation of excess air for better combustion of briquettes; Study of extraction of oil from rice bran; waste treatment plant in food industry; utilization of whey; recovery of peel, germ and germ oil from by-product of cereals; Bioconversion and recycling of agro-wastes and by-products; Visits to various industries using waste and food byproducts.

PFE 408 Development of Processed Products and Equipments **2+1** **Sem. II**

Applications of unit operations to the food industry, analytical processing concepts with regards to mass and energy balances, equipment involved in the commercially important food processing methods and unit operations; value addition to cereals like rice, wheat etc. Parboiling of rice, quality of processed products of rice and wheat. Processing of pulses, spices and condiments; extruded food product, fermented food product, frozen and dried product, technology of meat, fish and poultry products, technology of milk and milk products. Technology of oilseeds and fat products, snack foods, Fruits and vegetables product: candy, nutraceuticals, food product development trends, food additives and labeling. Process equipment for thermal processing-evaporation, dehydration, drying, blanching, pasteurization, distillation; mechanical separation-filtration, sieving, centrifugation, sedimentation; mechanical handling-conveying and elevation; size reduction and classification-mixing; kneading, blending.

Practical: Working principle, operation and maintenance of Engleberg huller; cleaners, graders, paddy destoner-cum-cleaner, rubber roll sheller, paddy separator and vertical cone whitener; familiarization with operation and performance of Satake rice milling unit of 500 kg/hr; planning and layout of rice and roller wheat flour milling; visit to milk plant, roller flour mill, Markfed canneries, fruit/vegetable processing plants; Flow process diagram and various models of the machines used in a sugar mill.

PFE 409 Food Processing Plant Design and Layout **2+1** **Sem. II**

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

report. Quantitative analysis for Plant Layout: engineering economy. Common Problems in Plant Layout and Process scheduling. Practical Layout. Common materials of construction of Food plant, building. Maintenance of Food Plant Building, Cleaning and sanitization.

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

PFE 433 Engineering Principles in Food Processing **3+1** **Sem. I**

(For students of College of Agriculture)

Unit and Dimensions. Material and energy balances, Size reduction and related energy laws, cleaning, grading, sorting, mixing and material handling. Elementary fluid dynamics and statics, heat transfer, exchanger and psychrometerics. Principles of thermal processing, pasteurization, sterilization, refrigeration, freezing, evaporation, dehydration and centrifugal separation.

Practical: Temperature and moisture content measurements. Performance characteristics of size reduction, separating, mixing and drying equipment. Study of parallel and counter current heat exchangers. Enthalpy calculations of a vat pasteurizer. Energy auditing and canning operations. Determination of boiling point rise in concentrated solutions. Measurement of water activity of foods.

Postgraduate Courses

PFE 501 Transport Phenomena in Food Processing **2+1** **Sem. I**

Steady and unsteady state heat conduction, analytical and numerical solution of unsteady state heat conduction equations, Applications in food processing including freezing and thawing of foods. Convective heat transfer in food processing systems involving laminar and turbulent flow heat transfer in boiling liquids, heat transfer between fluids and solid foods. Functional design of heat exchangers: Radiation heat transfer and its governing laws, its applications in food processing. Molecular diffusion in gases, liquids and solids; molecular diffusion in biological solutions and suspensions molecular diffusion in solids, unsteady state mass transfer and mass transfer coefficients, molecular diffusion with convection and chemical reaction, diffusion of gases in porous solids and capillaries, mass transfer applications in food processing.

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

PFE 502/FMP 510 Engineering Properties of Biological Material **2+1** **Sem. I**

Physical characteristics of different food grains, fruits and vegetables; Shape and size, description of shape and size, volume and density, porosity, surface area. Rheology; ASTM standard, terms, physical states of materials, classical ideal material, rheological models and equations, viscoelasticity, creep-stress relaxation, Non-Newtonian fluid and viscometry, rheological properties, force, deformation, stress, strain, elastic, plastic behaviour. Contact stresses between bodies, Hertz problems, firmness and hardness, mechanical damage, dead load and impact damage, vibration damage, friction, effect of load, sliding velocity, temperature, water film and surface roughness. Friction in agricultural materials, rolling resistance, angle of internal friction, angle of repose, flow of bulk granular materials, aero dynamics of agricultural products, drag coefficients, terminal velocity. Thermal properties: Specific heat, thermal conductivity, thermal diffusivity, methods of determination, steady state and transient heat flow. Electrical properties; Dielectric loss factor, loss tangent, A.C. conductivity and dielectric constant, method of determination, energy absorption from high frequency electric field. Application of engineering properties in design and operation of agricultural equipment and structures.

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

PFE 503 AdvanceFood Process Engineering 2+1 Sem. II

Thermal processing: Death rate kinetics, thermal process calculations, methods of sterilization and equipments involved, latest trends in thermal processing. Evaporation: heat and. mass balance in single effect and multiple effect evaporator, aroma recovery, Drying: Rates, equipments for solid, liquid and semi-solid material and their applications, theories of drying, novel dehydration techniques. on-thermal processing: Microwave, irradiation, ohmic heating, pulsed electric field preservation, hydrostatic pressure technique . Freezing: Freezing curves, thermodynamics, freezing time calculations, freeze drying, principle. Separation: Mechanical filtration, membrane separation, centrifugation, principles, equipments and applications. Extrusion: Theory, equipments, applications. Distillation and leaching: Phase equilibrium, multistage calculations, equipments, solvent extraction.

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

PFE 504 Unit Operations in Food Process Engineering 2+1 Sem. II

Mass and energy balance. Principles of fluid flow, Psychrometry, dehydration/drying, types of dryers, blanching, pasteurization, steam requirements in food processing. Refrigeration principles and Food freezing. Mechanical separation techniques, size separation equipments; Filtration, sieving, sedimentation. Material handling equipment, conveyors and elevators; Size reduction processes; Grinding and milling. Homogenization; Mixing- mixers, kneaders and blenders. Extrusion. Membrane technology. Food plant hygiene- cleaning, sterilizing, waste disposal methods, Food packaging: Function materials, technique, machinery and equipment.

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, oil mills, cotton-ginning units, milk plants, food industries . Energy audit study and management strategies in food processing plants. Identification of energy efficient processing machines. Assessment of overall energy consumption, production and its cost in food processing plants, visit to related food processing industry.

PFE 506 Processing of Cereals, Pulses and Oilseeds 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 by-products and their utilization. Storage of milled products, Expeller and solvent extraction processing, assessment of processed product quality. Packaging of processed products, design characteristics of milling equipments; selection, installation and their performance, BIS standards for various processed products.

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

PFE 507 Food Processing Equipment and Plant Design **2+1** **Sem. II**

Design considerations for processing agricultural and food products. Design of machinery for drying, milling, separation, grinding, mixing, evaporation, condensation, membrane separation. Human factors in design, selection of materials of construction and standard component, design standards and testing standards. Plant design concepts and general design considerations. Feasibility analysis and preparation of feasibility report. Hygienic design aspects and worker's safety, functional design of plant building and selection of building materials, estimation of capital investment, management techniques in plant design including applications of network analysis, preparation of project report and its appraisal.

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

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

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

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

Objectives and functions of packaging and packaging materials. packaging requirements and selection of packaging materials-paper, glass, metals, plastics-their properties and methods of testing and evaluation. Barrier properties of packaging materials - Theory of permeability and its measurement. Prediction of shelf life of foods, selection and design of packaging material for different foods. Packaging systems for different food. Packaging equipment and machinery-vacuum, controlled atmosphere and modified atmosphere. Seal and shrink packaging, form and fill sealing, aseptic packaging systems, bottling and carton making equipments. Biodegradable Packaging. Recent advances in packaging.

Practical: Identification and testing of packaging materials. Determination of wax from wax paper. Measurement of tin coating weight. Sulphide stain test. Thickness, substance weight, water absorption,

capability of flexible packaging materials. Determination of equilibrium moisture content. Grading of glass bottles for alkalinity. Determination of water vapour and gas transmission rate of packaging material. Vacuum and shrink packaging. Testing the compression strength of the boxes. Testing the strength of glass containers. Testing the strength of filled pouches by drop tester. Visit to packaging institute/industry.

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 disinfesting 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, seed treater, weighing and bagging machines, their operation and maintenance, installation and determination of their capacity, seed quality maintenance during processing, plant design and layout, economy and safety consideration in plant design. Seed drying principles and methods, theory of seed drying, introduction to different types of heated air dryers, significance of moisture equilibrium, method of maintaining safe seed moisture, thumb rule and its relevance, importance of scientific seed storage, types of storage structures to reduce temperature and humidity; management and operation/cleanliness of seed stores, packaging-principles, practices, materials and hermetic packaging, seed treatment methods and machines used, method of stacking and their impact, design features of medium and long term seed storage building.

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

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

Applications of engineering principles; mass and energy balance, fluid flow principles, unit operations of process engineering. Fundamentals of growth kinetics, maintenance energy and yield concepts, principles of media sterilization, media formulations of industrial fermentation. Aerobic and agitated rheology of fermentative fluids, design and scale-up of bioreactors, enzyme reactors. Principles of recovery of fermented products in bio- processing, instrumentation, transport phenomenon.

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

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

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

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

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

Texture classification. Relation of food texture with structure and rheology. Principles and practices of objective texture measurements, viscosity measurements. Sensory methods of texture and viscosity measurements and their correlation. Rheological properties of foods. Mathematical models and their application along with pipe line design and pump selection for non-Newtonian fluids. Recent advances in textural, rheological and viscoelastic characteristics of foods and their associated mathematical models.

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

PFE 602 Advances in Food Processing 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

An overview of the modeling process. Introduction to mathematical, correlative and explanatory models. Formulation, idealization and simplification of the problems. Probability models, series and linear mathematical approximation, dynamic and interacting dynamic processes. Applications of mathematical modelling techniques to food processing operations like parboiling, convective drying, pasteurization, dehydration, shelf-life prediction, fermentation, aseptic processing, moisture diffusion, deep fat drying, microwave processing, infrared heating and ohmic heating. Stochastic finite element analysis of thermal food processes. Neural networks approach to modelling food processing operations.

PFE 604 Advances in Drying of Food Materials **2+1** **Sem. II**

Isotherm models, psychrometry, construction and use of psychrometric charts. Air flow and resistance, principles and equipments for air movement and heating, drying methods and theory of drying, driers, classification and other allied equipment, drying models. Heat requirements and thermal efficiency of drying system, aeration, tempering and dehydration, operation of driers and their controls, selection of driers, performance testing of grain driers, drying characteristics of cereals, pulses and oilseeds, microwave drying, radio frequency drying and tunnel drying, principles and equipment. Drying of liquid foods, spray drying, drum drying, freeze drying, foam mat drying, heat pump drying, osmotic dehydration.

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

PFE 605 Agricultural Waste and By-Products Utilization **2+1** **Sem. II**

Generation of by-products, agricultural and agro industrial byproducts/ wastes, properties, on site handling, storage and processing. Collection of wastes, utilization pattern as fuel, agricultural waste fired furnaces: Mechanism, construction and efficiency, suitability of wastes as fuel, fuel briquettes, briquetting process, equipment, factors affecting briquetting. Utilization of wastes for paper production, production of particle board, utilization, by-products from rice mill, rice husk, rice bran, utilisation. Thermo-chemical conversions, densification, combustion and gasification, extraction, biological conversions, anaerobic digestion, biochemical digestion process, digestion systems, energy from anaerobic digestion, cellulose degradation, fermentation process.

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

PFE 591 Seminar

PFE 600 Master's Research

PFE 700 Doctoral Research

SOIL AND WATER ENGINEERING

A. SOIL AND WATER ENGINEERING

PROGRAMMES

M. Tech.

Ph.D.

COURSE REQUIREMENTS

M.Tech.

Field of Specialization	Soil and Water Engineering
Required Courses	SWE 501, SWE 502, SWE 503, SWE 504, SWE 505
Supporting Courses	Stat. 421, PGS 501 and other courses from subject matter fields (other than Minor) relating to area of special interest and research problem.
Minor Field	Civil Engineering, Electrical Engineering, Computer Science and Engineering, Mathematics, Soil Science or any other as approved by the Dean Postgraduate Studies.
Deficiency Courses	As recommended by the student's Advisory Committee and apporved by the Dean, Postgraduates Studies

Ph. D.

Field of specialization	Soil and Water Engineering
Required courses	SWE 601, SWE 602
Supporting courses	Courses from subject matter fields (other than Minor) relating to area of special interest and research problem.
Minor Field	Civil Engineering, Electrical Engineering, Computer Science and Engineering, Soil Science,Energy Science and Technology or any other as approved by the Dean Postgraduate Studies.
Deficiency courses	As recommended by the student's Advisory Committee and apporved by the Dean, Postgraduates Studies

DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

SWE 101 Fundamentals of Soil and Water Conservation Engineering 2+1 Sem. I,II

(For the College of Agriculture in collaboration with Department of Civil Engineering)

Surveying- survey equipments, chain survey. Plotting procedure. Calculations of area of regular and irregular fields. Levelling- equipment, terminology, methods of calculation. Types of levelling and contouring. Irrigation- classification of projects, flow irrigation and lift irrigation. Water sources. Water lifting devices- pumps, their capacity and power calculations. Irrigation water measurement- weirs, flumes and orifices. Water conveyance systems- open channel and underground pipeline. Surface, drip and sprinkler irrigation methods. Soil and water conservation, soil erosion, types and control measures.

Practical: Acquaintance with chain survey equipment. Ranging and measurement of offsets. Chain triangulation and plotting. Levelling equipment. Differential levelling. Profile levelling. Contour survey and plotting. Study of centrifugal pumping system and irrigation water measuring devices. Surface irrigation methods. Study of different components of sprinkler and drip irrigation systems. Uniformity of water application in drip and sprinkler systems. Study of soil and water conservation measures.

