SECTION VIII

FACULTY OF AGRICULTURAL ENGINEERING AND TECHNOLOGY

General Information

Disciplines

- Farm Machinery and Power Engineering
- Processing and Food Engineering
- Soil and Water Engineering
- Remote Sensing and GIS
- Civil Engineering
- Mechanical Engineering
- Energy Science and Technology
- Electrical Engineering and Information Technology
  - (A) Electrical Engineering
  - (B) Computer Science and Engineering
  - (C) Information Technology
- Course curriculum for B.Tech. (Agri. Engg.) 4 year programme

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 so 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 graduated in 1969. The undergraduate teaching was initially handled by the Departments of Agricultural Engineering, Civil Engineering, Electrical Engineering and Mechanical Engineering. The Department of Agricultural Engineering was trifurcated in 1974 into the Departments of Farm Power and Machinery (now Farm Machinery and Power Engineering), Soil and Water Engineering, Processing and Agril. Structures (now Processing and Food Engineering). The School of Information Technology (SIT), established in 2009 in the University, was made an integral part of the College in 2010. After merging the Department of Electrical Engineering and SIT, the School of Electrical Engineering and Information Technology was created in 2012. The Training Unit and the Farm Machinery Testing Centre are also operational in the College which tests the manufactured machinery as per BIS standards. The College has state of the art

infrastructure and well equipped undergraduate and postgraduate laboratories. The Placement Cell of the College has excellent track-record resulting in the employment of the students by several multi national companies and government departments. The Alumni Association of the College is highly active and its inter-active website is functional within the website of the Punjab Agricultural University, Ludhiana.

With the growth of the College, M.Tech. and Ph.D. programmes were started in different disciplines keeping in view the employment needs of the students and beneficiaries like industry, public sector and farmers of the State. The M.Tech programme in Remote Sensing and GIS was started in collaboration with Punjab Remote Sensing Centre, Punjab from the academic session 2012-13. The B.Tech (Agril. Engg.) admission is made on the basis of JEE (Main) conducted by the CBSE, where as the PG admission is made on the basis of merit list prepared through written test and interview at PAU level and ICAR PG test.. The undergraduate and postgraduate programmes have duly been recognized by ICAR. The revision of course curricula is a continuous process. The revised B.Tech. (Agril. Engg.) programme in the light of the recommendations of the Vth Deans' Committee (ICAR) has been adopted from the session 2016-2017. The model curricula and the revised/restructured PG programmes as per the recommendations of the National Core Group (ICAR) was introduced in the academic session 2010-2011. The curricula have sufficient components of engineering disciplines, basic sciences, agricultural sciences, practical and hands on training. The newly included Student READY programme as per ICAR guidelines has been introduced.

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

FARM MACHINERY AND POWER ENGINEERING

PROGRAMMES

M. Tech.

Ph.D.

COURSE REQUIREMENTS

M.Tech.

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

DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

FMP 51 Farm Mechanization **2+1** **Sem. I**

(For students of Diploma in Agriculture)

Familiarization with sources of power used at the farm. Internal Combustion (IC) engines and terminology. Working principles of two stroke and four stroke engines. Different systems of tractors, types and selection. Maintenance of prime movers and agricultural machinery. Safety on the farm and on the road. Duties of the tractor driver/ operator while on the road. Mandatory and cautionary signs. Offences, penalties and procedure. Mensuration. Weights and measures. Cost of operation of tractor and machinery. Mechanics of machines. Introduction to agricultural machinery including precision farming. Introduction to post-harvest equipment. Familiarization with farm structures. Rural sanitation. Log books.

Practical: Main parts of diesel engine (two stroke and four stroke) and their functions. Daily maintenance of prime movers and their safety aspects. Various systems of tractor. Working of bio-gas plant and solar equipment. Field measurements. Study of various parts of agricultural machines and processing equipment along with their functions. Tractor driving and operation of agricultural machines and hauling operation. Repair and maintenance of various machine, their adjustment and performance parameters.

FMP 102 Farm Machinery and Power **1+1** **Sem. II**

(For students of College of Agriculture)

Status of Farm Power in India, Sources of Farm Power, Internal Combustion (IC) engines and its working, IC engine terminology, comparison of two and four stroke cycle engines, Study of IC engine systems: air cleaning, fuel, lubrication, cooling etc. and solved problems. Familiarization with tractor power transmission systems. Tractor types. Cost analysis of tractor power and attached implements. Familiarization with Primary and Secondary Tillage implements. Implements for hill agriculture. Familiarization with sowing and planting equipment, calibration of a seed drill and problem solving Familiarizations with transplanters. Familiarization with equipment for plant protection and inter cultural operations. Familiarization with harvesting and threshing equipment.

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

FMP 201 Tractor and Farm Machinery Operation **0+1** **Sem. I**

Familiarization with different makes and models of agricultural tractors. Identification of various functional systems including air supply, fuel, cooling, transmission, steering and

hydraulic systems. Maintenance points to be checked before starting a tractor. Familiarization with controls on a tractor. Safety rules and precautions to be observed while driving a tractor. Practice of driving a tractor and with tillage tools (Primary/Secondary tillage implements) and their adjustment in the field. Field patterns while operating a tillage implement. Hitching and de-hitching of mounted and trailed type implements to the tractor. Practice for driving of a trailed type trolley: forward and in reverse direction.

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

Introduction to farm mechanization. Classification of farm machines. Unit operations in crop production. Identification and selection of machines for various operations on the farm. Hitching systems and controls of farm machinery. Calculation of field capacities and efficiencies. Calculations for economics of machinery usage. Comparison of ownership with hiring of machines. Introduction to seed-bed preparation and its classification. Familiarization with land reclamation and earth moving equipment. Introduction to machines used for primary, secondary, rotary, deep and minimum tillage. Measurement of draft of tillage tools and calculations for power requirement for the tillage machines. Identification of major functional components of tillage machines: mould-board plough, disc plough, chisel plough, sub-soiler, harrows, cultivators, rotavator, laser land leveler. Attachments with tillage machinery. Introduction to sowing, planting & transplanting equipment. Identification of major functional components of seed drills, no-till drills, strip-till drills, happy seeder, planters, bed-planters and paddy transplanters. Study of types of furrow openers and metering systems in drills and planters. Calibration of seed-drills/ planters. Adjustments during operation. Introduction to materials used in construction of farm machines. Introduction to heat treatment processes and their requirement in farm machines. Properties of materials used for critical and functional components of agricultural machines. Introduction to steels and alloys for agricultural application.

Practical: Familiarization with different farm implements and tools. Study of hitching systems, Problems on machinery management. Primary and secondary tillage machinery: construction, operation, adjustments, calculations of power and draft requirements. Sowing and planting equipment: construction, types, calculation for calibration and adjustments. Transplanters: paddy, vegetable etc. Identification of materials of construction in agricultural machinery and study of material properties. Heat treatment processes subjected to critical components of agricultural machinery.

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

Study of sources of farm power: conventional and non-conventional energy sources. Classification of tractors and IC engines. Review of thermodynamic principles of IC (CI & SI) engines and deviation from ideal cycle. General energy equation and heat balance sheet. Mechanical, thermal and volumetric efficiencies. Engine components, their construction, operating principles and functions. Engine strokes, 2- stroke and 4-stroke engine cycles. CI and SI engines. Engine valve systems, valve mechanism, valve timing diagram and valve clearance adjustment. Cam profile, valve lift and valve opening area. Importance of air cleaning system. Types of air cleaners and performance characteristics of various air cleaners. Fuel supply system. Fuels, properties of fuels, calculation of air-fuel ratio. Tests on fuel for SI and CI engines. Detonation and knocking in IC engines. Carburetion system, carburetors and

their main functional components. Fuel injection system: injection pump, their types, working principles. Fuel injector nozzles: their types and working principle. Engine governing: need of governors, governor types and governor characteristics. Lubrication system: need, types, functional components. Lubricants: physical properties, additives and their application. Engine cooling system: need, cooling methods and main functional components. Thermostat valves. Additives in the coolant. Radiator efficiency. Ignition system of SI engines. Electrical system including battery, starting motor, battery charging, cut-out, etc. Comparison of dynamo and alternator. Familiarization with the basics of engine testing.

Practical: Introduction to different systems of CI engines: engine parts and functions, working principles etc. Study of valve system: construction and adjustments. Determination of physical properties of oil and fuels. Air cleaning system. Fuel supply system of SI engine. Diesel injection system & timing. Cooling system, fan performance, thermostat and radiator performance evaluation. Part load efficiencies and governing. Lubricating system. Starting and electrical system. Ignition system. Tractor engine heat balance and engine performance curves. Visit to engine manufacturer/ assembler/ spare parts agency.

FMP 306 Farm Machinery and Equipment-II 2+1 Sem. I

Introduction to plant protection equipment: sprayers and dusters. Classification of sprayers and sprays. Types of nozzles. Calibration of sprayers. Introduction to intercultural equipment. Study of weeders: functional requirements, types and main components and functional requirements. Familiarization of fertilizer application equipment. Harvesting operation: terminology, principle of cutting and harvesting methods. Mowers: types, constructional details, working and adjustments. Study of shear type harvesting devices: cutter bar, inertial forces, counter balancing, terminology, cutting pattern. Reapers, binders and windrowers: principle of operation and constructional details. Importance of hay conditioning, methods of hay conditioning and baling and calculation of moisture content of hay. Introduction to threshing systems: manual and mechanical systems. Types of threshing drums and their applications. Types of threshers: tangential and axial flow, their constructional details and cleaning systems. Factors affecting thresher performance. Grain combines: terminology, classification, material flow and computation of grain losses. Study of combine troubles and troubleshooting. Chaff cutters and capacity calculations. Straw choppers and combines: working principle and constructional details. Study of root crop diggers: principle of operation, blade adjustment and approach angle, calculation of material handled. Potato and groundnut diggers. Cotton harvesting machinery: different mechanisms, pickers and strippers, functional components. Study of maize de-husking cum shelling machinery and harvesting combines. Introduction to vegetables and fruit harvesting equipment and tools.

Practical: Familiarization with plant protection and intercultural equipment. Study of sprayers, types and functional components. Dusters, types and functional components. Calculations for chemical application rates. Nozzle types and spray pattern using patternator. Familiarization with manual and powered weeding equipment and identification of functional components. Fertilizer application equipment including manure spreaders and fertilizer broadcasters. Various types of mowers, reaper and reaper binder. Functional components of mowers and reapers. Familiarization with threshing mechanisms and cleaning systems. Calculations of losses in threshers. Familiarization with functional units of grain combines and their types. Calculations for grain losses in combines. Root crop diggers and

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

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

Study for need of transmission system in a tractor. Transmission system: types, major functional systems. Clutch: need, types, functional requirements, construction and principle of operation. Familiarization with single plate, multi-plate, centrifugal and dual clutch systems. Gear box: gearing theory, principle of operation, types, functional requirements and calculation for speed ratio. Differential system: need, functional components, construction, calculation for speed reduction. Need for a final drive. Brake system: types, principle of operation, construction, calculation for braking torque. Steering system: requirements, steering geometry characteristics, functional components, calculation for turning radius. Familiarization with Ackerman steering. Steering systems in track type tractors. Hydraulic system in a tractor: principle of operation, types, main functional components, functional requirements. Familiarization with the hydraulic system adjustments and ADDC. Tractor power outlets: PTO, PTO standards, types and functional requirements. Introduction to traction and traction terminology. Theoretical calculations of shear force and rolling resistance on traction device. Wheels and tyres: solid and pneumatic tyres, construction and specifications. Study of traction aids. Tractor mechanics: forces acting on the tractor. Determination of CG of a tractor. Determination and importance of moment of inertia of a tractor. Tractor static equilibrium, tractor stability especially at turns. Determination of maximum drawbar pull. Familiarization with tractor as a spring-mass system. Ergonomic considerations and operational safety. Introduction to tractor testing deciphering of codes.

Practical: Introduction to transmission systems and components. Study of clutch functioning, parts and design problem on clutch system. Types of gear boxes, calculation of speed ratios, design problems on gear box. Differential, final drive and planetary gears. Brake systems and some design problems. Steering geometry and adjustments. Hydraulic systems in a tractor, hydraulic trainer and some design problems. Appraisal of various controls in different makes of tractors in relation to anthropometric measurements. Determination of location of CG of a tractor. Moment of Inertia of a tractor. Traction performance of a tractor wheel.

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

Introduction to tractor maintenance: precautionary and break-down maintenance. Tractor starting with low battery charge. Introduction to trouble shooting in tractors. Familiarization with tools for general and special maintenance. Introduction to scheduled maintenance after 10, 50, 100, 250, 500 and 1000 hours 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 of implements: adjustment of functional parameters in tillage implements. Replacement of broken and worn-out components in tillage implements. Replacement of furrow openers and blades of rotavators. Maintenance of cutter bar in a reaper. Adjustments in a thresher for different crops. Replacement of V-belts on implements. Setting of workshop for agricultural machinery.

Elective Courses

FMP 411 Tractor Design and Testing 2+1 Sem. II

Procedure for design and development of agricultural tractor. Study of parameters for design of balanced tractor for stability and weight distribution. Traction theory. Hydraulic lift and hitch system design. Design of mechanical power transmission in agricultural tractors: single disc, multiple disc and cone clutches. Rolling friction and anti-friction bearings. Design of Ackerman and hydraulic steering. Study of special design features of tractor engines and their selection: cylinder, piston, piston pin, crankshaft etc. Design of seat and controls of an agricultural tractor. Tractor testing.

Practical: Design problems of tractor clutch system: single and multiple discs. Design of gear box: constant mesh, synchro-mesh and variable speed drive. Selection of tractor tires and problem solving. Problems on design of governor. Design and selection of hydraulic pump. Engine testing as per BIS code. Draw bar 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. Air cleaner and noise measurement test. Visit to tractor testing center/industry.

FMP 412 Farm Machinery Design and Production 2+1 Sem. II

Introduction to design parameters of agricultural machines and design procedure. Characteristics of farm machinery design. Research and development aspects of farm machinery. Design of standard power transmission components used in agricultural machines: mechanical and hydraulic units. Introduction to safety in power transmission. Application of design principles to the systems of selected farm machines. Critical appraisal in production of agricultural machinery. Advances in material used for agricultural machinery. Cutting tools including CNC tools and finishing tools. Advanced manufacturing techniques including powder metallurgy, electro-discharge machining (EDM). Heat treatment of steels including pack carburizing, shot-peening process etc. Limits, fits and tolerances. Jigs and fixtures. Industrial lay-out planning. Quality production management, reliability. Economics of process selection. Familiarization with project report.

Practical: Familiarization with different design aspects of farm machinery and selected components. Solving design problems on farm machines and equipment. Jigs and fixtures: study in relation to agricultural 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. Visits to agricultural machinery and tractor manufacturing industry.

FMP 413 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 and traction prediction equation. Introduction to traction and mechanics, off road traction and mobility, traction models. Traction improvements: tyre size, tyre lug geometry and their effects, tyre testing. Soil compaction and plant growth. Variability and application of GIS in soil dynamics.

Practical: Measurement of static and dynamic soil parameters related to tillage, puddling and floatation. Draft for passive, rotary and oscillating tools. Slip and sinkage under dry and wet

soil conditions. Load and fuel consumption for different farm operations. Weight transfer and tractor loading including placement and traction aids. Studies on tyres, tracks and treads under different conditions, soil compaction and number of operations.

FMP 414 Ergonomics and Safety **2+1** **Sem. II**

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

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

FMP 415 Hydraulic Drives and Controls **2+1** **Sem. II**

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 circuits, fittings and connectors. Pumps: classifications, operation, performance, displacement. Design of gear, vane and piston pumps. Hydraulic actuators, cylinders, construction and applications, maintenance, hydraulic motors. Valves: pressure, directional and flow-control valves, valve installation, valve failures and remedies, valve assembly. 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 hydraulic and pneumatic drives in agricultural systems, Introduction about programmable logic controls (PLCs).

Practical: Introduction to hydraulic systems. Study of hydraulic pumps and actuators. Study of hydraulic motors, valves, colour 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 416 Precision Agriculture and System Management **2+1** **Sem. II**

Precision Agriculture: need and functional requirements. Familiarization with issues relating to natural resources. Familiarization with equipment for precision agriculture: laser guided land levelers, precise sowing and planting machines, variable rate sprayers, yield monitoring system and moisture sensor for grain combines etc. Introduction to GIS based precision

agriculture and its applications. Introduction to different soil and plant sensors. Application of GPS based navigators and sensors for data handling in agricultural machinery management. System concept and approach in farm machinery management, problems on machinery selection, maintenance and scheduling of operations. Application to PERT and CPM for machinery system management

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

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

Introduction to biomass management, biomass resource assessment techniques, supply chains. Processing of paddy straw: densification, extrusion process, pellets, mills and cubes. Baling: machines, classification and uses. Residue management for surface mulch and incorporation: paddy straw choppers and spreaders, straw managing system as an attachment to combine harvester, mulch seeder, forage chopper cum loader etc. Processing of straw/fodder for animal use, agricultural and horticultural use, cushioning material for fruits and vegetables, mulching and composting, paper and cardboard manufacturing, straw as a fuel.

Practical: Familiarization with different straw management techniques: on-farm and off- farm uses of straw, collection, loading and transport equipment's 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.

FMP 418 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 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. Problems related to selection of equipment, replacement, break- even analysis, etc. Presentation of seminar on topic assigned related to farm machinery management. Design of farm mechanization plan for different farm size and cropping pattern.

Postgraduate Courses

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

Research and development procedure in farm equipment and agricultural tractors. Design problems and application in typical farm equipment and other organizations. Design analysis

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

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

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

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 software's software development process, Algorithm design, program composition, quality control, documentation and maintenance, software strategy. Approximation, roundoff errors, truncation errors. Nature of simulations systems models and simulation ,discreet event simulation, time advance mechanisms, components of discreet event simulation model. Simulation of singular server que-programme organization and logic-development of algorithm. Solving differential equation on computers-modeling engineering systems with ordinary differential equations- solution techniques using computers.

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

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

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 pickups, optical speed sensor, thermocouples. Vibration, measurement exercises. Application of instrument in farm machinery.

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

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

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

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

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 earheads/ 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. Anthropometry and Biomechanics: Anthropometry 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 equipment’s, 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 display and control of tractors and other equipment. Study of human response to noise and vibration.

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

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

Practical: Experiments for the determination of physical properties like, length, breath, thickness, surface area, bulk density, porosity, true density, coefficient of friction, angle of repose and colour for various food grains, fruits, vegetables, spices and processed foods,

aerodynamic properties like terminal velocity, lift and drag force for foodgrains, thermal properties like thermal conductivity, thermal diffusivity and specific heat, firmness and hardness of grain, fruits and stalk, electrical properties like dielectric constant dielectric loss factor, loss tangent and A.C. conductivity of various food material.

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

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 modelling.

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

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

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

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 arms, 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 fluidics-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 operations in agricultural production systems viz. crop, livestock and aqua cultural: 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, modeling using CAD, architecture of CAD system. Geometric modeling, requirements, geometric construction methods, representation of curve desirable modeling facilities. CAD standards, Graphical Standard system Exchange of modeling data. System analysis. Relevance of system approach to biological systems and engineering systems. Role of a system analyst in design of a system and development of computer systems. Characteristics of Agricultural systems. Tools of structured analysis. The data flow model. Object oriented approach. Feasibility study Steps in feasibility analysis cost analysis. System design process structured design. Application to farm machinery scheduling problem. Application to farm factory co-ordination case study. Design of farm machinery with the help of CAD.

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

FMP 605 Machinery for Natural Resource Management and Precision Farming **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 gradeability. 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, draglines, earth diggers, clamshells etc. Earthwork estimation, unit cost of operation, work scheduling, machinery maintenance, entrepreneurship.