SWE 304 Irrigation Engineering 3+1 Sem. I

Irrigation Engineering, irrigation, impact of irrigation on Human Environment, some major and medium irrigation schemes of India, purpose of irrigation, sources of irrigation water, present status of development and utilization of different water resources of the country. Measurement of irrigation water, weir, notches, flumes, orifices and other methods. Water conveyance and design of irrigation field channels. Underground pipe conveyance system and irrigation structures. Channel lining. Land grading, different design methods and estimation of earth work and cost. Soil water plant relationship, soil water movement, infiltration, evapo-transpiration, soil moisture characteristic, crop water requirement, soil moisture constants, depth of irrigation, frequency of irrigation and irrigation efficiencies. Surface irrigation methods of water application, border, check basin, furrow and contour irrigation. Sprinkler and drip irrigation method, merits, demerits, selection, design and evaluation. Irrigation water quality. Participatory irrigation management. Economics of water resources utilization.

Practical: Measurement of soil moisture by different soil moisture measuring instruments. Measurement of irrigation water and infiltration rate. Computation of evaporation and transpiration. Land grading exercises. Design of underground pipeline system. Infiltration- advance in border irrigation. Measurement of advance and recession in border and furrow irrigation and estimation of irrigation efficiency. Uniformity coefficient of sprinkler and drip irrigation method. Field problems and remedial measures for sprinkler and drip irrigation method.

SWE 305 Soil and Water Conservation Engineering 2+1 Sem. II

(Pre-requisite: CE 204)

Introduction, soil erosion, types and agents of soil erosion. Gullies and their classification. Soil loss measurements and estimation. Erosion control measures. Level and graded broad base terraces and their design. Bench terraces and their design. Contour bunds, graded bunds and their design. Gully and ravine reclamation. Principles of gully control. Vegetative and temporary structures. Wind erosion, mechanics of wind erosion and soil loss estimation. Wind erosion control measures, wind breaks and shelter belts, sand dunes stabilization. Sedimentation in reservoirs and streams, estimation and measurement. Contours and preparation of contour maps. Land use capability classification. Grassed water ways and their design. Introduction to water harvesting techniques. Stream water quality and pollution.

Practical: Study of soil loss measurement techniques. Details of Coshocton wheel and multi-slot runoff samplers. Determination of sediment concentration through oven dry method. Universal Soil Loss Equation. Preparation of contour map. Vegetative waterways. Contour bunding system. Graded bunding system. Bench terracing systems. Rate of sedimentation and storage loss in reservoir. Shelter belts and wind breaks.

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

(Pre-requisite: SWE 305)

Introduction, classification and functional requirements of soil erosion control structures. Flow in open channels, types, state and regimes of flow. Specific energy and specific force. Hydraulic jump and its application. Runoff measuring structures. Straight drop spillway. Components of spillway. Hydrologic and hydraulic design. Structural design of a drop spillway. Safety against sliding, over turning, crushing and tension. Chute spillway, general description and its components. Hydraulic design, energy dissipaters and design criteria of a SAF stilling basin. Drop inlet spillway, general description, functional use and design criteria. Design of diversions. Small earth embankments, types and design principles. Farm ponds and reservoirs. Cost estimation of structures.

Practical: Design of H-flume and Parshall flume. Construction of specific energy and specific force diagram. Measurement of hydraulic jump parameters. Hydraulic design of a straight drop spillway. Uplift force and construction of uplift pressure diagram. Loads on headwall and construction of triangular load diagram. Stability analysis of a straight drop spillway. Hydraulic design of a Chute spillway. Design of a SAF energy dissipater. Small earthen embankments and water harvesting structures. Cost estimation of structures.

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

Occurrence and movement of ground water. Aquifer and its types. Classification of wells. Steady and transient flow into partially, fully and non-penetrating and open wells. Design of open well. Groundwater exploration techniques. Design, construction and development of tubewells. Determination of aquifer parameters. Well interference. Multiple well systems. Surface and subsurface exploitation and estimation of ground water potential. Quality of ground water. Artificial groundwater recharge planning and modeling. Ground water project formulation. Water lifting devices. Types of pump. Design principles, performance curves and selection of centrifugal, submersible, turbine and propeller pumps. Selection of prime mover and pulleys. Trouble shooting in pumping sets. Priming and self priming devices. Positive displacement pumps and Hydraulic ram.

Practical: Verification of Darcy's Law. Study of different drilling equipments. Sieve analysis. Estimation of specific yield and specific retention. Testing of well screen. Drilling of a tubewell, Measurement of water level and draw down in pumped wells. Estimation of aquifer parameters. Estimating ground water balance. Studies of artificial ground water recharge structures. Positive displacement and centrifugal pumps, their installation, testing and cavitation. Performance characteristics of hydraulic ram. Study and testing of submersible pump.

SWE 405 Drainage Engineering **1+1** **Sem. I**

Drainage and familiarization with the drainage problems. Surface drainage and types of surface drainage systems. Sub-surface drainage and types of sub-surface drainage systems. Hydraulic conductivity and drainable porosity. Design of surface drains, interceptor and relief drains. Derivation of Hooghoudt's and Ernst's drain spacing equations. Design of subsurface drainage system. Drainage materials, drainage pipes, drain envelope. Layout, construction and installation of drains. Drainage structures. Vertical drainage. Bio-drainage. Tile Drains. Drainage of irrigated and humid areas. Salt balance, reclamation of saline and alkaline soils. Leaching requirements. Conjunctive use of fresh and saline waters. Economic aspects of drainage.

Practical: Determination of drainage coefficients. Installation of piezometer and observation well. Preparation of iso-bath and isobar maps. Measurement of hydraulic conductivity and drainable porosity. Design of surface and sub-surface drainage systems. Determination of chemical properties of soil and water. Fabrication and testing of drainage tiles. Gypsum requirement for land reclamation. Installation of sub-surface drainage system. Cost analysis of surface and sub-surface drainage system.

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

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

yield. Planning and execution of on farm development activities. Use of remote sensing techniques for command area development. Case studies of some selected commands. Farmer's participation in command area development. Economic aspects of irrigation and pricing of water. Preparation of project plan.

Practical: Topographic survey and preparation of contour map. Preparation of command area development layout plan. Land leveling design for a field. Earthwork and cost estimation. Irrigation water requirement of crops. Preparation of irrigation schedules. Planning and layout of water conveyance system. Design of irrigation system. Conjunctive water use planning. Application of remote sensing for command area development. Technical feasibility and economic viability of a command area project. Study tour to minor irrigation and command area development projects.

Cafeteria Courses

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

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

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

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

Past, present and future need of micro-irrigation systems. Role of Govt. for the promotion of micro-irrigation in India. Merits, demerits and types of micro-irrigation system. Micro- irrigation system- design, design synthesis, installation, and maintenance. Sprinkler irrigation - types, planning factors, uniformity, hydraulics, lateral, sub-mains and main line design. Pump and power unit selection. Drip irrigation - potential, automation and crops suitability. Fertigation - Fertilizer application criteria, suitability of fertilizer compounds, fertilizer mixing, injection duration, rate and frequency and capacity of fertilizer tank. Quality control in micro-irrigation components. Design and maintenance of polyhouse. Waste land development - hills, semi-arid, coastal areas and water scarce areas. Benefit and Cost analysis.

Practical: Study of different types of micro-irrigation systems. Field visit of micro-irrigation system. Water filtration unit. Discharge measurement study of different micro-irrigation systems. Water distribution and uniformity coefficient. Wetted front and moisture distribution. Design of micro-irrigation system for an orchard and row crops. Spray type micro-irrigation system. Micro-irrigation system for hilly terraced land. Automation in micro- irrigation system. Micro climate inside a polyhouse. Study of maintenance and cleaning of different components of various systems. Design of sprinkler and landscape irrigation system.

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

Problems and prospects of watershed management. Watershed based land use planning. Watershed characteristics. Factors affecting watershed management. Hydrologic data for watershed planning. Watershed delineation, delineation of priority watershed, water yield assessment and measurement from a watershed. Hydrologic and hydraulic design of earthen embankments and diversion structures. Sediment

yield estimation and measurement from a watershed and sediment yield models. Rainwater conservation technologies. Design of water harvesting tanks and ponds. Water budgeting in a watershed. Effect of cropping system, land management and cultural practices on watershed hydrology. Evaluation and monitoring of watershed programmes. People's participation in watershed management programmes. Planning and formulation of project proposal. Cost benefit analysis of watershed programmes. Optimal land use models. Case studies.

Practical: Study of watershed characteristics. Analysis of hydrologic data for watershed management. Delineation of watershed and measurement of area under different vegetative and topographic conditions. Measurement of water and sediment yield from watershed. Study of different watershed management structures. Study of various water budget parameters. Study of watershed management technologies. Preparation of a techno-economically effective project proposal.

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

Introduction, causes of flood occurrence. Flood classification. Flood estimation and methods of estimation. Estimation of flood peak - Rational method, empirical methods and Unit hydrograph method. Statistics in hydrology. Flood frequency methods - Log normal, Gumbel's extreme value and Log-Pearson type-III distribution. Depth-area-duration analysis. Flood forecasting. Flood routing - channel routing, Muskingum method, reservoir routing and modified Pul's method. Flood control, history of flood control, structural and non-structural methods of flood control measures. Storage and detention reservoirs, levees and channel improvement. Gully erosion and its control. Soil erosion and sediment control measures. River training works. Planning of flood control projects and their economics.

Practical: Determination of flood stage-discharge and peak-area relationships in a watershed. Determination of frequency distribution functions for extreme flood values using Gumbel's method and log-Pearson Type-III distribution. Confidence limits of the flood peak estimates for Gumbel's extreme value distribution. Probable maximum flood. Standard project flood and spillway design flood. Design of levees and jetties for flood control. Vegetative and structural measures for Gully stabilization. Designing and planning of a flood control project. Cost and benefit analysis of a flood control project.

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

Remote Sensing and stage in remote sensing. Modern remote sensing technology versus conventional aerial photography. Visual image interpretation, image interpretation, basic principles of image interpretation and factors governing the quality of an image. Factors governing interpretability. Visibility of objects. Elements of image interpretation, techniques of image interpretation, digital image processing and digital image. Remote sensing in agriculture progress and prospects. Microwave radiometry for monitoring agriculture crops and hydrologic forecasting. Aerial photo interpretation for water resources development and soil conservation survey. GIS, history of development of GIS definition, basic components and standard GIS packages. Data-entry, storage and maintenance. Data types, spatial-non-spatial (attribute data) and data structure. Data format, point line vector- raster. Polygon-object structural model. Files, files organization. Data base management systems (DBMS). Entering data in computer digitizer. Scanner-data compression.
Practical: Familiarization with remote sensing and GIS hardware. Use of instruments for aerial photo interpretation. Interpretation of aerial photographs and satellite imagery. Basic GIS operations such as image display. Study the various features of GIS software package. Scanning and digitization of maps. Data base query and map algebra. GIS supported case studies in water resources management.

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

Earthen embankments, functions, advantages and disadvantages. Classification of earthen dams. Foundation requirements and grouting. Seepage through dams, estimation of seepage discharge, location of seepage/phreatic line by graphical and analytical methods, flow-net and its properties, seepage pressure and seepage line in composite earthen embankments. Drainage filters, piping and its causes. Design and construction of earthen dam. Stability of earthen embankments against failure by tension, overturning, sliding etc. Stability of slopes and analysis of failure by slice method. Types of reservoirs and farm ponds. Design and estimation of earth work. Cost analysis.

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

shear and sudden draw down condition. Stability of slopes of earthen dams by friction circle method / different methods. Construction of flow net for isotropic and anisotropic medium. Computation of seepage by different methods. Determination of settlement of earthen dam. Input-output-storage relationships by reservoir routing. Design of farm ponds. Cost estimation of farm ponds and other structures.

Postgraduate Courses

SWE 501 Watershed Hydrology **2+1** **Sem. I**

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 techniqes 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 waterlogged 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 subsurface 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 waterlogged and saline soils.

SWE 504 Groundwater Engineering **3+0** **Sem. I**

Occurrence, storage and movement of groundwater in alluvial and hard rock formations. Stream -aquifer interaction and its parameter identification. Groundwater balance. Fluctuation of water table beneath a recharge 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**

Aquifer and fluid properties and forces responsible for water movement in soils. Porosity, permeability and differential equations of saturated and Unsaturated flow, initial and boundary conditions. Dupuit and Boussinesq approximations and linearization techniques. Stream functions, potential functions and flow

net theory, Analysis or seepage from canals and ditches. Infiltration and capillary rise flux dynamics. Hydro-dynamic dispersion in soil- aquifer system

SWE 506 Crop Environmental Engineering 2+0 Sem. II

Principles of heat, mass and momentum transport. Dynamics of water movement in Soil - Plant - Atmosphere system. Laws of electromagnetic radiation, its measurement and estimation. Profile balance of heat, mass and momentum in and above crop communities. Climatic changes and plant response to environmental stresses, measurement and estimation of potential evapotranspiration, crop coefficients and crop water requirements. ET-models, ET-yield relations. Principles of optimal scheduling of irrigation and seasonal allocation of limiting water supplies. Instrumentation and techniques for monitoring plant environments. Design and operation of controlled environment facilities and their instrumentation.