FMP 591 Seminar

FMP 600 Master's Research

FMP 700 Doctoral Research

PROCESSING AND FOOD ENGINEERING

PROGRAMMES

M. Tech.

Ph.D.

COURSE REQUIREMENTS

M. Tech.

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

DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

PFE 51 Elementary Agro-Processing **1+1** **Sem. I**

(For students of College of Agriculture)

Concept of agro processing and its importance in context to Punjab. Concept of Agro Processing complexes. Layout and Planning. Components of Agro Processing Complex. Unit operations in agro-processing industry. Milling of wheat and its machinery. Milling of paddy and its machinery. Milling of pulses and its machinery. Oilseed processing and machinery.

Practical: Milling quality of paddy, knowledge about rice, wheat, oilseed and pulses milling machinery. Visit to agro processing complexes.

PFE 102 Post Harvest Engineering **2+1** **Sem. II**

(For students of College of Agriculture)

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

discharge, buckets types; Pneumatic conveying system: Capacity and power requirement, types, air/product separators; Gravity conveyor design considerations, capacity and power requirement.

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

PFE 201 Unit Operations in Food Processing-I **2+1** **Sem. I**

(For students of College of Agriculture)

Size reduction- benefits, classification and determination of the fineness of ground material, sieve analysis, principle and mechanisms of comminution, energy laws, size reduction equipments – various types of crushers, grinders, ultrafine grinders and cutting machines, their principle and working. Mixing – theory of solids mixing, mixing indices, rate of mixing, theory of liquid mixing, power requirement, mixing equipments – mixers for liquids and pastes, dry powders and particulate solids. Mechanical separation- theory, centrifugation, liquid-liquid centrifugation, liquid-solid centrifugation, clarifiers, desludging and decanting machines. Filtration – rate of filtration, pressure drop during filtration, constant rate filtration and constant-pressure filtration, filtration equipments, plate and frame filter press, rotary filters, centrifugal filters and air filters, filter aids. Membrane separation – general considerations, materials for membrane construction, membrane separation methods, ultrafiltration, processing variables, membrane fouling, application of ultra-filtration in food processing, reverse osmosis, mode of operation and applications, demineralization by electro-dialysis, gel filtration, ion exchange, pervaporation and micro filtration.

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

PFE 202 Unit Operations in Food Processing-II **2+1** **Sem. II**

(For students of College of Agriculture)

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

time calculation by using Plank's equation. Freezing systems: direct contact systems, air blast immersion, IQF, changes in foods, frozen food properties, factors influencing freezing time and thawing time. Freeze concentration: principles, process and methods. Frozen food storage and quality changes. Freeze drying: heat and mass transfer, equipment and practices. Expression/ Extraction: liquid-liquid extraction processes, equipment and design for liquid-liquid and continuous multistage counter current extraction. Leaching: process, preparation of solids, rate of leaching, equipments, equilibrium relations. Crystallization and dissolution: theory and principles, kinetics, applications, equipments. Distillation: principles, vapour-liquid equilibrium, continuous flow, batch/differential, fractional, steam distillation, distillation of wines and spirits. Baking: principles, baked foods, equipment. Roasting: principles and equipments. Frying: theory, principles, shallow or contact and deep fat frying, heat and mass transfer in frying and equipments. Puffing: methods and equipments. Pasteurization: purpose, microorganisms and their reaction to temperature and other influences, methods of heating, design and operation of vat, tubular and plate heat exchangers. Sterilization: principles, process time, T-evaluation, batch and continuous sterilization, equipments, ultra high temperature (UHT), in the package sterilization and equipment, temperature, pressure patterns and equipment. Aseptic processing: principles, analysis of thermal resilience, conduction heating time calculation. Blanching: principle and equipment. Homogenization and emulsification.

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

PFE 203 Food Refrigeration and Cold Chain **2+1** **Sem. II**

(For students of College of Agriculture)

Principles and importance, unit of refrigerating capacity, coefficient of performance, production of low temperatures, expansion of a liquid with flashing, reversible/irreversible adiabatic expansion of a gas/real gas, thermoelectric cooling and adiabatic demagnetization. Air refrigerators: Carnot and reversed Carnot cycle, selection of operating temperatures, Bell Coleman and reversed Brayton cycle, analysis of gas cycle, polytropic and multistage compression. Vapour Compression refrigeration system: vapour as a refrigerant in reversed Carnot cycle with p-V and T-s diagrams, limitations of reversed Carnot cycle. Modifications in reverse Carnot cycle with vapour as a refrigerant (dry vs wet compression and throttling vs isentropic expansion), representation of vapour compression cycle on pressure enthalpy diagram, super heating, sub cooling, liquid-vapour regenerative heat exchanger for vapour compression system, effect of suction vapour super heat and liquid sub cooling and actual vapour compression cycle. Azeotropes, Components of vapour compression refrigeration system, (evaporator, and compressor, condenser and expansion valve). Vapour absorption refrigeration system: process, calculations and maximum coefficient of performance.

Common refrigerants: classification, nomenclature and desirable properties (physical, chemical, safety, thermodynamic and economical). Ice manufacture: principles and systems of ice production, treatment of water for making ice, brines, freezing tanks, ice cans, air agitation and quality of ice. Cold storage: design for different categories of food resources, size and shape, construction, material, insulation, vapour barriers, floors, frost-heave, interior finish and fitting, evaporators, automated cold stores and security of operations. Refrigerated transport: handling and distribution, cold chain, refrigerated product handling, order picking, refrigerated vans and refrigerated display. Air-conditioning: factors affecting, classification, sensible heat factor air-conditioning, industrial air-conditioning, numerical problems on sensible heat factor (winter/summer/year round air-conditioning), unitary, central air-conditioning, physiological principles, air distribution and duct design methods, design of complete air-conditioning systems, humidifiers and dehumidifiers. Cooling load calculations: load sources, product cooling, conducted heat, convected heat, internal heat sources, heat of respiration and peak load.

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

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

Importance of engineering properties of agricultural produce and its classification. Physical properties: shape, size, roundness, sphericity, volume, density, porosity, specific gravity, surface area of grains, fruits and vegetables. Thermal properties: heat capacity, specific heat, thermal conductivity, thermal diffusivity, heat of respiration and co-efficient of thermal expansion. Frictional Properties: static friction, kinetic friction, rolling resistance, angle of internal friction, angle of repose, flow of bulk granular materials. Aero dynamics of agricultural products, drag coefficients, terminal velocity. Rheological properties (Force, deformation, stress, strain, elastic, plastic and viscous behaviour). Newtonian and Non-Newtonian liquid, visco-elasticity, pseudoplastic, dilatant, thyrotrophic, rheopectic, bingham plastic foods and flow curves. Electrical properties, dielectric loss factor, loss tangent, A.C. conductivity, dielectric constant and method of determination. Application of engineering properties in handling processing machines and storage structures.

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

PFE 301 Food Process Equipment Design 2+1 Sem. I

(For students of College of Agriculture)

Materials and properties: materials for fabrication, mechanical properties (ductility and hardness), corrosion, protective coatings, corrosion prevention linings, equipment, choice of materials and material codes. Design considerations: stresses created due to static and dynamic loads, combined stresses, design stresses, theories of failure, safety factor, temperature and radiation effects, effects of fabrication method and economic considerations. Design of pressure and storage vessels: operating condition, design conditions and stress, design of shell and its component, stresses from local load and thermal gradient, mountings and accessories. Design of heat exchangers: design of shell and tube, plate, scraped surface heat exchanger, sterilizer and retort. Design of evaporators and crystallizers: single and multiple effect evaporators, components, design of rising and falling film evaporators, feeding arrangements, crystalliser and entrainment separator. Design of agitators and separators: agitators, baffles, agitation system components and drive, centrifuge separator, equipment components, shafts, pulleys, bearings, belts, springs, drives and speed reduction systems. Design of freezing equipment: ice cream freezers and refrigerated display system. Design of dryers: tray, tunnel, fluidized, spray, vacuum, freeze and microwave dryer. Design of conveyors and elevators: belt, chain, screw, pneumatic conveyor and bucket elevator. Design of extruders: cold and hot, screw and barrel and twin screw extruder. Design of fermenter vessel and numerical problems. Hazards and safety considerations: Hazards in process industries, analysis of hazards, safety measures, safety measures in equipment design, pressure relief devices.

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

PFE 302 Food Storage Engineering **2+1** **Sem. I**

(For students of College of Agriculture)

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

Practical: Visits to traditional storage structures, FCI Godowns, cold, CA and evaporative

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

PFE 303 Protected Cultivation and Secondary Agriculture 1+1 Sem. II

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

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

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

PFE 304 Agricultural Structures and Environmental Control 2+1 Sem. I

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

Practical: Measurement for environmental parameters and cooling load of a farm building.

Design and layout of a dairy farm, poultry house, goat house and sheep house. Design of a farm fencing system, feed and fodder storage structure, grain storage structures, commercial bag and bulk storage facilities. Performance evaluation of different domestic storage structure. Cost estimation of farm buildings.

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

Cleaning and grading of grains, aspiration, scalping, size separators, screens and sieve analysis, capacity and effectiveness of screens. Separators: specific gravity, magnetic, disc, spiral, pneumatic, inclined draper, velvet roll, colour sorters, cyclone, shape graders. Size reduction: principle, Bond's law, Kick's law, Rittinger's law, procedure (crushing, impact, cutting and shearing), and size reduction machinery (Jaw crusher, hammer mill, plate mill and ball mill). Conveyors: belt, roller, chain and screw. Elevators: bucket, Cranes & hoists. Trucks (refrigerated/ unrefrigerated) and pneumatic conveying. Drying: moisture content, water activity, free, bound moisture and equilibrium moisture content, isotherm, hysteresis effect, equilibrium moisture content (EMC) determination. Psychometric chart and its use, drying principles and theory, thin layer and deep bed drying analysis, falling rate and constant rate drying periods, maximum and decreasing drying rate period, drying equations, mass, energy balance, Shedd's equation and dryer performance. Methods of drying, tempering during drying. Grain dryers: bin, flat bed, LSU, columnar, RPEC, fluidized, rotary and tray. Mixing: theory of mixing of solids and pastes, mixing index, mixers for solids, liquid foods and pastes. Milling of rice: conditioning and parboiling, traditional methods, CFTRI, Jadavpur and pressure parboiling methods, types of rice mills, modern rice milling, different unit operations and equipment. Milling of wheat: unit operations and equipments. Milling of pulses: traditional milling methods, commercial methods, pre-conditioning, dry and wet milling: CFTRI and Pantnagar methods, pulse milling machines. Milling of corn and its products, dry and wet milling. Milling of oilseeds: mechanical expression, screw press, hydraulic press, solvent extraction methods, preconditioning of oilseeds, stabilization of rice bran and refining of oil. Extrusion cooking: principle, factors affecting single and twin screw extruders. By-products utilization.