SWE 507 Design of Pumps for Irrigation and Drainage 2+0 Sem. II

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

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

Review of rainfall-runoff relationship. Measurement of rainfall, runoff and soil loss from a watershed. Probability and continuous frequency distribution; Fitting empirical distributions. Layout and planning of soil and water conservation structures including contour bunds and terraces; Gully control measures. Hydraulic jump and energy dissipaters for soil conservation structures; Hydrologic, hydraulic and structural design of drop structures. Sediment deposition process. Estimation of sediment load. Earthen dams, seepage through dams and stability analysis. Rainwater harvesting structures, design, operation and maintenance of small water harvesting structures. Flood control and stream bank protection measures.

Practical: Measurement of rainfall, runoff and soil loss from a watershed. Design of drop spillway, chute spillway, drop inlet spillway, hydraulic jump calculation, Design of earthen dam, slit detention structures. Visit to a watershed. Planning soil and water conservation structures in a watershed.

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 system. Mathematical programming techniques, linear programming, simplex method. Non-linear programming, classical optimization. Transportation problem and solution procedure. Geometric programming and dynamic programming. application of optimization techniques for water resources planning. Conjunctive use of water. Crop production functions and irrigation optimization. Multi objective water resource planning. critical path method. programme evaluation and review technique. Economic models

SWE 510 GIS and Remote Sensing for Land and Water Resource Management 2+1 Sem. II

Basic principles of Remote sensing sensors. Elements of Photogrametry. Electromagnetic spectrum. Energy interaction with surface features. Aerial Photo and satellite imagery. Photo and image interpretation. Establishment of Ground Truth. Principles of Geographical information system tools, their types and capabilities. Advantages of GIS over conventional methods. Digital Elevation model (DEM). GIS and Remote sensing for land and water resources data collection and analysis. Applications of GIS in water and land resource development and management.

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 Parallexes 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 **2+1** **Sem. II**

Concept of watershed. Status of watershed management programs in India. Problems of desertification and degradation. Concept of watershed management and sustainability, participatory approach and operational watershed. Surveys, monitoring, reclamation and conservation of agricultural and forest watersheds, hill slopes and ravines. Watershed management research instrumentation and measurement, problem identification, simulation and synthesis. Dry farming and drought management. Modeling of flood and drought phenomenon. Use of Remote sensing and GIS in watershed management and modeling. Watershed modeling approaches, mathematical bases and structure of existing watershed models. National land use policy, legal and social aspects. Case studies of watershed management.

Practical: Selection and delineation of a watershed. Benchmark surveys. Preparation of watershed land use map. Preparation of watershed development proposal. Preparation of watershed evaluation and impact assessment report. Application of watershed models for evaluation of conservation treatments. Use of Remote sensing and GIS in watershed management and modeling.

SWE 512 Land Development and Earth Moving Machinery **2+0** **Sem. I**

(in collaboration with Department of Farm Machinery and Power Engineering)

Objectives, methods and equipments for land clearing and development. Land leveling design methods, Land leveling indices. Grading of sloppy lands. Machinery selection, operating methods for vegetation types. Earth moving machinery and basic mechanics. Principles of mechanisms used in crawler mounted tractors. Trench machinery. Earth diggers and ditchers, Bull dozers and scrappers. Elevating and self powered graders. Laser guided leveler with global positioning system. Automation of earth moving and grading machines. Different methods of boring and boring machines.

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

Review of finite difference operators. Concept of linear space and basis functions. Approximating from finite dimensional sub spaces. Variational and weighted residual methods. Langrange polynomials. Triangular and quadrilateral shape functions. Isoparametric elements and transformation of coordinates. Basis functions in three dimensions. Galerkin finite element solution of Laplace, diffusion and dispersion convection equations. Method of collocation, application in surface and sub surface hydrology.

SWE 601 Advanced Hydrology **3+0** **Sem. II**

Hydrologic models, processes and systems. Uncertainty in hydrological event. Statistical homogeneity. Probabilistic concept. Frequency analysis. Probability distribution of hydrological variables. Confidence intervals and hypothesis testing. Simple and Multiple linear regressions, correlation, statistical optimization and reliability of linear regression models. Analysis of hydrologic time series and modeling. Auto-correlation, correlogram and cross-correlation analysis. Markov processes, Stochastic hydrologic models including Markov chain models. Various steps involved in formulation of statistical models and their application in hydrology.

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

Concept of soil aquifer system, flow of water in partially saturated soils. Partial differential equation of flow, pressure under curved water films, moisture characteristic functions. Determination of unsaturated hydraulic conductivity and model for it estimation. Diffusivity and its measurement. Infiltration and exfiltration from soils in absence and presence of water table. Movement of groundwater in fractured and swelling porous media. Spatial variability, theory of krigging. Statistical approaches in soil water dynamics.

SWE 603 Modeling Soil Erosion Processes **3+0** **Sem. I**

Mechanics of soil erosion. Erosion-sedimentation systems of small watersheds. Overland flow theory and simulation; Basic theory of particle and sediment transport; sediment deposition process. Modeling upland erosion and component processes. Modes of transport and transport capacity concept and computation. Channel erosion. Classification of models, structure and mathematical bases of sediment yield models. Calibration and testing of models. Erosion and sediment yield measurement, and estimates. Universal soil loss equation, its modification and revision; stochastic and dynamic sediment yield models. Reservoir sedimentation surveys and computation. Erosion control measures and their evaluation.

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, Evapo-transpiration models, simulation methods, structure of a water balance model. Overland and Channel flow simulation - modeling approaches, parameters, stream flow statistics, surface water storage requirements. Flood control storage capacity. Total reservoir capacity - surface water allocations. Ground water models. Design of nodal network, General systems frame work - Description of the model; Irregular boundaries, General - Numerical approaches. Practical: Rainfall - Runoff models, Infiltration models, ET models, Overland flow and channel flow modeling. Stanford watershed model - model parameters and input data requirements of various Hydrologic Modeling Systems. Soil Water Assessment Tool - Catchments, Simulation Hydrologic Model - use of unit hydrograph. Generalized groundwater models.

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

Review of hydrodynamics in flow through porous media. Miscible displacement, physical processes, breakthrough curves and mathematical models for miscible displacement. Hydrodynamic dispersion convection equation. Statistical models for dispersion. Concept of adsorption in solute transport. Analytical and numerical models of contaminant transport in unsaturated soil profile and groundwater aquifers.

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

Introduction to crop growth modeling. Simulation and simulation techniques. Types of models and modeling approaches. Relational diagram for principal process, structures of a generalized agricultural simulator. Input environment and techniques of monitoring plant environment, process and aspect of growth and development. Input yield models. Quantitative analysis of plant processes like photo-synthesis, respiration, growth, water uptake and their mathematical modeling.

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

Advances in surface irrigation system and modeling - surge irrigation: effect of surging on surface flow hydraulics, cab legation: water supply management. Automization and fertigation design in micro irrigation systems ; multi purpose and special uses of micro irrigation. Synthetic materials for drainage systems. Environmental issues related to drainage. Socio economic impacts of drainage systems. Controlled drainage for reducing agricultural non point pollution. Study and application of simulation models for drainage systems. Solving boundary value problem on drainage and modeling.

SWE 591 Seminar

SWE 600 Master's Research

SWE 700 Doctoral Research

B. REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM

PROGRAMMES

M. Tech.

(in collaboration with Punjab Remote Sensing Centre)

COURSE REQUIREMENTS

M.Tech.

Field of Specialization	Remote Sensing and Geographic Information System
Required Courses	RSGIS 501, RSGIS 502, RSGIS 503, RSGIS 504, RSGIS 510
Supporting Courses	Stat. 421, PGS 501 and other courses from subject matter fields (other than Minor) relating to area of special interest and research problem.
Minor Field	Computer Science and Engineering, Soil and Water Engineering, Soil Science, Forestry and Natural Resources, Agrometeorology, Agronomy, Information Technology or any other as approved by the Dean Postgraduate Studies.
Deficiency Courses	As recommended by the student's Advisory Committee and apporved by the Dean, Postgraduates Studies

DESCRIPTION OF COURSE CONTENTS

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

Overview of Remote Sensing. Interactions of EM Radiation with atmosphere and target, Atmospheric windows, Imaging Spectrometry, Principles and techniques of visual Interpretation & their keys. Types of platforms, Orbit of satellite: Kepler's law, satellite characteristic; satellites for earth observation studies. Types and classification of Sensors, Imaging modes, Characteristics of optical sensors, Sensor resolutions, Data reception and transmission, data quality and Global and Indian data products. Errors types and sources. Principles of Microwave Remote Sensing, Microwave sensors and image characteristics, Microwave Image Interpretation. Physics of Thermal Remote Sensing, Kinetic & Radiant temperature, emissivity of different material Characteristics of images and different types of available data products, Thermal Image Interpretation. Hyper-spectral Remote Sensing.

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

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

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

path, multi criteria analysis. Cloud GIS, Free and Open source tools and web resources, Decision support systems, Introduction to geodesy and its development, Earth and its size, shape, motions. Earth and its gravity field and its atmosphere, temporal variations, gravitational field of the atmosphere. GPS working principle and history, Types of receivers; GPS satellite Signals, Accuracy and error sources. GPS applications, Fundamentals of Mobile Mapping and its application.

Practical: Familiarization With GIS Software, Geo-referencing and Projection, Spatial Data Entry & Editing, Linking Spatial and Non Spatial Data, Query and Analysis, Vector Data Analysis, Network Analysis and Modeling, Output Map Generation, Exercise on Multi criteria Analysis, Field exercise on GPS data collection in stand- alone and Differential Mode, Field Exercise on Mobile mapping, Demo on Decision Support System.

RSGIS 503 Digital Image processing **2+1** **Sem. II**

Digital Image, Image Histogram, Image Display, Color Composites- FCC generation. Data and Image storage formats, Data compression, Radiometric correction, Image Rectification, Contrast Enhancement, Spatial and frequency domain filtering. Spectral Indices, Image Transformations: Principal component analysis, IHS transformation, Orthogonal transformation, Principle of Image Classification Types of Classification Schemes, Training site selection: Feature Selection & Separatability Analysis, Types of Image classification, Classification Accuracy, Image fusion, Change detection concept and algorithms. Concept of feature extraction process, Data processing techniques, spectral similarity analysis, end 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.

Practical: Familiarization with Digital Image Processing, Softwares, Importing raw data and creating Subset, Displaying Image data and identification of objects, Image Rectification and Registration, Spectral Indices & Principal Component Analysis, Ground truth collection and field exercise, Supervised/ Unsupervised Classification and Accuracy Assessment, Image Data Fusion, Change detection analysis, Exercise on Hyper-spectral data processing, Neural network/ Fuzzy Logic Classification, Microwave data processing.

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

Optics, Aerial Cameras, Types of photographs, Geometry of aerial photographs and Scale, Tilt, Relief, Displacement, Stereovision and stereoscopes, Concept of Parallax, Rotation matrix, Concept of omega, phi and kappa, Aerial triangulation, Theory of orientation, Collinearity and Co-planarity, Transformation matrices. Stereo coverage from satellite sensor, Photogrammetric solution in Satellite Photogrammetry: Data Processing for stereo generation, Polynomial Rectification, RFM/RFC Automatic DEM generation. Grid Sampling criteria, Grid re-sampling methods, DTM derivatives, Differential Rectification ortho-image/ image map generation. Types of maps: Topographic and thematic maps, basic characteristics of map, cartographic representation of geographic objects, Map projection, Types of projection, Digital mapping, Integration with Geo Spatial Data Base, Digital Cartography.

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

RSGIS 505 Agri-Informatics **2+1** **Sem. II**

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

Practical: Spectral reflectance of crops. Crop discrimination and area estimation using digital analysis. Cropping pattern & cropping indices analysis. Spectral vegetation index based yield model. Crop condition

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

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

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

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

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

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

Practical: Basin/catchment/watershed delineation, Statistical and spatial analysis of precipitation data, Surface water body mapping and water quality analysis, Estimation of surface runoff using SCS method, Estimation of climatic water balance components, Rainfall retrieval using satellite data, Irrigation command area mapping using multi-temporal satellite data, Performance evaluation of irrigation command area, Ground water targeting, Ground water modeling.

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

Need for land resource development and planning. Land use/land cover classification schemes Utility of remote sensing data for land resource management. High resolution images, various vegetation indices. Levels & Scales of mapping. Visual and digital image interpretation techniques. Classification accuracy assessment. Technologies for Large Scale Mapping (LSM) of urban areas. Total Station Differential Global Positioning System (DGPS). Issues in Large Scale Mapping. Selecting appropriate technologies and methodologies. Concept and history of cadastral survey, Cadastral survey methods and survey maintenance, cadastral map reproduction, development of cadastral information system. Governance of urban regions: mapping administrative boundaries, city base map generation, property enumeration and property GIS, tax revenue rationalisation.

Practical: Land Use /Land Cover mapping - Visual and digital analysis of satellite data. Mapping accuracy assessment. LU/LC temporal change analysis. Land Evaluation: Land irrigability classification, Land Evaluation: Land capability classification, Productivity indices and FAO method. Field work for ground truth data collections.

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

Concept of watershed. Status of watershed management programs in India. Problems of desertification and degradation. Concept of watershed management and sustainability, participatory approach and operational watershed. Surveys, monitoring, reclamation and conservation of agricultural and forest watersheds, hill slopes and ravines. Watershed management research instrumentation and measurement, problem identification, simulation and synthesis. Dry farming and drought management. Modeling of flood and drought phenomenon. Use of Remote sensing and GIS in watershed management and modeling.

Watershed modeling approaches, mathematical bases and structure of existing watershed models. National land use policy, legal and social aspects. Case studies of watershed management.

Practical: Selection and delineation of a watershed. Benchmark surveys. Preparation of watershed land use map. Preparation of watershed development proposal. Preparation of watershed evaluation and impact assessment report. Application of watershed models for evaluation of conservation treatments. Use of Remote sensing and GIS in watershed management and modeling.

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

Data base concept. Sequential, indexed sequential and random access files. Storage and retrieval of data: quarry languages. Data languages. Data validation. Use of a standard data base management package.

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

RSGIS 591 Seminar

RSGIS 600 Master's Research

Optional Courses (Course contents in the parent department)

Stat. 528	**Statistics for Image Processing**	**2+1**	**Sem. I**
Soils 512	**Environmental Soil Science**	**3+0**	**Sem. I**
Forst. 511	**Remote Sensing and GIS Applications in Forestry**	**2+1**	**Sem. I**
Forst. 512	**Land use Planning, Biometry and Forest Management**	**2+1**	**Sem. II**

CIVIL ENGINEERING

PROGRAMMES

M. Tech.

Ph. D.

COURSE REQUIREMENTS

M. Tech.

Fields of Specialization	Hydrology and Water Resources Engineering, Structural Engineering
Required Courses	CE 501, CE 502, CE 503, CE 504 for Hydrology and Water Resources Engineering CE 505, CE 506, CE 507, CE 508, CE 509 for Structural Engineering.
Supporting Courses	Stat. 421, PGS 501 and other courses from subject matter fields (other than Minor) relating to area of special interest and research problem.
Minor Field	Soil and Water Engineering, Computer Science and Engineering, Processing and Food Engineering, Mathematics, Statistics or any other as approved by Dean Postgraduate Studies.
Deficiency Courses	As recommended by the student's Advisory Committee and apporved 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 apporved by the Dean, Postgraduates Studies

DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

CE 104 Surveying and Leveling **1+2** **Sem. II**

Introduction to surveying. Classification ofsurveying. Basicprinciples. Linear measurements. Chain surveying. Compass surveying. Errors in measurements, their elimination and corrections. Plane table surveying. Levelling. Contouring. Computation of area and volume. Theodolite traversing. Elements of simple circular curve and setting of simple circular curves.

Practical: Chain survey of an area and preparation of map. Compass survey of an area and plotting of compass survey. Plane table surveying. Leveling. L-section and X-sections and their plotting. Contour survey of an area and preparation of contour map. Computation of area. Introduction of software in drawing contours. Theodolite surveying. Ranging by theodolite. Height of object by using theodolite. Setting out curves by theodolite. Use of minor instruments.

CE 203 Engineering Mechanics **2+1** **Sem. II**

Introduction to engineering mechanics. Basic concepts. Force systems. Centroid. Moment of inertia. Free body diagram. Equilibrium of forces. Frictional forces. Analysis of simple trusses using methods of joints, methods of sections and graphical method. Simple stresses. Shear force and bending moment diagrams. Bending and shear stresses in beams. Torsion in shafts. Plane and complex stresses.

Practical: Problems on Composition and resolution of forces, moments of forces, couples, centroid of simple and composite areas. Problems on moment of inertia. Equilibrium of concurrent - coplaner and non-concurrent - coplaner force systems. Simple problems involving frictional forces. Analysis of simple trusses by method of joints, method of sections and by graphical method. Problems relating to simple stresses and strains. Shear force and bending moment diagrams of beams. Bending and shear stresses in simple beams. Computation of torsional stresses in shafts. Problems related to plane and complex stresses.

CE 204 Watershed Hydrology **2+1** **Sem. I**

Introduction to water shed hydrology. Hydrological cycle. Precipitation. Measurement of precipitation. Precipitation analysis. Estimation of missing data. Infiltration. Evaporation. Evapo-transpiration. Geomorphology of watersheds. Horton's laws. Runoff. Estimation of average runoff, runoff volume and peak flow/runoff. Hydrograph. Unit hydrograph. S curve hydrograph. Dimensionless unit hydrograph. Synthetic unit hydrograph. Stream flow measurement. Flood control methods. Flood routing. Introduction to watershed management and planning.

Practical: Visit to meteorological observatory; Study of different types of rain gauges; Exercises on analysis of rainfall data. Computation of average rainfall. Optimum number of raingauges. Rainfall hyetograph. Double mass curve technique. Estimation of missing precipitation data. Rainfall frequency analysis. Intensity duration curves. Intensity duration frequency curves. Problems on stream flow measurements. Estimation of peak runoff rate and runoff volume. Problems related to hydrograph and unit hydrograph. Exercises on design and location of retards for channel improvement. Flood routing problem.

CE 205 Soil Mechanics **2+1** **Sem. II**

Introduction to soil mechanics. Phase diagram. Index properties of soil. Classification of soils. Permeability. Consolidation. Compaction. Shear Strength. Earth pressure. Introduction to bearing capacity and stability analysis.

Practical: Determination of water content of soil by oven drying method, specific gravity of soil by pycnometer method, field density of soil by core cutter method and sand replacement method. Grain size

analysis by sieving and by hydrometer method. Determination of plastic limit, shrinkage limit and liquid limit. Permeability of given soil by constant head method and variable head method. Study of compaction properties by standard proctor test. Determination of shear parameters of soil by direct shear test, unconfined compressive strength test and triaxial test. Study of consolidation properties of soils.

CE 305 Strength of Materials **2+1** **Sem. I**

(Pre-requisite: CE 203)

Introduction. Slope and deflection of beams using integration techniques, moment area method and conjugate beam method. Columns and Struts. Riveted and welded connections. Stability of masonry dams. Statically indeterminate beams. Propped beams. Analysis of fixed beams. Analysis of continuous beams using three moment theorem and moment distribution method.

Practical: Mechanical behaviour of engineering materials under loads: axial tensile, axial compressive, bending, torsion and impact. Behaviour of closely coiled helical spring in tension and compression. Determination of hardness of given specimens. Compressive and tensile strength of cement. Determination of void ratio and bulk density of cement, fine aggregates and coarse aggregates. Measurement of workability of concrete. Determination of fatigue strength of a given specimen.

CE 403 Design of Structures **2+1** **Sem. II**

(Pre-requisite: CE 305)

Introduction to design concepts. Different types of loads and use of BIS Codes (IS 800 and IS 456). Design of steel connections. Design of structural steel members in tension, compression and bending. Design of steel roof truss. Analysis and design of singly and doubly reinforced sections, Shear, Bond and Torsion. Design of Flanged Beams, Slabs, Columns, Foundations, Retaining walls and Silos.

Practical: Design of tension members, compression members and steel beams; Design and drawing of steel roof truss. Design of singly and doubly reinforced concrete rectangular beams and T beams. Design of one way and two way slabs. Design of columns, isolated footing and combined foundation. Design and drawing of a simple RCC building. Design and drawing of cantilever retaining wall.

Cafeteria Courses

CE 404 Environmental Engineering **2+1** **Sem. II**

Importance of safe water supply system. Domestic water requirements for urban and rural areas. Sources of Water supply. Intakes and transportation of water. Drinking water quality. Indian Standards of drinking water. Introduction to water treatment. Importance of sanitation. Domestic waste water: quantity, characteristics, disposal in urban and rural areas. Sewer: types, design discharge and hydraulic design. Introduction to domestic wastewater treatment. Design of septic tank. Solid waste: quantity, characteristics and disposal for urban and rural areas. Introduction to air pollution. Types of pollutants properties and their effects on living beings. ISI standards for pollutants in air and their abetments.

Practical: Determination of turbidity, pH, suspended solids, dissolved solids, total solids, temporary hardness, permanent hardness, fluorides, chlorides, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand. Collection of air samples and their analysis. Numerical problems related to theory, Visit to treatment plant.

CE 405 Building Technology & Construction Practices **2+1** **Sem. II**

Introduction of building materials. Stone. Bricks. Testing of bricks. Cement. Testing of cement. Cement concrete. Workability and strength of cement concrete. Testing of cement concrete. Reinforced cement concrete. Timber. Miscellaneous materials: plastics, fly ash, bitumen, plywood, corrugated sheets and paints. Brick bonds. Foundations. Damp Proofing Course. Floors and roofs. Doors and windows. Introduction to plumbing and drainage, low cost housing/rural housing and construction practices.

Practical: Laying out of a building in the field. Construction practices in field. Detailed drawing of a small building from measurements. Drawing of walls of various thicknesses in different bonds. Foundation drawing. Damp proof course drawing. Drawing of floors and roofs.

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 of flow. Resistance to flow. Bed load. Wash load. Suspended load. Total load. Methods 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 catchment. Sediment transport through pipes. Bed level variations in alluvial streams.

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 correlation. Cross-correlation. Covariance functions. Power spectral and cross spectral 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**

Review of free and forced vibration of single degree of freedom (SDOF) system. Response to harmonic, periodic impulsive and general dynamic loading including earth quake. Free vibration of lumped multi degree of freedom system - approximate methods for obtaining natural frequencies and mode shapes. Frequency domain analysis of lumped multi degree of freedom system using normal mode theory. Time domain analysis using numerical integration scheme. Free and forced vibration of continuous system. Introduction to the dynamics of soil structure interaction and wave propagation in the periodic structures.

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

Principles of Limit State design, Flexural strength of R. C. Sections. Strength of R. C. Sections in shear, torsion and bond. Limit state of serviceability. Inelastic design of reinforced concrete beams and columns. Analysis of continuous beams and frames. Design of steel members in tension, compression and bending. Design of aluminum members. Plastic analysis. Design of indeterminate beams and frames.

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

Concrete mix design. Rheological, physical and mechanical properties of concrete. Permeability. Volume change and creep. Gunite and shotcrete. Ferro-cement. Prestressed concrete members. Design of tension members. Pre-stressing systems and losses of prestress, design of simply supported and continuous prestressed concrete pavement. Anchorage of prestressed concrete cables. Design of piles, sleepers, slabs etc.

CE 510 Experimental Stress Analysis **2+1** **Sem. II**

Strain and stress-strain relationship. Generalized Hook's Law. Strain Gauges-Mechanical, optical, electrical, acoustical and pneumatic etc and their use. Different types of electrical resistance strain gauges. Semi-conductor strain gauges. Rosette analysis. Strain gauge circuits. Strain measurements at high temperatures. Two dimensional and three dimensional photo-elastic method of strain analysis. Bifringent coatings and scattered light in photo-elasticity. Brittle coating methods. Moiré's method of strain analysis. Grid method of strain analysis. Photo elastic strain gauges.

Practical: Problems on analysis of stress, analysis of strain, stress-strain relationship and rosette analysis. Measurement of strain with strain gauge. Photo elastic methods and

Moiré's apparatus.

CE 511 Viscous Fluid Flow **2+0** **Sem. I**

Introduction to invoid flow. Laminar boundary layer. Boundary layer along a flat plate. Blasius equation. Momentum integral theorems for boundary layer and its applications. Separation of boundary layer. Turbulent flow, Reynolds' equation and Reynolds' stress. Prandtl mixing theory. Turbulent boundary layer over a smooth plate.

CE 512 Agro Industrial Pollution Control **2+1** **Sem.II**

Introduction to agro industrial waste water. Relevant standards for wastewater. Characteristics of agro industrial liquid wastes from cannery, brewery, distillery, dairy, meat packing, sugar, fertilizers and pesticides industries. Quantity of wastewater from different industries and monitoring of its quality. Treatment processes. Principles of operation and flow diagrams of various waste treatment processes. Design to control pollution of environment. Disposal standards and disposal of waste water. Disposal of sludge.

Practical: Determination of pH, total solids, suspended solids and volatile solids; dissolved oxygen, Biochemical oxygen demand, chemical oxygen demand, turbidity colour etc. Design of treatment plant.

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

Introduction. Terminology in pollution control. Sources. Classification, quantities and characteristics of solid wastes. Collection. Transport and reduction at source. Disposal methods-open dumping, site selection, ocean disposal. Feeding to nog. Merits and demerits. Treatment methods-methods of refuse processing.

Fertilizer. Fuel and food values. Sanitary landfill, composting, incineration and pyrolysis. Recycle and reuse- Materials and energy recovery operations.

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

A general description of earth crust. Underground exploratory methods. Origin of soils. Formation of clay minerals. Bonds in clay. Fundamental structures and properties of clay minerals. Common soil minerals. Mineral composition & form. Clay water relations. Clay particles in an aqueous suspension. Clay minerals identification. Types of water inside clay. Free water. Bound water. Physical properties of clay water mix. Properties of compacted clay water systems Effect of clay minerals on engineering properties of soil viz. Permeability, swelling potential, plasticity, compressibility, sensitivity, strength. Soil admixture with lime, cement and other materials. Effect on the properties of stabilized clay soils.

CE 515 Foundation Engineering **2+1** **Sem.I**

General survey and soil investigation for foundations. Fundamentals of foundation engineering. Properties of natural soils serving as a support for foundation. Bearing capacity of soils & shallow foundations. Causes of settlement. Estimation of total and differential settlement. Plate Load Test, Standard penetration test. Spread footing, Combined footing, Mat foundation. Pile foundation. Caissons. Sheet piles and cofferdams.

Practical: Determination of bearing capacity of soil by Terzaghi theory, Meyerhof's bearing capacity theory, Hansen's bearing capacity theory, Vesic bearing capacity theory and IS Code Method. Design and detailing of foundations for different types of soils.

CE 516 Similitude in Engineering **2+1** **Sem. II**

Dimensions and units. Dimensional and similarity analysis. Theory of models. True, distorted and dissimilar models. Application to different systems with special reference to Structural and fluid flow systems, Analogues.

Practical: Equations for the period of simple pendulum. Uniform rectangular cantilever beam. Spring mass level system. Investigation of extrapolation. Deflection of a cantilever beam. Prediction of the deflection of a beam using a model. Analogue model experiments.