Practical: Performance evaluation of different types of cleaners and separators. Size reduction machines, performance evaluation, fineness modulus and uniformity index. Types of conveying and elevating equipments. Mixers and types of mixers. Moisture content: dry and wet basis, drying characteristics, drying constant and EMC (Static and dynamic method). Various types of dryers. Performance evaluation of different equipments in rice, pulse and oil mills. Process flow charts with examples relating to processing of cereals, pulses and oil seeds. Visit to grain processing industries.

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

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

chilling and freezing, application of refrigeration in different perishable food products, freezing time calculations, slow and fast freezing, equipments (mechanical and cryogenic). Cold storage heat load calculations and design. Refrigerated vehicle and cold chain system Dryers for fruits and vegetables. Osmo-dehydration. Packaging: requirements in terms of light transmittance, heat, moisture and gas proof, micro organisms and mechanical strength, packaging materials, products, bulk and retail packages and packaging machines. Handling and transportation of fruits and vegetables. Pack house technology. Minimal processing. Methods of storage: low temperature, evaporative cooled, controlled atmosphere, modified atmosphere packaging. Preservation technology: methods of preservation of fruits and vegetables, brief description and advantages and disadvantages of different physical/ chemical and other methods of preservation. Flowcharts for preparation of different finished products, important parameters and equipment used for different unit operations. Post harvest management and equipments for spices and flowers. Quality control in fruit and vegetable processing industry. Food supply chain.

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

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

Deterioration in food products and their controls. Physical, chemical and biological methods of food preservation. Nanotechnology: concepts, tools, techniques, applications in food packaging and products, implications, environmental impact of nano-materials and their potential effects on global economics and regulation of nanotechnology. Dairy development in India. Engineering, thermal and chemical properties of milk and milk products, process flow charts for dairy products. Unit operations of dairy and food processing systems. Principles and equipment related to receiving of milk, pasteurization, sterilization, homogenization and centrifugation for cream separation. Methods and equipment for manufacture of cheese/ paneer, butter and ice cream. Packaging of milk and milk products. Dairy plant design and layout, plant utilities, principles of operation and equipment for thermal processing, canning and aseptic processing. Evaporation: principle, types of evaporators, steam economy, multiple effect evaporation, vapour recompression. Drying of liquid and perishable foods principle, spray, drum and freeze drying. Filtration: principle, types of filters, membrane separation, reverse osmosis (RO), nano, ultra and macro-filtration, equipment and applications. Non-thermal and alternate thermal processing in food.

Practical: Study of pasteurizers, sterilizers, homogenizers, separators, butter churns, evaporators, milk dryers, freezers and filtrates. Design and layout of food processing plants, visit to multi-product dairy plant. Estimation of steam and refrigeration requirements in dairy and food plant. Visits to food industry and dairy plant.

Elective courses

PFE 401 Development of Processed Products 2+1 Sem. II

Composition of food and their waste and by-products. Process flow chart with mass and

energy balance, unit operations and equipments for processing. Uses of food waste, waste disposal. New product development. Technology for value added products from cereal, pulses and oil seeds. Milling, puffing, flaking, roasting, bakery, snack foods and extruded products. Oil extraction and refining. Technology for value added products from fruits, vegetables, spices, canned foods, frozen foods, dried and fried foods, fruit juices and sauce. Sugar base confection, candy, fermented food product and spice extracts. Technology for animal produce processing: meat, poultry, fish and egg products. Health foods: nutra-ceuticals, functional and organic food.

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

PFE 402 Food Quality and Control 2+1 Sem. II

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

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

PFE 403 Process Equipment Design 2+1 Sem. II

Introduction to process equipment design, application of engineering design for processing equipments, design parameters and general design procedure, material specification, types of material for process equipments and design codes. Design of process equipment: pressure vessel, cleaners, tubular, shell and tube and plate heat exchangers, belt, screw conveyer, bucket elevator, dryers and milling equipments. Optimization of design with respect to process efficiency, energy and cost. Computer Aided Design (CAD).

Practical: Design of pressure vessel, cleaners, milling equipments, tubular, shell and tube type, plate heat exchangers, dryer, belt, screw conveyor and bucket elevator.

PFE 404 Food Plant Design and Management 2+1 Sem. II

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

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

PFE 405 Food Packaging Technology 2+1 Sem. II

Factors affecting shelf life of foods during storage, interactions of spoilage agents with environmental factors (water, oxygen, light and pH), general principles of control of the spoilage agents, difference between food infection, food intoxication and allergy. Packaging of foods: importance, scope, requirement, packaging strategy, environmental considerations. Packaging systems: type (flexible, rigid, retail and bulk), levels, machines, technical and data management packaging systems. Packaging materials: properties, applications, manufacture of metal cans, plastic packaging, polymers used in food packaging and their barrier properties Manufacture of plastic packaging materials (profile, blown film/ sheet extrusion, extrusion blow molding, injection blow molding, stretch blow molding and injection molding). Glass containers: types, manufacture of glass and glass containers, closures for glass containers. Paper and paper board packaging: manufacture process, barrier properties, characteristics, advantages, disadvantages and effect of these packaging materials on packed commodities. Nutritional labelling on packages. Controlled atmosphere (CA), modified atmosphere (MA), shrink, cling, vacuum, gas, active and smart packaging. Packaging requirement for raw and processed foods and their selection of packaging materials. Factors affecting the choice of packaging materials, disposal and recycle of packaging waste. Printing, labeling and lamination. Package testing: testing methods for flexible, rigid and semi rigid materials. Tests for packaging materials: paper (thickness, bursting strength, breaking length, stiffness, tear resistance, folding endurance, ply bond and surface oil absorption), plastic film and laminates (thickness, tensile strength, gloss, haze and burning test to identify polymer), aluminium foil (thickness and pin holes), glass containers (visual

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

Practical: Identification of different types of packaging materials. Determination of tensile/compressive strength of given material/package. Destructive and non-destructive test for glass containers. Vacuum packaging of agricultural produce. Determination of tearing strength of paper board. Measurements of thickness of packaging materials. Determination of bursting strength and water-vapour transmission rate of packages. Shrink wrapping of horticultural produce. Testing of chemical and grease resistance of packaging materials. Drop test for food package strength. Visit to relevant industries.

PFE 406 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, germand germ oil from by-product of cereals; Bioconversion and recycling of agro-wastes and by-products; Visits to various industries using waste and food byproducts.

Postgraduate Courses

PFE 501 Transport Phenomena in Food Processing 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, deadload and impact damage, vibration damage, friction, effect of load, sliding velocity, temperature, water film and surface roughness. Friction in agricultural materials, rolling resistance, angle of internal friction, angle of repose, flow of bulk granular materials, aero dynamics of agricultural products, drag coefficients, terminal velocity. Thermal properties: Specific heat, thermal conductivity, thermal diffusivity, methods of determination, steady state and transient heat flow. Electrical properties; Dielectric loss factor, loss tangent, A.C. conductivity and dielectric constant, method of determination, energy absorption from high frequency electric field. Application of engineering properties in design and operation of agricultural equipment and structures.

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

PFE 503 Advance Food Process Engineering 2+1 Sem. II

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

PFE 506 Processing of Cereals, Pulses and Oilseeds 2+1 Sem. I

Production and utilization of cereals and pulses, grain structure of major cereals, pulses and oilseeds and their milling fractions; grain quality standards and physico-chemical methods for evaluation of quality of flours. Pre-milling treatments and their effects on milling quality; parboiling and drying, conventional, modern and integrated rice milling operations; wheat roller flour milling; processes for milling of corn, oats, barley, gram, pulses, paddy and flour milling equipments. Dal mills, handling and storage of byproducts and their utilization. Storage of milled products, Expeller and solvent extraction processing, assessment of processed product quality. Packaging of processed products, design characteristics of milling equipments; selection, installation and their performance, BIS standards for various processed products.

Practical: Physical properties of cereals and pulses, raw and milled products quality evaluations; parboiling and drying; terminal velocities of grains and their fractions; study of paddy, wheat, pulses and oilseeds milling equipments; planning and layout of various milling

plants, visit to related agro-processing industry.

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

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

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

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

Applications of engineering principles; mass and energy balance, fluid flow principles, unit operations of process engineering. Fundamentals of growth kinetics, maintenance energy and yield concepts, principles of media sterilization, media formulations of industrial

fermentation. Aerobic and agitated rheology of fermentative fluids, design and scale-up of bioreactors, enzyme reactors. Principles of recovery of fermented products in bio-processing, instrumentation, transport phenomenon.

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

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

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

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

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

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 modeling food processing operations.

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

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

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

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

Generation of by-products, agricultural and agro-industrial byproducts/ wastes, properties, onsite 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 particle boards from agricultural wastes.

PFE 591 Seminar

PFE 600 Master's Research

PFE 700 Doctoral Research

SOIL AND WATER ENGINEERING

A. SOIL AND WATER ENGINEERING

PROGRAMMES

M. Tech.

Ph.D.

COURSE REQUIREMENTS

M. Tech.

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

Ph.D.

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

DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

SWE 102 Soil and Water Conservation Engineering 1+1 Sem. II

(For students of College of Agriculture)

Introduction to soil and water conservation. Soil erosion: definition, causes and agents. Water erosion: forms of water erosion. Gully classification and control measures. Soil loss estimation by Universal Soil Loss Equation. Soil loss measurement techniques. Principles of erosion control: contouring, strip cropping, tillage practices, bunding and terracing. Grassed waterways and its maintenance. Water harvesting and its techniques. Wind erosion: mechanics of wind erosion, types of soil movement. Principles of wind erosion control and its control measures.

Practical: General status of soil conservation in India. Calculation of erosion index. Estimation of soil loss. Measurement of soil loss. Preparation of contour maps. Study of grassed water ways, contour bunds, graded bunds and bench terracing system.

SWE 201 Irrigation Engineering 2+1 Sem. I

Purpose of irrigation, environmental impact of irrigation projects, sources of irrigation water. Major and medium irrigation schemes of India, present status of development and utilization of different water resources of the country. Measurement of irrigation water: weirs, flumes, orifices and other methods. Open channel water conveyance system: design and lining of irrigation field channels, on farm structures for water conveyance, control and distribution. Underground pipe conveyance system: components and design. Land grading: criteria, design methods and estimation of earth work. Soil-water-plant relationships: soil properties influencing irrigation water management, soil water potential, movement and infiltration, soil moisture characteristics, constants and their measurement, moisture stress and plant response. Water requirement of crops: concept, measurement and estimation of evapotranspiration (ET). Irrigation requirement: depth, frequency, duration and its efficiencies. Surface methods of water application: border, check basin and furrow irrigation, adaptability, specification and design considerations.

Practical: Measurement of soil moisture, irrigation water and infiltration characteristics using different instruments. Determination of bulk density, field capacity and wilting point of soil. Estimation of evapotranspiration (ET). Land grading methods. Design of underground pipeline system. Estimation of irrigation efficiencies. Study of advance, recession curve and computation of infiltration opportunity time. Infiltration by inflow-outflow method. Evaluation of border, furrow and check basin irrigation method.

SWE 202 Soil and Water Conservation Engineering 2+1 Sem. II

Soil erosion: definition, causes, types, agents and its effects. Water erosion: types, factors and its mechanics. Gully erosion: classification and stages of development. Soil loss estimation: Universal Soil Loss Equation (USLE) and modified USLE. Estimation of rainfall erosivity indices. Estimation of soil erodibility indices. Topography, crop management and conservation practice factors. Measurement of soil erosion: runoff plots and soil samplers. Rate of sedimentation, silt monitoring and storage loss in tanks. Water erosion control measures: agronomical measures (contour farming, strip cropping, conservation tillage and mulching), engineering measures (bunds and terraces, their types, planning, design, layout procedure and surplussing arrangements, contour stone wall and trenching. Ravine reclamation. Principles of gully control: vegetative measures and temporary structures, diversion drains. Grassed waterways and design. Wind erosion: factors affecting, mechanics,

soil loss estimation and control measures (vegetative, wind breaks, shelter belts, mechanical measures and stabilization of sand dunes).

Practical: Study of different types and forms of water erosion. Computation of rainfall erosivity and soil erodibility indices. Determination of length of slope (LS) and cropping practice (CP) factors for soil loss on by USLE and modified USLE. Soil loss estimation/measuring techniques. Study of rainfall simulator for erosion assessment. Measurement of sediment rate using Coshocton wheel sampler and multi-slot devisor. Determination of sediment concentration through oven dry method. Design and layout of contour bunds, graded bunds, broad base terraces and bench terraces. Design of vegetative waterways. Estimation of rate of sedimentation and storage loss in tanks. Computation of soil loss by wind erosion. Design of shelter belts and wind breaks for wind erosion control. Visit to watershed project areas for studying soil erosion and temporary control measures.

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

Sprinkler irrigation: adaptability, types, problems and prospects. Sprinkler/micro sprinkler irrigation system design: steps, layout, selection, design of lateral, sub-main and main pipeline, selection of pump and power unit. Performance evaluation of sprinkler irrigation system: uniformity coefficient and pattern efficiency. Micro irrigation system: types, merits and demerits, components. Design of drip irrigation system: general considerations, wetting patterns, irrigation requirement, emitter selection, hydraulics and design steps. Steps for proper operation of a drip irrigation system. Maintenance of micro irrigation system: clogging, filter cleaning, flushing and chemical treatment. Fertigation: advantages, limitations, methods, fertilizers solubility and their compatibility, precautions, frequency, duration and injection rate. Economics: Cost estimation of sprinkler and micro irrigation system.

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

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

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

diagram for various flow conditions, creep line theory, uplift pressure estimation, safety against sliding, overturning, crushing and tension. Chute spillway: description, components, energy dissipaters, design criteria of Saint Antony Falls (SAF) stilling basin and its limitations. Drop inlet spillway: description, functional use and design criteria.

Practical: Study of different types of farm ponds. Computation of storage capacity of embankment type of farm ponds. Design of dugout farm ponds, percolation pond and nala bunds. Runoff measurement using H-flume. Exercise on hydraulic jump and energy dissipation in water flow. Hydrologic, hydraulic and structural design of drop and drop inlet spillway and stability analysis of drop spillway. Design of SAF stilling basins in chute spillway and small earthen embankment. Practice on software's for design of soil and water conservation structures. Field visit to watershed project areas treated with soil and water conservation structures.

SWE 302 Drainage Engineering 1+1 Sem. I

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

Practical: In-situ measurement of hydraulic conductivity by single and inverse auger hole method. Estimation of drainage coefficients. Installation of piezometer and observation wells. Preparation of isobath and isobar maps. Determination of drainable porosity. Design of surface, subsurface drainage system and gravel envelope. Determination of chemical properties of soil and water. Study and fabrication of drainage tiles. Study of drainage pipes. Installation of sub-surface drainage system. Cost analysis of surface and sub-surface drainage system.

SWE 303 Watershed Planning and Management 2+1 Sem. II

Watershed: definition, delineation and characteristics. Watershed management: concept, objectives, factors affecting, watershed planning based on land capability classes, hydrological data for watershed planning and codification. Watershed development: problems and prospects. Bench mark surveys: overview of topographic survey, soil characteristics, vegetative cover, present land use practices and socio-economic factors. Prioritization of watersheds: sediment yield index. Water budgeting in a watershed. Management measures: rainwater conservation technologies (in-situ and ex-situ storage and recycling). Dry land farming: moisture conservation techniques, inter-terrace and inter-bund land management. Integrated watershed management: concept, components, arable (agriculture, horticulture) and non-arable (forestry, fishery and animal husbandry) lands. Effect of cropping systems, land management and cultural practices on watershed hydrology. Watershed programme: execution, follow-up practices, maintenance, monitoring and evaluation. Participatory watershed management: concept, need and role of watershed associations, user groups and self-help

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

Practical: Delineation of watersheds using toposheets. Preparation of watershed map. Quantitative analysis of watershed characteristics and parameters. Watershed investigations for planning and development. Analysis of hydrological data for planning watershed management. Water budgeting of watersheds. Prioritization of watersheds based on sediment yield index. Study of functional requirement of watershed development structures, watershed management technologies and role of various functionaries in its development programmes. Practice on software for analysis of hydrological parameters of watershed. Techno-economic viability analysis of watershed projects. Visit to watershed development project areas for planning and management. Case studies.

SWE 304 Groundwater Wells and Pumps 2+1 Sem. II

Occurrence and movement of groundwater. Aquifer and its types. Classification of wells: fully penetrating tubewells and open wells, familiarization of various types of bore wells. Design of open wells, tubewells and gravel pack. Groundwater exploration techniques. Methods of drilling of wells: percussion, rotary, reverse rotary. Types, selection and installation of well screen, completion and development of well. Groundwater hydraulics: determination of aquifer parameters by different methods such as Theis, Cooper-Jacob, Chow's and Theis recovery method. Well interference, multiple well systems. Estimation of groundwater potential and quality of groundwater. Artificial groundwater recharge techniques. Pumping systems: water lifting devices, types and classification of pumps, components of centrifugal pumps, priming, pump selection, installation and troubleshooting, performance curves, effect of speed on capacity, head and power, effect of change of impeller dimensions on performance characteristics. Other pumps: hydraulic ram, propeller, mixed flow pumps and their performance characteristics. Deep well turbine and submersible pump.

Practical: Verification of Darcy's Law. Study of different drilling equipment's. Sieve analysis for gravel and well screens design. Estimation of specific yield and specific retention. Study/testing of well screen. Estimation of aquifer parameters by Theis, Cooper-Jacob, Chow and Theis Recovery method. Well design under confined and unconfined aquifer. Determination of well losses and efficiency. Estimation of groundwater balance. Study of artificial groundwater recharge structure. Study of radial and mixed flow centrifugal pumps, turbine, propeller and submersible/multistage pumps. Installation of centrifugal pump. Study of cavitation and hydraulic ram. Testing of centrifugal and submersible pump.

Elective Courses

SWE 401 Floods and Control Measures 2+1 Sem. II

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

location and construction. Gully erosion and control structures: design and implementation. Ravine control measures. River training works, planning of flood control projects and their economics. Earthen embankments: functions, classification, hydraulic fill and rolled fill dams (homogeneous, zoned and diaphragm type), foundation requirements, grouting, seepage through dams, flow net and its properties, seepage pressure, seepage line, drainage filters, piping and its causes. Design and construction of earthen dam, stability of earthen dam against failure by tension, overturning, sliding. Stability of slopes and analysis of failure by different methods. Subsurface dams: site selection and constructional features. Check dam: small earthen embankments (types and design criteria).

Practical: Determination of flood stage-discharge relationship in a watershed, flood peak-area relationships, frequency distribution functions for extreme flood values using Gumbel's method, confidence limits of the flood peak estimate for Gumbel's extreme value distribution, frequency distribution functions for extreme flood values using log-Pearson Type-III distribution, probable maximum flood, standard project flood and spillway design flood. Design of levees and jetties for flood control. Study of vegetative and structural measures for gully stabilization. Design of gully/ravine control structures and cost estimation. Designing, planning and cost-benefit analysis of a flood control project. Study of different types, materials and design considerations of earthen dams. Determination of the position of phreatic line in earthen dams for various conditions. 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 and other methods. Construction of flow net for isotropic and anisotropic media. Computation of seepage by different methods. Determination of settlement of earthen dam. Input-output-storage relationships by reservoir routing. Visit to sites of earthen dam and water harvesting structures.