CE 517 Application of Finite Element Method in Structural Engineering **2+0** **Sem.I**

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 **4+0** **Sem. II**

General state of stress and strain at a point. Hooke's law. Theories of failure. Bending axis and shear centre for beams. Stresses and deflections. Case of unsymmetrical bending. Analysis of curved flexural members. Circumferential and radial stresses. Thick walled cylinders. Stress concentration. Continuous beams on elastic support. Differential equation of equilibrium. Boundary conditions. Conditions of compatibility. Use of stress function in solution of problems. Two dimensional problems in rectilinear coordinates. Use of polynomials. Solution of problems of cantilever loaded at end and simply supported beam loaded along span. Use of Fourier series. Two dimensional problems in polar coordinates. Bending of a curved bar, wedge, circular disk, infinite plate. Superposition. Reciprocal theory. Torsion of a prismatic bar.

CE 519 Theory of Plates and Shells **4+0** **Sem.II**

Bending of long rectangular plates to a cylindrical surface. Pure bending of plates. Small deflections of laterally loaded plates. Simply supported rectangular plates. Rectangular plates with various edge conditions. Plates of various shapes. Large deflection of plates. Introduction to grids. Introduction to bending theory of closed circular cylindrical shells under symmetric and asymmetric loads. Bending theory of shells of revolution under axisymmetric load. Membrane theory. Shells of general shape. Introduction of folded plates.

CE 520 Design of R. C. C. Bridges **2+1** **Sem.I**

Use of Codes. Investigation for bridges. General design considerations. Standards for Road & Railway bridges. Loads and Stresses. Design of foot bridge. Slab bridge, T-beam 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**

Mechanism of shear resistance, theories of failure and stress path. Measurement of shear strength, Drained and undrained shear strength. Shear strength as a function of effective stress. Pore water pressure parameters and their determination. Hyorslev's strength theory and its modifications. Effect of remoulding and disturbance on shear strength. Bearing capacity theories. Improvement of soil. Stability of slopes.

Practical: Problems related to shear strength determination by direct shear test, unconfined compressive strength test and triaxial test. Measurement of shear strength under UU, CU and CD conditions. Vane shear test. Stability of Finite slopes by Swedish Circle & Friction Circle Method.

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

Dynamic loading on structures due to wind, earthquake, blast, moving loads and water waves. Dynamic response of buildings. Tall Structures and Bridges. Codal provisions for design against earthquake and wind. Dynamic response of submerged, tall structures. Response due to wave induced loading. Structure- fluid interaction. Hydrodynamic pressure in water retaining structures and dams.

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

Planning of industrial structures. Exploration of the site. Elements of an industrial building. Design steps of industrial building. Design of single and multiple industrial structures in steel and concrete. Bunkers and silos, Pressure vessels and chimneys, Cooling towers, Large span roof structures, Suspension roof structures. Machine foundation.

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

General considerations. Gravity systems in buildings. Lateral systems for buildings. Wind effects. Seismic Design. Structural systems and concepts. Criteria & loadings. Matrix and approximate methods. Interaction of frames-shear wall frames. Twist of frames. Analysis of coupled shear walls. Effect of openings, Large panel construction. Foundation super structure interaction. Earthquake effects and design for ductility. Construction, planning and management of projects. Safety aspects of tall buildings.

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 freedom system. Response to linear single and multi-degree of freedom system to stationary and non-stationary random excitation Response of continuous systems. Normal mode method. Non-linear random vibration. Level crossing. Peak and envelope statistics. First excursion and fatigue failures. Applications to mechanical, aero, civil, ocean and agricultural engineering systems.

CE 591 Seminar

CE 600 Master's Research

CE 700 Doctoral Research

MECHNAICAL 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 apporved 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 apporved by the Dean, Postgraduates Studies

DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

ME 103 Engineering Drawing **0+2** **Sem. I**

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

ME 104 Workshop Practice **0+1** **Sem. II**

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

ME 105 Thermodynamics and Heat Engines **3+1** **Sem. II**

Thermodynamic properties, closed and open system, flow and non-flow processes, gas laws; Zeroth law of thermodynamics and temperature measurement; First law of thermodynamics- internal energy, work and heat, application in non-flow and steady flow processes; Second law, Kelvin-Planck and Claussius statements, reversible process, carnot cycle, carnot theorem, entropy, change of entropy in thermodynamics processes; gas and vapour, change of phase during constant pressure process, triple point and critical point, generation of steam, internal energy and entropy of steam, steam tables and Mollier chart, heating and expansion of vapour in non-flow processes, measurement of dryness fraction, classification of boilers, Cochran, Lancashire, Locomotive and Babcock- Wilcox boilers, mountings and accessories; Rankine cycle, desirable properties of working fluid used for power plants, Expansive and non expansive working. Steam Engine, saturation curve and missing quantity, governing of simple steam engine, calculations of cylinder dimensions. Introduction to compound steam engines. Otto, Diesel and Dual cycles, air standard efficiency, other engine efficiencies and terms., calculation of efficiency, mean effective pressure and their comparison. Measurement of IP, BP and heat balance calculations (not involving combustion). Engine performance.

Practical: Study of boilers and their mountings and accessories; Study and test on steam engine; measurement of dryness fraction of steam; Study of I.C. engines including valve timing diagrams of 2 and 4-stroke engines; Performance test on 2- cylinder diesel engines; Performance test and heat balance test on a diesel engine; To conduct Morse test on multi-cylinder petrol engine; Comparison of different temperature measuring methods; To verify inverse square and Stefan-Boltzman law of radiation; To determine the emissivity of a given material.

ME 106 Thermodynamics **2+0** **Sem. II**

Thermodynamic properties, closed and open system, flow and non-flow processes, gas laws; laws of thermodynamics, internal energy. Application of first law in heating and expansion of gases in non-flow processes; First law applied to steady flow processes. Kelvin-Planck and Claussius statements. Reversible processes, Carnot cycle, Entropy, Change of entropy of gases in thermodynamics processes. Difference between gas and vapour, change of phase during constant pressure process, Generation of steam, triple point and critical point. Internal energy and entropy of steam, Use of steam tables and Mollier chart,

heating and expansion of vapour in non-flow processes, measurement of dryness fraction, Classification of steam boilers, mountings and accessories.

ME 205 Workshop Technology **2+1** **Sem. I**

(Pre-requisite: ME 104)

Introduction to welding, types, gas welding, types of flames, welding techniques and equipment. Arc welding, equipment and tools. Casting processes. Classification, constructional details of Center Lathe, Accessories and Attachments, operations and tools used. Types of shapers, Constructional details of shaper. Work holding devices, shaper tools and main operations. Types of drilling machines. Constructional details of pillar types and radial drilling machines. Work holding and tool holding devices. Main operations. Twist drills, drill angles and sizes. Types and classification. Constructional details and principles of operation of column and knee type universal milling machines. Plain milling cutter. Main operations on milling machine.

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

ME 206 Heat and Mass Transfer **2+0** **Sem. II**

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

ME 207 Theory of Machines **2+1** **Sem. II**

(Pre-requisite: ME 103)

Elements, pairs, kinematics chain, mechanism, their classification. inversions of mechanisms. Velocity, acceleration-graphical method. Instantaneous centers. Gears, types, nomenclature, law of gearing, teeth profile, interference/undercutting. simple, compound, reverted, and epicyclic gear trains, analysis by tabular method. Flywheel, turning moment diagrams, size. Belts, flat and V belts, materials, power transmitted, size, centrifugal tension, creep and slip. Chain drives. Friction, types, laws, pivots and collars, single disc, multiple disc, and cone clutches. Rolling friction. Governors, Watt, Porter, Proell governors, Effect of friction, terms relating to governor. Static and dynamic balancing. Balancing of rotating masses in one and several planes. Partial primary balancing of reciprocating masses.

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

ME 303 Fluid Mechanics **2+1** **Sem. I**

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

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

ME 304 Hands on Training in CAD/CAM and Machine Drawing **0+3** **Sem. II**

(Pre-requisite: ME 103)

Introduction. Manual drawing from models and isometric views. Drawing of missing views. Sectioning. Sectional drawing of simple machine parts. Types of rivet heads and joints. Symbols for welded joints. Thread profiles. Representation of threads. Types of nuts, bolts, lock nuts, studs, machine screws, cap screws and wood screws etc. Definition and benefits of CAD, CAD system components. Computer hardware for CAD. Line generation. Points and lines, Polygons, filling of polygons. Text primitive. Other primitives. Windowing and clipping, view port. Homogeneous transformations. Planar and space curves design. Analytical and synthetic approaches. Parametric and implicit equations. B-spline and Beizer curves. Geometric modeling techniques. Wire frames. Solid modeling. Introduction to numerical control, basic components of NC system, NC coordinates and motion control systems. Computer numerical control, direct numerical control, combined CNC/DNC. NC machine tools and control units. Tooling for NC machines, part programming, punched tape, tape coding and format, manual and computer assisted part programming.

ME 311 Instrumentation and Process Control **2+1** **Sem. I**

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

Introduction, definition, recorders and monitors, panel boards. General characteristics of instruments, static and dynamic characteristics. Temperature and temperature scales., various types of thermometers-mercury-in-glass, bimetallic, pressure-spring thermometers, thermocouples, resistance thermometers and pyrometers. Pressure and pressure scales, manometers, pressure elements, differential pressure. Liquid level measurement, different methods of liquid level measurement. Flow measurement, kinds of flow, rate of flow, total flow differential pressure meters, variable area meters Transmission. Pneumatic and electrical. Control elements, control actions pneumatic and electrical control systems.

Practical: Study of instrumentation symbols. Measurement of temperature by different thermometers, pressure by U tube manometer (inclined tube manometer), liquid level in the tank with the help of bob and tape, Determination of relative humidity by wet and dry bulb thermometer. Measurement of velocity of fluid by using venturimeter/orificemeter/pitot tube, RPM of an electric motor by tachometer, wind velocity by anemometer, intensity of sunshine by sunshine recorder. Characteristics of valve, PI performance, T, P flow and level close leak control system.

ME 402 Machine Design **2+1** **Sem. II**

(Pre-requisite: ME 207)

Design, phases, considerations. Mechanical properties of engineering materials. Types of loads and stresses, theories of failure, Stress concentration, fatigue and creep. Cotter, knuckle and pinned joints, turn buckle. Design of welded joints subjected to static loads. Design of threaded fasteners subjected to direct static loads, bolted joints loaded in shear or subjected to eccentric loading. Design of shafts under torsion and combined bending and torsion. Design of keys, muff/sleeve, rigid flange couplings, helical and leaf springs,

flat belt and V-belt, pulleys, gears, brackets, levers, columns, thin cylindrical and spherical shells, curved beams, crane hooks, circular rings, etc.. Design of screw motion mechanisms like screw jack, lead screw, etc. Selection of antifriction bearings.

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

ME 403 Refrigeration and Air Conditioning **2+1** **Sem. I**

(Pre-requisite: ME 105)

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

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

Postgraduate Courses

ME 501 Viscous Flow and Convective Heat Transfer **3+0** **Sem. II**

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

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

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**

Kinematics of mechanisms, analysis and synthesis, mobility, systematic of mechanisms, deriving other mechanisms from linkages, Relative motion, instantaneous center method, Kennedy's theorem. Graphical

and analytical methods of kinematic analysis, Computer - Aided analysis of mechanisms. Synthesis of linkages for path generation, function generation, Graphical techniques. Relative pole method and method of inversion. Analytical kinematics synthesis of linkages, Freudenstein's method, Loop closure equations based on complex variable approach, Gears and their motion-Analysis and Synthesis of epicyclic gear trains. Cams-follower system; standard follower motions and combinations, importance of follower acceleration in cam system dynamics, terms related to cam design - their importance. Cam synthesis - graphical cam profile layout for a desired follower motion. Analytical determination of cam profile co-ordinates for disc cam operating common types of follower.

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**

Vibration motion and its terminology. Undamped free vibrations, equations of motion- natural frequency. Energy method, Rayleigh method; effective mass principle of Virtual work. Equivalent spring stiffness in parallel and in series. Harmonic analysis and Fourier Series. Damping - viscous, solid, coulomb equivalent dampers. Viscosity damped free vibrations, Logarithmic decrement. Forced vibrations with harmonic excitation and rotating unbalance, Energy dissipated by damping. Forced vibration with damping, Vibration isolation and force and motion transmissibility. Two degree of freedom systems. Principal modes of vibration, co-ordinate coupling. Vibration absorbers, Free vibration equation of motion for multi-degree of freedom systems. Influence coefficients and Maxwell's reciprocal theorem, stiffness coefficients. Numerical methods for finding natural frequencies for multi-degree of freedom systems. Vibration of lumped parameter systems and continuous systems. Lagrange equations. Vibration measuring instruments, Vibrometers, velocity pickups, Accelerometer and frequency measuring instruments. Applications of vibrations. Vibration control, balancing of rotating and reciprocating machines, design of vibration isolators.

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; thermo electric systems, Thermoionic converter.

ME 507 Fatigue Design **2+1** **Sem. II**

Theories of failure, maximum normal stress, maximum shear stress and distortion energy theory, failure of ductile materials, failure of brittle materials. Stress concentration and its evaluation, stress concentration

of ductile and brittle materials under static loading and under dynamic loading, determining geometric stress concentration factors, designing to avoid stress concentration. Fatigue of machine components, mechanism of fatigue failure, fatigue failure models and their considerations in design of machine elements, fatigue loads. Fatigue testing and presentation of fatigue data. Influence of stress conditions on fatigue strength/endurance limit of metals. Low and high cycle fatigue and cumulative fatigue damage. Designing for finite and infinite life. Improving fatigue resistance of machine elements. Stress corrosion. Corrosion fatigue.