SWE 402 Wasteland Development **2+1** **Sem. II**

Land degradation: concept, classification, arid, semi-arid, humid and sub-humid regions, denuded rangeland and marginal lands. Wastelands: factors, classification and mapping of wastelands, planning of waste lands development, constraints, agro-climatic conditions, development options and contingency plans. Conservation structures: gully stabilization, ravine rehabilitation, sand dune stabilization, water harvesting and recycling methods. Afforestation: agro-forestry, agro-horti, silvi-pastural methods, forage and fuel crops, socioeconomic constraints, shifting cultivation and optimal land use options. Wasteland development: hills, semi-arid, coastal areas, water scarce areas, reclamation of waterlogged and salt-affected lands. Mine spoils: impact, land degradation, reclamation and rehabilitation, slope stabilization and mine environment management. Micro irrigation in wasteland development. Sustainable wasteland development: drought situations and socio-economic perspectives. Government policies. Participatory approach. Preparation of proposal for wasteland development and benefit-cost analysis.

Practical: Mapping and classification of wastelands. Identification of factors causing wastelands. Estimation of vegetation density and classification. Planning and design of engineering measures for reclamation of wastelands. Design and estimation of different soil and water conservation structures under arid, semi-arid and humid conditions. Planning and design of micro irrigation in wasteland development. Cost estimation of the soil and water conservation measures. Visit to wasteland development project sites.

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

Concept of Information Technology (IT) and its application potential. Role of IT in natural resource management. Existing system of information generation and organizations involved in the field of land and water management. Application and production of multimedia. Internet application tools and web technology. Networking system of information. Problems and prospects of new information and communication technology. Development of database concept for effective natural resource management. Application of remote sensing, geographic information system (GIS) and GPS for land and water resource management. Relational data base management system. Object oriented approaches. Information systems, decision support systems and expert systems. Agricultural information management systems: use of mathematical models and programmes. Application of decision support systems, multi sensor data loggers and overview of software packages in natural resource management. Video-conferencing of scientific information.

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

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

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

Practical: Familiarization with remote sensing and GIS. Use of software for image interpretation. Interpretation of aerial photographs and satellite imagery. GIS operations such

as image display. Study of various features of GIS software package. Scanning, digitization of maps and data editing. Data base query and map algebra. GIS supported case studies in water resources management.

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

Purpose, benefits and ill effects of irrigation. Network of canal irrigation system and its different physical components, canal classification based on source of water, financial output, purpose, discharge and alignment. General considerations for canal alignment. Performance indicators for canal irrigation system evaluation. Estimation of water requirements for canal command areas and determination of canal capacity. Duty, base period, delta and their relationship, factors affecting duty and its improvement. Silt theory: Kennedy's and Lacey's regime theory, equations and design of channel by Kennedy's and Lacey's theory. Maintenance of unlined irrigation canals, measurement of discharge in canals, rostering (canal running schedule) and warabandi. Canal lining: necessity, advantages and disadvantages, types and desirable characteristics for the suitability of lining materials. Design of lined canals, functions of distributary head and cross regulators, canal falls, their necessity and factors affecting canal fall. Channel crossing structures. Sources of surplus water in canals and types of canal escapes, requirements of a good canal outlet and types of outlets.

Practical: Estimation of water requirement of canal commands. Determination of canal capacity. Layout of canal alignments on topographic maps, drawing of canal sections in cutting, full banking and partial cutting and banking. Determination of longitudinal section of canals. Design of irrigation canals based on silt theories. Design of lined canals. Formulation of warabandi. Study of canal outlets, regulators, escapes and canal falls.

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

Classification of irrigation projects, factors affecting performance and types of minor irrigation systems in India. Development and utilization of water resources through different minor irrigation schemes. Lift irrigation systems: feasibility, type of pumping stations, site selection and design. Tank irrigation: grouping of tanks, storage, supply works and sluices. Command area development (CAD) programme: components, need, scope and development approaches, historical perspective, CAD authorities functions and responsibilities, on farm development and reclamation works and use of remote sensing techniques for CAD works. Water productivity: concepts, measures for enhancing productivity and Farmers' participation in CAD.

Practical: Preparation of command area development layout plan. Irrigation water requirement of crops. Preparation of irrigation schedules. Planning and layout of water conveyance system. Design of surplus weir of tanks. Determination of storage capacity of tanks. Design of intake pipe and pump house.

SWE 407 Precision Farming Techniques for Protected Cultivation 2+1 Sem. II

Protected cultivation: introduction, components, perspective, types and cladding materials. Plant environment interactions: principles of limiting factors, solar radiation, transpiration, greenhouse effect, light, temperature, relative humidity and carbon dioxide enrichment. Design and construction of greenhouses: site selection, orientation, design, construction, design for

ventilation requirement using exhaust fan system and equipment used. Greenhouse cooling system: necessity, methods (ventilation with roof and side ventilators, evaporative cooling), shading materials, fogging, combined fogging and fan-pad cooling system, design of cooling system, maintenance of cooling and ventilation systems and pad care. Greenhouse heating: necessity, components, methods and design of heating system. Earth-Heat-Exchange within greenhouse condition and thermal behaviour of greenhouse. Root media: types (soil and soil less media), composition, estimation, preparation, disinfection and bed preparation. Planting techniques in green house cultivation. Design and installation of irrigation system: water quality, types, components, design, installation and material requirement and maintenance. Fogging system: introduction, benefits, design, installation material requirement and maintenance. Fertilization: nutrient deficiency symptoms and functions of essential nutrient elements, principles of selection of proper application of fertilizers, rate of fertilizer application, methods, scheduling and automated fertilizer application. Greenhouse climate measurement. Study of different greenhouse environment control instruments. Insect and disease management in greenhouse and net houses. Selection of crops for greenhouse cultivation. Major crops in greenhouse: irrigation requirement, fertilizer management, cultivation, harvesting and post-harvest techniques. Economic analysis.

Practical: Estimation of material requirement for construction of greenhouse and root media. Root media preparation, bed preparation and disinfections. Study of different planting techniques. Design and installation of irrigation and fogging system. Greenhouse heating. Study of different greenhouse environment control instruments. Operation, maintenance and fault detection in irrigation and fogging system. Determination of fertilization schedule and rate of application for various crops. Economic analysis of greenhouses and net houses. Visit to greenhouses.

SWE 408 Water Quality and Management Measures 2+1 Sem. II

Water resources and quality issues in India. Natural factors affecting quality of surface and groundwater, water quality in relation to domestic, industrial and agricultural activities. Drinking water quality standards, irrigation water quality classification as per US Salinity Laboratory (USSL) and All Indian Coordinated Research Project (AICRP) criteria. Point and non-point water pollution sources. Water contamination due to inorganic, organic compounds, agricultural chemicals, food industry, hydrocarbon and synthetic organic compounds. Arsenic and fluoride contamination in groundwater and remedial measures. Water decontamination technologies, cultural and management practices for using poor quality water for irrigation.

Practical: Water quality analysis and classification according to USSL and AICRP criteria. Soil chemical analysis and estimation of lime and gypsum requirements. Study of salinity development under shallow and deep-water table conditions, contaminant movement and transport in soil profile. Study of water decontamination techniques and cultural and management practices for using poor quality water for irrigation. Field visit to industrial effluent disposal sites.

SWE 409 Landscape Irrigation Design and Management 2+1 Sem. II

Conventional method of landscape irrigation: hose irrigation, quick release coupling and portable sprinkler system with hose pipes. Modern methods of landscape irrigation: pop-up and spray pop-up sprinklers, shrub adopter, drip irrigation and bubblers. Types of landscapes and

suitability of different irrigation methods, water requirement for different landscapes, segments and main components of modern landscape irrigation systems and their selection criteria. Merits and demerits of conventional and modern irrigation systems. Types of pipes, pressure ratings, sizing and selection criteria. Automation system for landscape irrigation: main components, types of controllers and their applications. Design, operation and maintenance of modern landscape irrigation systems.

Practical: Study of irrigation equipment for landscapes. Design and installation of irrigation system for landscape. Determination of water and power requirements for pump selection. Irrigation scheduling of landscapes. Study of irrigation controllers and other equipment. Use of Auto CAD in irrigation design: blocks and symbols, head layout, zoning and valves layout, pipe sizing and pressure calculations. Visit to landscape irrigation system and its evaluation.

SWE 410 Plastic Applications in Agriculture **2+1** **Sem. II**

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

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

Postgraduate Courses

SWE 501 Watershed Hydrology **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 techniques of effective rainfall. Farm irrigation systems, irrigation efficiencies, economic feasibility, irrigation water quality and salinity management techniques. Design of water conveyance, control and distribution systems. Hydraulics, design and operation of border, check basin, furrow, sprinkler and trickle irrigation systems. Flow dynamics, drop size distribution and spray losses in sprinklers. Application of chemicals through sprinkler and drip systems. Maintenance, filtration and flushing of drip system. Irrigation performance parameters. Evaluation of irrigation systems and practices. Basic water management concepts and objectives. Alternative irrigation scheduling techniques. Integrated approach to irrigation water management.

SWE 503 Agricultural Drainage Systems 2+0 Sem. II

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

SWE 504 Groundwater Engineering 3+0 Sem. I

Occurrence, storage and movement of ground water in alluvial and hard rock formations. Stream-aquifer interaction and its parameter identification. Groundwater balance. Fluctuation of water table beneath are charge site. Derivation of hydraulics of fully and partially penetrating wells in confined, leaky and unconfined aquifers. Steady flow in sloping aquifers. Analysis of multi aquifers. Flow analysis in interfering wells. Pumping tests for estimation of aquifer parameters. Groundwater recharge. Wells near recharge and impermeable boundaries Design of well field. Skimming well technology. Groundwater modeling for resources planning, calibration and validation of models.