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, Microgeometry of bearing surfaces, self-aligning, floating bushings, high speed and vibration-proof bearings, Lubricants and lubrication systems, types and properties of additives used in lubricants, antifriction (Rolling- elements) bearings, types of rolling element bearings, co-efficient of rolling friction, allowable peripheral speeds, load-carrying capacity and durability, selection of bearing series, high speed bearings, high temperature bearings, design of ball and roller bearings and their lubrication. Mounting of rolling bearings on shafts and installation in the housings.

ME 510 Industrial Heat Transfer **3+0** **Sem. I**

Three modes of heat transfer. Conduction in solids. Derivation of general equation of conduction in rectangular, cylindrical and spherical coordinates, steady-state heat conduction in one dimension through a plane wall, a cylinder and a sphere with and without heat generation, heat transfer from extended surfaces, heat conduction with two or more independent variables. Unsteady state heat conduction. Convection: dimensional analysis approach, physical significance of dimensionless parameters, similarity parameters from differential equations, review of Navier Stokes equations and dimensional analysis applications, external flow over bodies, internal flow through bodies. Radiation: processes and properties, view factor, radiation between black and grey surfaces, radiation combined with convection and conduction. Types of heat exchangers, overall heat transfer coefficient, heat exchanger analysis using Log Mean Temperature Difference and Effectiveness-NTU method for parallel, counter, multipass and cross-flow heat exchangers, methodology for heat exchanger calculation, compact heat exchangers, passive and active heat transfer enhancement methods in heat exchangers.

ME 511 Refrigeration Systems **3+0** **Sem. I**

Reversed Carnot cycle, Carnot, Brayton and Aircraft refrigeration systems, Vapour compression refrigeration systems; Use of p-h chart, Effect of pressure changes on COP, sub cooling of condensate on COP and capacity, super heating, Single stage, multi- stage and cascade systems. Vapour absorption systems: Theory of mixtures, temp- concentration and enthalpy concentration diagrams, Adiabatic mixing of two systems, Diabatic mixing, Throttling process, Ammonia water and water lithium bromide systems. Centrifugal and steam jet refrigeration systems. Thermoelectric refrigeration systems, its

advantages, comparison with vapour compression system, Vortex tube refrigeration system, its thermodynamic analysis. Ultra low temp refrigeration. Ejection and Centrifugal refrigeration. Water refrigeration and steam jet refrigeration, its characteristics, effect of boiler efficiency on overall COP actual steam jet system and two fluid jet refrigeration.

ME 512 Ideal Fluid Flow **3+0** **Sem. I**

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

ME 513 Solar Energy Utilization **3+0** **Sem. I**

Extra-terrestrial radiation, atmospheric attenuation, radiation intensity. Solar geometry, basic angles and derived angles, incidence angle on general inclined surfaces, irradiance on titled surfaces. Flat plate collectors, top loss coefficient, heat removal factor, performance of flat plate collectors, all glass collectors. Evacuated solar collector, solar air heating systems, types of concentrators, non tracking and tracking concentrators; linear and point focusing concentrators, tracking methods, Solar distillation, effect of various parameters on distillate output, other designs of solar still, Storage of solar energy. Rock bed storage, Latent heat storage, Photovoltaic systems. Analysis of solar ponds and solar stills, solar crop dryings systems. Other applications of solar energy like greenhouse, biogas plant, solar cooker.

ME 514 Steam Power Engineering **2+I** **Sem. II**

Fuels and their properties, combustion, stoichiometry. Types of combustion processes, flame temperature, flame structure, flame propagation and stability. Furnaces and burning equipment burners, cyclone and fluidized combustion, stokers. Design of combustion equipment. Boilers and their accessories. Heat exchangers, superheaters and reheaters, economizers, air pre-heaters, feed water heaters, evaporators and condensers. Steam turbines, impulse and reaction turbine. Velocity diagram and work done, stage efficiency, multi-staging and bleeding. Steam consumption and conservation.

Practical: Proximate and ultimate analysis of fuel. Fuel gas analysis. Boiler performance (heat balance). Steam balance and steam distribution system in a sugar mill. Performance 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**

Formulation of conduction heat transfer problem; lumped system analysis, criteria for lumped system analysis, heat transfer in lumped systems, transient heat conduction in large plane walls, long cylinders and spheres, transient heat conduction in semi-infinite solids, transient heat conduction in multi-dimensional systems, integral and differential formulation, Differential equations of Bessel and Legendre. Extended surfaces, Steady two and three dimensional systems; analytical and numerical methods. Transient heat conduction: analytical methods, approximate methods and numerical methods and their significance. Single and multi- dimension problems. Semi-infinite media. Solids with 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 duct flow. Transition to turbulence. Wall turbulence; internal and external flow. Laminar natural convection. Natural convection in enclosures. Influence of temperature-dependent fluid properties. Forced convection through porous media. Special heat transfer problems; heat transfer in liquid metals and heat transfer with phase change.

ME 603 Design of Solar Energy Systems **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**

Detonation and deflagration waves of premixed gases: Rankine-Hugoniot relations, the Hugoniot curve and its properties. Determination of Chapman Jouguet detonation waves velocity. One dimensional and multi-dimensional detonation wave structure. Deflagration to detonation transition in gaseous mixtures. Limits of detonability. Theory of Premixed laminar flames: Mallard and Le Chatelier's thermal theory, Comprehensive theory of Zel' dovich, Frank Kamenetky and Samenov and diffusion theory of Tonford and Peace. Flame velocity and flame speed stabilization of combustion wave in laminar storms. Flame quenching and flammability limits. Gaseous diffusion flames: Burke Schumann's theory of laminar diffusion flames, flame shape and flame height. Laminar diffusion flame jets and laminar Jet mixing. Turbulent flames: Mass weighted conservation and transport equations. Spray combustion systems, characteristics and models developed for spray combustion processes. Combustion of solid particles in fluidized bed.

ME 591 Seminar

ME 600 Master's Research

ME 700 Doctoral Research

ENERGY STUDIES FOR AGRICULTURE

PROGRAMME

Ph.D.

COURSE REQUIREMENTS

Field of Specialization	Energy Science and Technology
Required Courses	EST 601, EST 602, EST 603
Supporting Courses	Courses from subject matter fields (other than Minor) relating to area of special interest and research problem.
Minor Field	Farm Machinery and Power Engineering, Soil and Water Engineering, Processing and Food Engineering, or any other as approved by the Dean Postgraduate Studies.
Deficiency Courses	As recommended by the student's Advisory Committee and apporved by the Dean, Postgraduates Studies

DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

EST 302 Renewable Energy **1+1** **Sem. II**

(For the students of College of Agriculture)

Energy sources- Introduction and classification. Types of biogas plants and utilization of biogas. Agricultural wastes. Principles of combustion, pyrolysis and gasification. Types of gasifiers. Producer gas and its utilization. Briquettes- briquetting machine, uses of briquettes. Solar energy- solar flat plate and focusing plate collectors. Introduction to solar air heaters, cookers, water heating systems, grain dryers, refrigeration system, ponds, lantern, street lights, fencing and pumping systems. Wind energy- types and application of wind mills. Liquid bio fuels- biodiesel and ethanol from agricultural produce and its uses.

Practical: Constructional details of biogas plants. Constructional details of different types of gasifiers. To study and find the efficiency of solar cooker, dryers, domestic water heater. Performance of wind mills. Field visit to biogas plants and wind mills. Bio-diesel preparation.

EST 303 Renewable Energy Sources **2+1** **Sem. I**

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

Practical: Determination of calorific value; Estimation of ash content of biomass, moisture content of biomass, fixed carbon and volatile matter of biomass; Demonstration of down draft throat-less rice husk

gasifier, down draft gasifier with throat, working of a fixed dome type biogas plants, floating drum type biogas plants, biodiesel preparation; Measurement of basic solar parameters; Demonstration of solar water heater, photovoltaic cell and solar cooker.

Cafeteria Courses

EST 402 Renewable Energy Technologies **2+1** **Sem. II**

Design and operational parameters, performance evaluation and maintenance aspects of different renewable technologies like gasifiers, biogas plants, solar passive heating devices, photovoltaic cells and arrays, briquetting machines and balers; bio-diesel utilization in CI engines.

Practical: Performance evaluation of solar water heater,solar cooker; Characteristics of solar photovoltaic panel; Evaluation of solar air heater/dryer; Performance evaluation of a rice husk throat-less gasifier engine system, down draft gasifier with throat for thermal application, a fixed dome type biogas plant and floating drum type biogas plant; Estimation of calorific value of producer gas; Testing of diesel engine operation using biodiesel; Evaluation of briquette and briquetting machine using biomass material.

Postgraduate Courses

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

Energy resources on the farm: conventional and non-conventional forms of energy and their use. Heat equivalents and energy coefficients for different agricultural inputs and products. Pattern of energy consumption and their constraints in production of agriculture. Direct and indirect energy. Energy audit of production agriculture, and rural living and scope of conservation. Identification of energy efficient machinery systems, energy losses and their management. Energy analysis techniques and methods: energy balance, output and input ratio, resource utilization, conservation of energy sources. Energy conservation planning and practices. Energy forecasting, Energy economics, Energy pricing and incentives for energy conservation, factors effecting energy economics. Energy modeling.

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

Energy cycle of the earth; water flow and storage; ocean currents and tides. Energy heat flow and energy storage; photosynthesis and biomass; renewable energy sources. Thermodynamics of energy conversion; conversion of solar energy, wind energy, water flows, heat, biomass, etc.; other conversion processes. Development and use of biogas, alcohols and plant oils, plant oil esters in I.C. engines. Study of various parameters for measuring the performance of the I.C. Engines. Design of bio-fuel production units: design of gasifiers, gas flow rates, bio-gas plants. Establishment of esterification plant, fuel blending.

EST 503 Energy from Biomass **2+0** **Sem.I**

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

EST 504 Energy and Environmental Issues **2+0** **Sem.II**

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

EST 601 Agricultural Energetics **2+0** **Sem. II**

Energy requirements for agricultural inputs like Fertilizers and manures, Pesticides, Machinery and

fuel, Irrigation, Labour, Land, Transportation, Draft animals etc.; Agricultural energetic factors, energy norms and their computations; energy analysis: methods, problems and limitations; energy analysis of household activities, crop and livestock production systems including poultry and piggery; use of alternate energy sources for agricultural purposes; Evaluation of alternate energy sources and specific practices, substitution of energetic factors amongst themselves.

EST 602 Biomass Energy Conversion 2+1 Sem.I

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

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

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

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

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

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

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

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

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

EST 591 Seminar

EST 700 Doctoral Research

ELECTRICAL ENGINEERING AND INFORMATION TECHNOLOGY

A. ELECTRICAL ENGINEERING

PROGRAMMES

M. Tech.

Ph. D.

COURSE REQUIREMENTS

M. Tech.

Field of Specialization	Electrical Engineering
Required Courses	EE 501, EE 502, EE 503, EE 504
Supporting Courses	Stat.421, PGS 501 and other courses as recommended by the student's Advisory Committee
Minor Field	Computer Science and Engineering or any other as recommended by the student's Advisory Committee and apporved by the Dean, Postgraduates Studies
Deficiency Courses	As recommended by the student's Advisory Committee and apporved 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 apporved by the Dean, Postgraduates Studies

DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

EE 203 Electrical Circuits **2+1** **Sem. I**

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

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

EE 204 Electrical Machines **2+1** **Sem. I**

(Pre-requisite EE-203)

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

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

EE 302 Electronics and Instrumentation **2+1** **Sem. II**

(Pre-requisite EE-204)

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

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

Postgraduate Courses

EE 501 Applied Electronics **2+1** **Sem. II**

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

Practical: Study of Characteristics of Semiconductor Devices, Study of Amplifier Circuits, Oscillator Circuits, Operational Amplifiers, Design of Filters, Study of Various Logic Gates and Digital ICs. Development and testing of electronic systems.

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 toll 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**

Review of Primary Sensing Elements and Transducers, Signal Conditioning: Instrumentation amplifiers. Low-level DC/AC amplifiers. Filters: Low pass, High pass, Band Pass, Band Reject, Active Filters; Bridge Circuits, attenuators, compensators and discriminators, Integrators and differentiators, Function generators, A/D and D/A converters. Resolution and Quantization, Sampling, Signal transmission: Data Transmission & telemetry: Modulation Techniques, TDM, FDM, Bandwidth and Noise Restrictions. Digital displays, recorders. Power supplies, SMPS. Data acquisition systems, Review of 8085 Microprocessor/ 8051 microcontroller and Microprocessor /Microcontroller- based instrumentation systems.

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**

Introduction to Process Control - Control strategy, single variable and multi variable control systems, Process Control loop, Open loop and closed loop control system, Linear and non linear control system. Determining the Transfer function of Complex Control System, Representation of a Control System by block diagram and its Reduction Characteristics. Process Equation. Controlling and Controlled Variable. Transient & steady state response, Self Regulation Property, Control System Parameters, Evaluation of control System. Controller Modes or actions - ON/OFF Mode, Proportional Mode, Integral Mode, Derivative Mode, Composite control Modes. Pressure regulation, Liquid level and Temperature control Systems. Signal Conditioning, Design of OP AMPS 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 **2+1** **Sem. I**

Transducer principles. Displacement Transducers- Potentiometer, LVDT, Piezoelectric and Capacitive transducers, digital transducers. Velocity transducers - Analog and Digital. Acceleration and Force transducer. Torque, Power and Energy measuring techniques. Temperature measurement using Bi-metals, PTRs, Thermisters, Thermocouples, Electronic IC sensors and Pyrometers. Heat flux and Humidity

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

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

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

Operating systems: Evolution, fundamentals. Processes: Description and Control, Threads, Concurrency, Deadlock; Memory management: Requirements, Partitioning, Paging, segmentation, allocation considerations, Virtual Memory, Device management: I/O Devices, Buffering, Operating System design Issues. Files Management: File Organization, Directories, Sharing, Record Blocking, Secondary Storage Management. Scheduling: Types and Algorithms, Distributed systems: Distributed processing, client Server and Clusters, Distributed process management. Security.