SWE 505 Flow Through Porous Media **2+0** **Sem. I**

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, windmills, microturbines, solar pumps, hydraulic arm - their selection and design criteria. Design of pumping station, techno-economic evaluation, efficient pumping system operation, flow control strategies and conservation measures for pumping systems.

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

Review of rainfall-run off relationship. Measurement of rainfall, run off 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 bund sand 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 Photogrammetry. 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 Parallaxes in Images. Introduction to Digital image processing software and GIS software and their working principles. Generation of Digital elevation model (DEM) for land and water resource management. Case studies on Mapping, Monitoring and management of natural resources using remote sensing and GIS.

SWE 511/RSGIS 509 Watershed Management and Modelling **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 equipment's 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, Bulldozers 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 subspaces. Variational and weighted residual methods. Lang range polynomials. Triangular and quadrilateral shape functions. Isoperimetric 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 subsurface 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, Evapotranspiration 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. Groundwater models. Design of nodal network, General systems framework-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 Modeling 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; multipurpose 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

PROGRAMME

M. Tech.

(In collaboration with Punjab Remote Sensing Centre)

COURSE REQUIREMENTS

M. Tech.

Field of Specialization	Remote Sensing and Geographic Information System
Required Courses	RSGIS 501, RSGIS 502, RSGIS 503, RSGIS 504, RSGIS 510
Supporting Courses	Stat.421, PGS501 and other courses from subject matter fields (other than Minor) relating to area of special interest and research problem.
Minor Field	Computer Science and Engineering, Soil and Water Engineering, Soil Science, Forestry and Natural Resources, Agrometeorology, Agronomy, Information Technology or any other as approved by the Dean Postgraduate Studies.
Deficiency Courses	As recommended by the student's Advisory Committee and approved by The Dean, Postgraduates Studies

DESCRIPTION OF COURSE CONTENTS

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

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. Datatypes 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 Multicriteria Analysis. Field exercise on GPS data collection in stand-alone and Differential Mode. Field Exercise on Mobile mapping. Demon 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, HIS transformation, Orthogonal transformation, Principle of Image Classification Types of Classification Schemes, Training site selection: Feature Selection & Separability 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, Software's, 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 the matic maps, basic characteristics of map, cartographic representation of geographic objects, Map projection, Types of projection, Digital mapping, Integration with Geo Spatial Database, 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 and 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 water logging, sand dunes, gullied and ravenous lands, soil erosion mapping, soil-site suitability evaluation. Study of drainage and their characteristics. Delineation of watersheds, soil coding and soil information system in GIS.

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

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

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. Groundwater 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 rationalization.

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 511Watershed 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 database management package.

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

RSGIS 591 Seminar

RSGIS 600 Master's Research

CIVIL ENGINEERING

PROGRAMMES

M. Tech.

Ph.D.

COURSE REQUIREMENTS

M.Tech.

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

Ph.D.

Field of Specialization	Structural Engineering
Required Courses	CE 601, CE 602, CE 603, CE 604
Supporting Courses	Courses from subject matter fields (other than Minor) relating to area of special interest and research problem.
Minor Field	Computer Science and Engineering, Energy Science and Technology or any other as approved by Dean, Postgraduate Studies.
Deficiency Courses	As recommended by the student's Advisory Committee and approved by the Dean, Postgraduates Studies

DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

CE 105 Soil Mechanics **2+1** **Sem. I**

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

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

CE 106 Surveying and Levelling **1+2** **Sem. II**

Surveying: Introduction, classification and basic principles. Linear measurements. Chain surveying. Cross staff survey. Compass survey. Planimeter. Errors in measurement, their elimination and correction. Plane table surveying. Levelling,levelling difficulties and error in levelling. Contouring. Computation of area and volume. Theodolite traversing. Introduction to setting of curves. Total station, Electronic theodolite. Introduction to GPS survey.

Practical: Chain survey of an area and preparation of map. Compass survey of an area and plotting of compass survey. Plane table surveying. Levelling. L section and X

sections and its plotting. Contour survey of an area and preparation of contour map. Introduction of software in drawing contour. Theodolite surveying. Ranging by theodolite, height of object by using theodolite. Setting out curves by theodolite. Minor instruments. Use of total station.

CE 108 Engineering Mechanics 2+1 Sem. II

Basic concepts of Engineering Mechanics. Force systems, composition and resolution of forces, moment of a force, couple and its transmission, resolution of a force into a force and a couple. Centroid, Moment of inertia, polar moment of inertia, radius of gyration, polar radius of gyration of composite areas, Equilibrium of concurrent co-planer and non-concurrent co-planer force systems. Free body diagram and equilibrium of forces. Frictional forces. Analysis of simple framed structures using method of joints, method of sections and graphical method. Simple stresses. Shear force and bending moment diagrams for various combinations of loads and beams. Stresses in beams. Torsion. Analysis of plane and complex stresses.

Practical: Problems on composition and resolution of forces, moments of a force, couples, transmission of a couple, resolution of a force into a force & a couple. Problems relating to resultant of Co-planer force system, collinear force system, concurrent force system, co-planer concurrent force system, co-planer non-concurrent force system, Non-coplanar concurrent force system, Non-coplanar non-concurrent force system, system of couples in space. Problems relating to centroids of composite areas. Problems on moment of inertia, polar moment of inertia, radius of gyration, polar radius of gyration of composite areas. Equilibrium of concurrent co-planar and non-concurrent co-planar force system. Problems involving frictional forces. Analysis of simple trusses by method of joints and method of sections. Analysis of simple trusses by graphical method. Problems relating to simple stresses and strains. Problems on shear force and bending moment diagrams. Problems relating to stresses in beams. Problems on torsion of shafts. Analysis of plane and complex stresses.

CE 207 Watershed Hydrology 1+1 Sem. I

Hydrologic cycle. Precipitation, forms and measurement. Precipitation analysis. Estimation of missing data. Interception, infiltration, evaporation, their estimation and measurement, factors affecting Infiltration indices. Runoff: factors affecting, measurement, estimation of peak runoff rate and volume, rational method, Cook's method and SCS curve number method. Geomorphology of watersheds. Hydrograph: components, base flow separation, unit hydrograph theory, S curve. Synthetic hydrograph. Stream gauging: stage discharge rating curves, flood peak, design flood and computation of probable flood. Flood routing: channel and reservoir routing. Drought: classification, causes, impact and management.

Practical: Visit to meteorological observatory and study of different instruments. Design of rain gauge network. Exercise on intensity duration frequency curve. Exercise on depth area duration and double mass curve. Analysis of rainfall data and estimation of mean rainfall by different methods. Exercise on frequency analysis of hydrologic data and

estimation of missing data, test for consistency of rainfall record. Exercise on computation of infiltration indices. Computation of peak runoff and runoff volume by Cook's method and rational formula. Computation of runoff volume by SCS curve number method. Study of stream gauging instruments: current meter and stage level recorder. Exercise on geomorphic parameters of watershed. Exercise on runoff hydrograph. Exercise on unit hydrograph. Exercise on synthetic hydrograph. Exercise on flood routing.

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

Slope and deflection of beams using integration technique, moment area theorem and conjugate beam method. Columns and struts. Concept of effective length of column, analysis of axially loaded columns using Euler's method and Rankine's method for different end conditions. Stability analysis of masonry dams. Introduction to indeterminate beams. Analysis of statically indeterminate beams: propped beams, fixed and continuous beams using method of superposition, three moment equation and moment distribution method.

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

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

Building materials: rocks, stones, bricks, tiles, lime, cement, aggregates, concrete, glass, rubber, plastics, iron, steel, aluminum, copper, nickel and timber. Building components: walls, columns, beams, arches, lintels, slabs, staircases and floors. Different types of floors: brick floor, timber floor, reinforced cement concrete floor, terrazzo floor, marble floor. Finishing: damp proofing and water proofing, plastering, pointing, painting, whitewashing and distempering. Brick masonry and stone masonry. Different types of

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

CE 307 Design of Structures **2+1** **Sem. II**

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

Practical: Design and drawing of steel roof truss. Design and drawing of singly reinforced beam, doubly reinforced beam. Design and drawing of one way and two-way slabs. Design and drawing of RCC building. Design and drawing of retaining wall.

Postgraduate Courses

CE 501 Open Channel Flow **3+0** **Sem. I**

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

CE 502 Dams and Reservoir Operations **3+1** **Sem. II**

Dams classification. Suitable site selection for dams and reservoirs. Survey and planning of storage projects. Types of concrete dams. Forces acting on concrete dams. Stability analysis. Methods of design of gravity dams. Concrete cooling and temperature control for dams. Earth dams and their types. Methods of construction. Causes of failure and remedial measure. Seepage and stability analysis of earth dams. Foundation treatment and Abutment grouting. Instrumentation in dams. Spillway and spillway capacities. Spillway Gates. Reservoir planning. Storage, sedimentation and losses. Reservoir

economics. Flood routing. Practical: Stability analysis of gravity dam, Design of concrete dams, Stability analysis of earth dams, Design criteria of earth dam, Phreatic line determination in earth dams, Seepage analysis through earth dams, Reservoir design, Reservoir capacity determination, Flood routing through reservoir. Design of spillway.

CE 503 Water Quality and Pollution Control 3+1 Sem. II

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

CE 504 Fluvial Hydraulics 2+1 Sem. I

Sediment properties. Sediment problems. Incipient motion of sediment particles. Regimes 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. Birefringent 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

MECHANICAL ENGINEERING

PROGRAMMES

M.Tech.

Ph. D.

COURSE REQUIREMENTS

M.Tech.

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

Ph.D.