EE 507 / CSE 507 Design of Micro-computer Systems **2+1** **Sem. II**

Digital logic families. Microcomputer organization. Software program planning, programming in high level and symbolic languages. Interfaces and peripheral devices. Microprocessor-based system development aids. Design methodology and applications. Microprocessors with advanced architecture. Technology assessment.

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

EE 508 Linear System Analysis **2+0** **Sem. I**

Review of linear algebra. Laplace transformation, Laplace Transform theorems, Inverse Laplace Transformation, Solution of Linear differential equations by Laplace transform Methods, Discrete Time system and the Z-transform Methods, Z-transforms. Mathematical Models of Physical Systems. Use of graph theory, linearization. Transient and Steady State Response analysis. Stability. Controllability and Observability. State estimation. Computer aided solutions.

EE 509 Methods of Optimization **3+0** **Sem. I**

Parameter optimization. Linear programming, Application of Linear Programming Methods Formulation of LPPs, Solutions of LPP: Graphical, Simplex Method, Big M Method, 2- Phase Method. Duality in Linear programming, Dual Simplex Method, Integer programming, Sensitivity analysis. Network analysis in project planning - CPM, PERT, application of Network techniques, cost analysis and crashing of Network. Transportation problems. Assignment problems. Dynamic programming: Approach, Formulation and solution. Direct search methods. Gradient methods. Optimization under uncertainty and risk.

EE 510 Optimal Control **3+0** **Sem. I**

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

EE 511 Maintenance Management **2+0** **Sem. I**

Reliability: hazard rate, mean time between failures. System reliability: series, parallel and mixed configurations. Economics of introducing a standby or redundancy into a production system. Maintainability. Replacement decisions: age replacement policy, replacement policies to minimize downtime, economics of preventive maintenance. Inspection decision: optimal inspection frequency for profit maximization, minimization of downtime and availability maximization. Overhaul and repair decisions. Optimal overhaul/ repair/replace maintenance policies for equipment subject to breakdown. Spares provisioning.

EE 512 Direct Energy Conversion **2+0** **Sem. I**

Solar energy and its utilization. Solar cells. Thermo- electric and thermo ionic devices. Fuel cells. Magneto-Hydrodynamic energy conversion.

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

Mathematical preliminaries. System concepts. Systems methodology. Modeling of agricultural systems and operations. Response of systems. Elements of optimization. Computer as a tool in systems analysis.

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

General configuration and functional description of measuring systems. Signal flow graphs and block diagram reduction. Dynamic characteristics of instrumentation systems. Operational transfer functions. Error constants and sensitivity. Frequency and transient response. Stability criteria. Nyquist, Root locus and Bode analysis and design. Principles of stochastic methods in instrumentation design. Sample data systems analysis.

Practical: Determination of dynamic characteristics of instrumentation systems.

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

Non-linear systems and their analysis by linearization, describing function, piece-wise linear, phase plane: Delta Method and perturbation methods; Methods of constructing trajectories and obtaining time solution from Phase Plane plots; Numerical solution of ordinary differential equations- Bisection Method, Newton Raphson method, Gauss Jordon method, Cayley Hamilton Theorem; Stability of non-linear systems: Kiosovskii Method, Variable Gradient method. Saturation, dead zone and time delay. Time varying systems and their analysis.

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, Dijkastra Algorithm, Graph Traversal: Depth First and Breadth First; Spanning Forests, Symmetrical Directed, Connected Graphs, Minimum Spanning Trees. Large scale system modelling. Mass energy based economic models. Hierarchical systems. Simulation exercises of agricultural energy and other socio-economic systems. Case studies.

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

Mathematical preliminaries. Performance index approach to dynamic systems. Notion of optimum parameters. Control strategies. Parameter optimization by steepest descent, conjugate gradient, Davidsons' and Newton's search methods. Optimum controls and strategies. Newton-Kantorovich method for minimization of non-linear functions. Gradient and conjugate direction methods in function spaces. Optimization of trajectories.

EE 591 Seminar

EE 600 Master's Research

EE 700 Doctoral Research

B. COMPUTER SCIENCE AND ENGINEERING

PROGRAMMES

M. Tech.

COURSE REQUIREMENTS

M. Tech.

Field of Specialization	Computer Science and Engineering
Required Courses	CSE 501, CSE 502, CSE 503, CSE 504
Supporting Courses	Stat.421, PGS 501 and other courses as recommended by the student's Advisory Committee
Minor field	Electrical Engineering or any other as recommended by the student's Advisory Committee and apporved by the Dean, Postgraduates Studies
Deficiency Courses	As recommended by the student's Advisory Committee and apporved by the Dean, Postgraduates Studies

DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

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

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

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

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

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

Importance of computerization and IT in food industries, role of computers in optimization, introduction to operations research, linear programming problems, modeling of food technology systems and operations, graphical solution, simplex method, degeneracy and duality in linear programming, transportation problems, assignment problems, project management using PERT/CPM.

Practical: Applications of IT to solve the problems of food technology: use solution to linear programming problems using graphical, simplex, Big M and two phase methods, degeneracy, transportation and assignment solution in food industry. Computation of critical path, slacks and floats in PERT/CPM. Visit to Industry and knowledge of computer.

CSE 204 Computer Programming and Data Structures **0+3** **Sem. I**

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

CSE 302 Systems Engineering **2+1** **Sem. II**

System Concepts, System approach to Agricultural Engineering. Linear Programming Problems. Canonical and Standard forms of LPP, Mathematical formulation. Mathematical Models of physical system, modeling of Agricultural system and operations. Graphical method, Simplex Method, Artificial variable techniques, Big M method and two phase methods. Degeneracy and Duality in Linear problems. Transportation Problems, Assignment Problems. Network Analysis in Project Planning by PERT/CPM. Network (Arrow Diagram) Logic Numbering and Events (Fulker Son's Rule) PERT Computation in Tabular form. Crashing the Networks.

Practical: Solving the Linear programming Problems using Graphical method, Simplex method. Practice with transportation problems, Assignment problems and PERT /CPM. Crashing the networks problems.

CSE 303 Practical Training in Web Applications **0+2** **Sem. II**

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

Postgraduate Courses

CSE 501 Computer Engineering **2+1** **Sem. I**

Review of basic digital circuits and codes. Digital computer components. Memories. Instructions and digital computer operations. Arithmetic and control sections. Input-output equipment. Design of a selected system.

Practical: Application of logic gates in half and full - adders. Code converters and display devices. Study of computer systems with logic analyzer.

CSE 502 Computer Graphics **2+1** **Sem. I**

Graphic display devices, Interactive devices; Line and circle plotting techniques using Bresenham's algorithm, Windowing and clipping, Sutherland Cophen algorithm, Cyrus and Beck method, Mid-point subdivision algorithm. Curve drawing using Hermite Polynomial, Bezier curve, B-Splines; Picture Transformation, translation, rotation, Scaling and Mirroring; 3D Graphics, 3D transformation, rotation about an arbitrary axis. Curved surface generation, Hidden surface removal. Orthogonal Projection and multiple views, Isometric projection, Perspective projection, 3D Clipping. Generation of solids, Sweep method, Interpolation, Graphic Standards, CGS Modeling, Applications of Computer Graphics. Practical: Writing and testing of graphical algorithms. Use of graphics application packages.

CSE 503 Software Engineering **3+0** **Sem. II**

Software development cycle. Analyzing a software problem, designing and programming solution, testing results, making changes. Project planning. Requirement analysis: fundamentals and methods. Software design fundamentals. Data flow oriented design. Data structure oriented design. Programming languages and coding. Software quality assurance. Software testing techniques. Software testing strategies. Software maintenance and configuration management. Introduction to software reliability and selected models.

CSE 504 Computer Networks **2+0** **Sem. I**

Introduction, history and development of computer networks, networks topologies. Message and packet switching, data communication nodes and message handling, flow control. Protocols, interprocessor communication, terminal handling, Routing algorithms. Analysis, performance, optimization and design of networks. Random access channels; packet broad-casting; satellite communication. Study of networks: ETHERNET, ARCNET etc.

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**

Operating systems: evolution, fundamentals. Processes: Description and Control, Threads, Concurrency, Deadlock; Memory management: Requirements, Partitioning, Paging, segmentation, allocation considerations, Virtual Memory, Device management: I/O Devices, Buffering, Operating System design Issues. Files Management: File Organization, Directories, Sharing, Record Blocking, Secondary Storage Management. Scheduling: Types and Algorithms, Distributed systems: Distributed processing, client Server and Clusters, Distributed process management. Security.

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**

Introduction to database concepts. Data models, data normalization and data independence. Computer file types, filer creation, mapping, searching, sorting, merging, updating. Application and use of a database management package. Database utilities for back up, re-organization and host language calls. Linking databases with other software.

Practical: Data base design for simple problems.

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

Overview of file organization techniques - sequential, direct, indexed, hashed and inverted files. B-trees. Data models - relational, network and hierarchical. Relational model, relational algebra, relational calculus and normal forms, object oriented data base. Implementation of query languages. Basic concepts of network and hierarchical model, data security and protection of data. Recovery methods. Concurrent operations on data bases. Introduction to distributed data base systems. Case Studies.

CSE 510 Introduction to Computer Science **2+1** **Sem. I**

Computer organization: Instruction sets, buses, I/O channels, Interrupt processing, associative memories. System programming: Assemblers, linkers, loaders, editors, command processors, system call interface.

Operating systems: Scheduling process management. Data base structures: filter organization (ISAM, sequential, direct, B-trees.), Database models (relational, hierarchical, network).

Practical: Application of compilers, assemblers, linkers, loaders, editors and command processors.

CSE 511 Computer Architecture **2+0** **Sem.II**

Review of basic computer organization, impact of operating systems and programming languages on computer architecture. CPU design, Computer arithmetic, memory management, bit-slice architectures, interconnection, networks, data flow machines, RISC architecture, special purpose architectures.

CSE 512 System Programming **3+0** **Sem. II**

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

CSE 513 Artificial Intelligence **3+0** **Sem. II**

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

CSE 514 Expert System Design **3+0** **Sem. II**

Introduction to expert system: Types of expert systems; Nature of expertise and knowledge acquisition; Preparation/interview analysis cycle. Knowledge analysis techniques - epistemic nets, analysis and structures, Interpretation model technique. Project management for expert systems: Case Studies.

CSE 515 Computer Methods in Engineering **0+3** **Sem. II**

Introduction to computer hardware and operations, operating system, introduction to programming and numerical techniques, spreadsheet based application, simulation, modeling and optimization, data base management, graphics application, computer based instrumentation for data acquisition and control.

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

Introduction to neural network and its comparison with biological system. Perceptron and linear separable functions, multi-layers perceptrons. Back propagation, one basic learning algorithm for feed-forward neural network, variation and improvement for back-propagation algorithm, Generalisation of learning algorithm. Recurrent Networks: Hopefield networks and Boltzmann Machine. Unsupervised learning and self organized features maps. Application of neural network in function approximation, time series predictions, pattern recognition, control systems and optimization in engineering problems.

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

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 apporved by the Dean, Postgraduates Studies

PGDCA*

Fields of Specialization	Information Technology
Required Courses	IT 501, IT 502
Supporting Courses	MGT 511 or any other as recommended by the student's Advisory Committee
Minor Field	–
Deficiency Courses	–

***Requirements**

i) Major field courses	21
ii) Supporting courses	03
iii) Project research	08
Total	**32**

DESCRIPTION OF COURSE CONTENTS

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

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

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

IT 502 Operating System **3+1** **Sem. I**

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

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

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

Fundamentals of networking, overview of network topologies, classifications of networks. Introduction to the internet, advantages and disadvantages of internet, electronic mail, gopher, world wide web, Usenet, telecommunication networks, bulletin board service, wide area information service. Introduction to HTML, comparing static and dynamic web designing, elements, versions, designing a web page, text formatting & alignment, font control, arranging text and lists, background image & colors, images in web pages, method of linking, frames, user input using forms, event handling, Applying style formats using Style sheets, types of SS, external and inline and embedded style sheets. Java script introduction, variables, control statements, JavaScript arrays, methods, client side validations, embedding JavaScript, future of JavaScript. Server side scripting, installing and configuring web server, creating DSN, database interaction using server side scripts, database connectivity using DSN and DSN less, retrieving and searching data, adding and modifying contents of database.

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

IT 504 Dynamic Web Development **3+1** **Sem. II**

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

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

IT 505 Multimedia and Applications **2+1** **Sem. I**

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

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

IT 506 Relational Data Base Management System **2+2** **Sem. II**

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

Practical: E-R diagram construction, SQL, version of SQL, commands syntax, data types, DDL statements, DML statements, DCL statements, TCL statements, having clauses, order by and where clause, wild cards, operators, integrity constraints, primary key, reference key, check, unique, not null, index and views, sequences, functions, aggregate functions, numerical, string, date and time, sub queries, nesting of queries, normalization of database and case study on a database design and implementation. PL/SQL, variables, control structures, decisions and loops, exception handling, creating functions and procedures, cursors, implicit and explicit cursors, triggers.

IT 507 Visual Programming **1+2** **Sem. II**

Visual fundamentals, building your first application, developing applications in visual programming, working in the visual programming environment, using the intrinsic controls, working with projects, working with properties, deploying visual applications, advanced programming, debugging, creating controls, using active x controls, your applications, database programming, database basics and the data control. Making reports, enhancing the programming using the advanced data controls.

Practical: Programs for loops, typecasting. Developing user friendly programs in visual environment / platform on Linux/windows, methods and events, programming using data types, constants and variables, making statements in a program, working with conditional statements, working with loops, working with arrays, working with strings and typecasting, the elements of visual environment, creating menus, forms and dialog boxes, handling keyboard and mouse input, working with time and timers, adding graphics, writing reusable code with subs and functions, saving and retrieving data. Accessing Databases using advance Data control.

IT 508 Programming in C++ **2+2** **Sem. II**

Introduction to C++, character set, constants, variables and keywords and their types. Operators, type conversion. Control statements, conditional expression. Declaration of variables, statements, simple C++ program, manipulator functions, I/O stream flags. Functions, types of functions, local and global variables, default arguments, multifunction program. Storage class specifiers, pre-processor, header files and standard functions. Arrays, declaration, initialization, processing with array, array with functions, strings and their functions. Overview of classes and objects, definition, structures and classes, member functions, defining object, accessing a member, array of class objects, classes within classes. The I/O library and file handling, operations on files.

Practical: Programs on use of decision making statements in C++,using iterations and arrays, multidimensional array, input output manipulators, predefined manipulators and user defined manipulators, formatted and unformatted input output functions, set precision, user defined objects, defining function, return statement, Classes and Objects, using constructors and destructors in classes, object as a member, Member Functions, call and return values, passing parameters, actual and formal arguments, recursion, I/O library files, macros, stream buffers, istream, ostream and fstream, file handling, saving files on disk, reading contents from files, editing files, apply file modes, type of files.

IT 509 Data Structures and Algorithms **3+1** **Sem. I**

Overview of data structures, basic concepts, data organization, description of various data structures. Programming design and development. Algorithms, programming constructs algorithm complexity, big O notation, and concept of recursion. Arrays and matrices, stack, stack insertion and deletion, queue, circular queues, priority queues, link list, Representation and processing of linear linked lists, multiple linked structures, creating link list, inserting and deleting link nodes from a list, circular link list, doubly link list, Trees, traversing a tree, traversal methods, depth, level and height of a tree, binary tree, BST, AVL tree, threaded binary trees, M-Way search trees, B-Tree, heaps, multi way trees. Graphs, demonstrating graphs in memory, operations on graphs, applications of graphs. Searching and sorting, searching, linear search and binary search algorithm, hash list searches, collision resolution. Bubble sort, selection sort, insertion sort, radix sort, merge sort algorithm, quick sort, heap sort, shell sort.

Practical: Implementation of various types of structures, programs for array and multidimensional arrays, linked lists, doubly linked lists, circular linked lists, queue, de- queue, stack and tree, in-order, preorder and post-order tree traversals, string processing, searching and sorting techniques, graph and geometric algorithms and case studies.

IT 510 Core Java **1+2** **Sem. I**

Features of java, java and internet, java and www, hardware and software requirements, java support systems, java environment, java classes, access modifiers, managing classes and calling methods, inheritance, overloading, packages & interfaces, exception handling, multiple catch statements, finally statement, creating user defined exceptions, multithreading, thread control methods, thread life cycle.

Practical: Programs on java classes, methods, string class, decision making control statements, looping control statements, jumping statements, vectors, operators, arrays, multidimensional arrays, passing arrays to functions, array of objects, string handling in java, string functions, inheritance, types of inheritance, inheritance accessing modes, runtime and compile time binding, packages, importing classes and packages, interfaces, runnable interfaces, exception handling, types of exceptions, throwing exceptions, catch and try block, multiple catch blocks, finally keyword, multi threading, prioritizing the threads, Designing applets in WebPages, Extending applet class, I/O applets, importing classes and packages, extending applet class.

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

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

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

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

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

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

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

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

Elementary algorithmic, problem and instances, the efficiency of algorithms, average and worst case analyses, some examples, asymptotic notation, analysis of algorithms, greedy algorithms, general

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

IT 515 Information and Network Security **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 Defense, Most Common Attacks, Scripts Kiddies and Packaged Defense, Standards for network and information security, areas of standards, national and international initiatives for standards, ISO,BIS, Types And Sources Of Network Threats, Denial-of-Service, Unauthorized Access, Executing Commands Illicitly, Confidentiality Breaches, Destructive Behavior, Secure Network Devices, Secure modems, crypto capable routers, Virtual private networks.

IT 516 Soft Computing **2+0** **Sem. I**

Introduction to neural networks, working of an artificial neuron, linear seperability, perception training algorithm, back propagation algorithm, adalines and madalines. Introduction to soft-computing tools, fuzzy logic, genetic algorithm, neural networks and probabilistic reasoning, difference between human brain and neural brain, rough sets. Applications of fuzzy logic concepts in knowledge management. Optimization problem solving using genetic algorithm. Neuron as a simple computing element, the perceptron, multilayer neural networks, neural network approaches in data analysis, design and diagnostics problems, and applications of probabilistic reasoning approaches.

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 **1+0** **Sem. I,II**

Overview of the IT legal system in India. Intellectual properties, copyrights, patents, privacy, computer forensics. Access Control : Operating system Access Controls, Group and Roles, Access Control lists, Operating System Security , Capabilities, Granularity, Sandboxing and Proof-carrying code, Hardware protection, Other technical Attacks.

IT 520 Network Programming **2+1** **Sem. I,II**

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 **2+1** **Sem. I,II**

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).

Practical: Use of XML / PHP for designing web portals for agricultural informatics. Managing Session, using session variables and cookies, open source database connectivity (MySQL), CSS for designing web portals, managing users authentication, security issues on server side, managing user and passwords.

IT 522 Content Management **1+2** **Sem. I,II**

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**

Network management architecture. Installing Windows Server, registry, control panel, Network applications, TELNET, FTP, Wired and wireless networking standards. Microwaves, infrared, base band and broadband transmission. Network design and consideration, wired networks, wireless networks, network administration, system restoration. Simple network management protocol (SNMP), RMON 1, RMON 2. Management tools, systems and applications.

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**

Java AWT, Java AWT Package Container, Basic User Interface Components, Layouts. Java I/O Handling, I/O File Handling, File Input Stream, File Output Stream, File Class, Random Access File. Socket Programming, Introduction, TCP/IP Protocol, UDP Protocol, Ports, Using TCP/IP Sockets, Using UDP Sockets. Database Connectivity using JDBC, JDBC/ODBC bridge, Driver Manager Class, Java SQL Package, SQL Exception class. Remote Method Invocation, N-tier Architecture, Locating and loading Remote classes, Enabling remote method class, RMI Architecture, Naming, Remote Interface, Unicast Remote Object, Socket Vs RMI programming. Java Servlets, Introduction to Server Side Technologies, Servlet Life cycle, HttpServlets, GenericServlets, init(),service(), doGet(), doPost(), destroy(), Servlets and JDBC.

Practical: GUI problems using Java for Network, Java Connectivity with Web pages, Socket Programming, InetAddress Class, IP address resolver, Server socket, Datagram sockets, TCP sockets, stream sockets, Handling bytes, multicast sockets, JDBC connectivity, Loading database driver, oracle JDBC connection, Creating a JDBC Statement object, executing SQL statements.

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

I. Basic Sciences and Humanities		**Cr. Hrs.**
Chem. 205	Engineering Chemistry	2+1
Eng. 102	Comprehension and Communication Skills in English	1+2
Math. 211	Engineering Mathematics-I	2+1
Math. 212	Engineering Mathematics-II	2+1
Math. 311	Engineering Mathematics-III	2+1
Mgt. 422	Agribusiness Management and Trade	3+0
Mgt. 423	Introduction to Entrepreneurship and Marketing	2+1
Pbi. 101	Basic Punjabi	0+2(NC)
Pbi. Cul. 101	Punjabi Culture	2+0(NC)
Phy. 203	Engineering Physics	2+1
II. Agriculture		
Agron. 105	Agriculture for Engineers	3+1
Env. 301	Environmental Science	3+0
III. Home Science		
HD 106	Human Values in Education	1+1
IV. Agricultural Engineering		
CE 104	Surveying and Levelling	1+2
CE 203	Engineering Mechanics	2+1
CE 204	Watershed Hydrology	2+1
CE 205	Soil Mechanics	2+1
CE 305	Strength of Materials	2+1
CE 403	Design of structures	2+1
CSE 204	Computer Programming and Data Structures	0+3
EE 203	Electric Circuits	2+1
EE 204	Electrical Machines	2+1
EE 302	Electronics and Instrumentation	2+1
EST 303	Renewable Energy Sources	2+1
FMP 206	Field Operation and Maintenance of Tractors and Farm Machinery-I	0+1
FMP 303	Farm Machinery and Equipment-I	2+1
FMP 304	Farm Machinery and Equipment-II	2+1
FMP 305	Tractors and Automotive Engines	2+1
FMP 306	Field Operation and Maintenance of Tractors and Farm Machinery-II	1+1
FMP 403	Tractor Systems and Controls	2+1
FMP 404	Tractor Design and Testing	2+1
ME 103	Engineering Drawing	0+2
ME 104	Workshop Practice	0+1
ME 105	Thermodynamics and Heat Engines	3+1
ME 205	Workshop Technology	2+1

ME 206	Heat and Mass Transfer	2+0
ME 207	Theory of Machines	2+1
ME 303	Fluid Mechanics	2+1
ME 402	Machine Design	2+1
ME 403	Refrigeration and Air Conditioning	2+1
PFE 202	Engineering Properties of Biological Materials and Food Quality	2+1
PFE 305	Crop Process Engineering	2+1
PFE 306	Drying and Storage Engineering	3+1
PFE 404	Dairy and Food Engineering	2+1
PFE 405	Agricultural Structures and Environmental Control	2+1
PFE 406	Food Packaging Technology	2+1
SWE 304	Irrigation Engineering	3+1
SWE 305	Soil and Water Conservation Engineering	2+1
SWE 306	Soil and Water Conservation Structures	2+1
SWE 404	Groundwater, Wells and Pumps	2+1
SWE 405	Drainage Engineering	1+1
SWE 406	Minor Irrigation and Command Area	2+1

Project and Practical Training Courses

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

Cafeteria Courses

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

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

PFE 409	Food Processing Plant Design and Layout	2+1
SWE 407	Design and Maintenance of Greenhouse	2+1
SWE 408	Micro Irrigation Systems Design	2+1
SWE 409	Watershed Planning and Management	2+1
SWE 410	Gully and Ravine Control Structures	2+1
SWE 411	Remote Sensing and GIS Application	2+1
SWE 412	Reservoir and Farm Pond Design	2+1
Stat. 203	Engineering Statistics	2+0

Pre-requisites for courses

Sr No.	Course No.	Pre-requisites
1.	EE 204	EE 203
2.	EE 302	EE 204
3.	CE 305	CE 203
4.	CE 403	CE 305
5.	ME 205	ME 104
6.	ME 207	ME 103
7.	ME 304	ME 103
8.	ME 402	ME 207
9.	ME 403	ME 105
10.	SWE 305	CE 204
11.	SWE 306	SWE 305
12.	FMP 305	ME 105
13.	FMP 306	FMP 206
14.	FMP 404	FMP 403

SEMESTER-WISE STUDY PROGRAMME OF B.Tech (Agril. Engg.)

FIRST YEAR

SEM I			SEM II		
Math.	211	2+1	Env.	301	3+0
Phy.	203	2+1	CE	203	2+1
Chem.	205	2+1	ME	104	0+1
CSE	204	0+3	CE	104	1+2
ME	103	0+2	Math.	212	2+1
Agron.	105	3+1	ME	105	3+1
EE	203	2+1	Eng.	102	1+2
Pbi. 101/ Pbi. Cul.101		0+2 / 2+0(NC)	HD	106	1+1
NSS/NSO/NCC		0+1(NC)	NSS/NSO/NCC		0+1(NC)
		21(11+10) +3(NC)			22(13+9)+1(NC)

SECOND YEAR

SEM III			SEM IV		
CE	204	2+1	ME	207	2+1
EE	204	2+1	ME	206	2+0
Math.	311	2+1	EE	302	2+1
ME	205	2+1	SWE	305	2+1
FMP	206	0+1	FMP	303	2+1
SWE	304	3+1	PFE	305	2+1
PFE	202	2+1	CE	205	2+1
NSS/NSO/NCC		0+1(NC)	Edu. Tour		0+1
			NSS/NSO/NCC		0+1(NC)
		20(13+7)+1(NC)			20(14+6)+2(NC)

Third Year

SEM V			SEM VI		
ME	303	2+1	ME	402	2+1
CE	305	2+1	CE	403	2+1
SWE	306	2+1	PFE	405	2+1
FMP	304	2+1	SWE	404	2+1
FMP	305	2+1	FMP	306	1+1
PFE	306	3+1	PFE	404	2+1
Mgt.	422	3+0	FMP	403	2+1
		22(16+6)			20(13+7)

Fourth Year

SEM VII			SEM VIII		
ME	403	2+1	Proj. II		0+3
EST	303	2+1	Seminar		0+1
Mgt.	423	2+1	Econ.	428	0+3
SWE	405	1+1	ME	304	0+3
SWE	406	2+1	CSE	303	0+2
PFE	406	2+1	Cafeteria course I		4+2
FMP	404	2+1	Cafeteria course II		
Proj. I		0+3	Industrial training		0+6(NC)
		23(13+10)	In-house training-I		0+3 (NC)
			In-house training-II		0+3(NC)
					18(4+14)+12(NC)

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