Field of Specialization	Thermal Engineering
Required Courses	ME 601, ME 602, ME 603, ME 604
Supporting Courses	Courses from subject matter fields (other than Minor) relating to area of special interest and research problem.
Minor Field	Processing and Food Engineering, Energy Science & Technology or any other as approved by the Dean Postgraduate Studies.
Deficiency Courses	As recommended by the student's Advisory Committee and approved by The Dean, Postgraduates Studies

DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

ME 101 Workshop Technology **1+2** **Sem. I**

(For students of College of Agriculture)

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

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

ME 102 Engineering Drawing and Graphics **0+3** **Sem. II**

(For students of College of Agriculture)

Introduction of drawing scales; Principles of orthographic projections (First and third angle methods of projection); Different methods of dimensioning; References planes; Points and lines in space and traces of lines and planes; True length and inclination of lines; Projections of solids: Change of position method, alteration of ground lines; Concept of sectioning; Section of solids; Development of surfaces of geometrical solids; Isometric projection of geometrical solids; Preparation of manual drawings from models and isometric views of objects and machine components/food equipment; Nomenclature,

thread profiles, multi start threads, left and right hand threads. Square headed and hexagonal nuts and bolts. Conventional representation of threads. Different types of lock nuts, studs, machine screws. Design process, application of computers for design, definition of CAD, benefits of CAD, CAD system components; Computer hardware for CAD. Demonstration on computer graphics and computer aided drafting use of standard software; Practice in the use of basic and drawing commands on AutoCAD; Generating simple 2-D drawings with dimensioning using AutoCAD; Small Projects on food equipment and components using CAD.

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

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

ME 104 Workshop Technology and Practice **1+2** **Sem. II**

Introduction to welding, Oxyacetylene welding, types of flames, welding techniques and equipment. Arc welding and equipment. Casting processes. Lathe: Main accessories and attachments, operations and tools. Types of shapers, constructional details of standard shaper, work holding devices, tools and operations. Types of drilling machines. Constructional details of pillar type and radial drilling machines. Work holding and tool holding devices. Twist drills, drill angles and sizes. Types, constructional details and principles of operation of column and knee type universal milling machine. Plain milling cutter and operations.

Practical: Introduction to various carpentry tools, materials, types of wood and their characteristics and processes or operations in wood working. Preparation of simple joints: Cross half Lap joint and T-Halving joint, preparation of Dovetail joint, mortise and tenon joint. Introduction to smithy tools and operations. Jobs on bending, shaping, drawing, punching, riveting. Introduction to tools and measuring instruments for fitting, jobs on sawing, filing and right angle fitting of MS flat, practical in more complex fitting job. Operations of drilling, reaming and threading with tap and dies. Introduction to tools and operations in sheet metal work, making different types of sheet metal joints using G.I. sheets. Introduction to welding equipment, processes tools, their use and precautions. Jobs on arc welding: Lap, butt, T-Joint and corner joint in arc welding, Gas welding practice: Lap, butt and T-Joints. Introduction to metal casting equipment, tools and their use, mould making using one-piece pattern and two-piece pattern, demonstration of mould making using sweep pattern and match plate patterns. Introduction to machine shop machines and tools, demonstration on processes in machining and use of measuring instruments. Practical jobs on simple turning, step turning, taper turning, drilling and

threading. Operations on shaper and planer, changing a round MS rod into square section on a shaper, demonstration of important operations on a milling machine, making a plot, gear tooth forming and indexing. Any additional job.

ME 106 Food Thermodynamics **2+1** **Sem. II**

(For students of College of Agriculture)

Basic concepts: Definitions, approaches, thermodynamic systems, thermodynamic properties and equilibrium, state of a system, state diagram, path and process, different modes of work, Zeroth law of thermodynamics, concept of temperature, heat. First law of thermodynamics: Energy, enthalpy, specific heats, applications of first law, steady and unsteady flow analysis. Second law of thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, thermodynamic temperature scale, entropy, availability and irreversibility. Properties of pure substances: Thermodynamic properties of pure substances in solid, liquid and vapor phases, P-V-T behaviour of simple compressible substances, phase rule. Thermodynamic cycles: Carnot vapor power cycle, ideal Rankine cycle, Rankine Reheat cycle, air standard Otto cycle, air standard Diesel cycle, air standard Brayton cycle. Psychrometry: Thermodynamic properties of moist air, perfect gas relationship, absolute humidity, relative humidity, percentage humidity, humid volume, total heat, enthalpy, dry bulb temperature, wet bulb temperature, dew point temperature, adiabatic processes, wet bulb depression, humid heat, specific volume, heating, cooling, dehumidifying. Sorption isotherms, Three stages of water, phase diagram for water, vapour pressure-temperature curve for water, heat requirement for vaporization. Measurement of humidity. Properties of steam: Wet, dry saturated, superheated steam. Use of steam tables.

Practical: Determination of dryness fraction of steam. Vapor-compression refrigeration cycle. Determination of state of air using psychometric chart and hygrometer. Use of psychrometric chart during drying process/humidification process. Demonstration of equilibrium sorption isotherms. Visit to food plant with steam utilization.

ME 108 Heat and Mass Transfer **2+0** **Sem. II**

Concept and 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. Electrical analogy. Insulation materials. Fins, Free and forced convection, Newton’s law of cooling, heat transfer coefficient in convection. Dimensional analysis. Useful non dimensional numbers. 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 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, analysis of parallel and counter

flow heat exchangers. Steady state molecular diffusion in fluids at rest and in laminar flow, Flick's law, mass transfer coefficients. Reynold's analogy.

ME 201 Heat and Mass Transfer in Food Processing 2+1 Sem. I

(For students of College of Agriculture) (Practical part to be taught by Department of Processing and Food Engineering)

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

Practical: Heat transfer analysis during conduction and convection. Study on various types of heat exchangers used in food industry. Preparation and calibration of thermocouples. Determination of thermal conductivity of different food products. Study of working principle and constructional details of plate heat exchanger and shell & tube heat exchanger. Determination of overall heat transfer coefficient of shell and tube, plate heat exchangers, jacketed kettle used in food industry. Studies on heat transfer through extended surfaces. Studies on temperature distribution and heat transfer in high temperature short time (HTST) pasteurizer.

ME 202 Fluid Mechanics and Open Channel Hydraulics 2+1 Sem. II

Properties of fluids: ideal and real fluid. Pressure and its measurement. Pascal's law. Pressure forces on plane and curved surfaces, centre of pressure, buoyancy, metacentre and metacentric height, condition of floatation, stability of submerged and floating

bodies. Kinematics of fluid flow: Lagrangian and Eulerian description of fluid motion, 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 of fluid flow: Bernoulli's theorem, venturimeter, orifice meter, nozzle, siphon. Laminar flow: stress-strain relationship, flow between infinite parallel plates both plates fixed, one plate moving, discharge, average velocity. Laminar and turbulent flow in pipes. Darcy's equation for head loss, Moody's diagram, minor and major hydraulic losses through pipes and fittings, flow through network of pipes, hydraulic and energy gradient. Flow through orifices (Measurement of discharge and time). Flow through mouthpieces. Flow over notches and weirs. Chezy's formula for loss of head in pipes. Flow through simple and compound pipes. Open channel design and hydraulics: Chezy's formula, Bazin's formula, Kutter's Manning's formula, velocity and pressure profiles in open channels, hydraulic jump. Dimensional analysis and similitude: Rayleigh's method and Buckingham's pi-theorem, types of similarities, dimensional analysis, dimensionless numbers. Introduction to fluid machinery: pumps and turbines.

Practical: Study of manometers and pressure gauges. Verification of Bernoulli's theorem. Determination of coefficient of discharge of venturi-meter and orifice meter. Determination of coefficient of friction in pipeline. Determination of coefficient of discharge for rectangular and triangular notch. Determination of coefficient of discharge, coefficient of velocity and coefficient of contraction for flow through orifice. Determination of coefficient of discharge for mouth piece. Measurement of force exerted by water jets on flat and hemispherical vanes. Determination of meta- centric height. Determination of efficiency of hydraulic ram. Performance evaluation of Pelton and Francis turbine. Study of current meter. Velocity distribution in open channels and determination of Manning's coefficient of rugosity.

ME 207 Theory of Machines **2+0** **Sem. II**

Elements, links, pairs, kinematics chain and mechanisms. Classification of pairs and mechanisms, lower and higher pairs. Four bar chain, slider crank chain and their inversions. Determination of velocity and acceleration using graphical method (relative velocity and acceleration, instantaneous centers). Introduction to spur, helical, spiral, bevel and worm gears, law of gearing, nomenclature, velocity of sliding between two teeth in mesh, involute and cycloidal profile for gear teeth, interference and undercutting. Simple, compound, reverted and epicyclic trains, determining velocity ratio by tabular method. Flywheel: introduction and applications, turning moment diagrams, coefficient of fluctuation of speed and energy. Belt drives: types, materials and length of belt, power transmitted, velocity ratio, belt size for flat and V belts, effect of centrifugal tension, creep and slip on power transmission. Chain drives. Friction: types, laws of dry friction, friction of pivots and collars, single disc, multiple disc, and cone clutches, rolling friction, anti friction bearings. Governors: types, constructional details and analysis of Watt, Porter, Proell governors, effect of friction, controlling force curves, sensitiveness, stability, hunting, isochronism, power and effort of a governor. Static and dynamic balancing, balancing of rotating masses in one and different planes.

ME 208 Thermodynamics, Refrigeration and Air Conditioning 2+1 Sem. I

Thermodynamic properties and systems, flow and non-flow processes, gas laws, laws of thermodynamics, internal energy. Application of first law in non-flow and steady flow processes. Carnot cycle, Carnot theorem. Entropy, physical concept of entropy, change of entropy of gases in thermodynamic process. Principles of refrigeration, units, terminology, production of low temperatures, vapour refrigeration mechanism, P-V, T-s, P-h diagrams (or) Mollier diagram, vapor compression cycles, dry and wet compression, super cooling and sub cooling. Vapour absorption refrigeration system. Common refrigerants and their properties. Design calculations for refrigeration system. Cold storage plants. Thermodynamic properties of moist air, perfect gas relationship for approximate calculation, adiabatic saturation process, wet bulb temperature and its measurement, psychometric chart and its use, elementary psychometric process. Air conditioning: principles, types and functions of air conditioning, physiological principles in air conditioning. Air distribution and duct design methods, fundamentals of design of complete air conditioning systems. Humidifiers and dehumidifiers. Cooling load calculations. Types of air conditioners and their applications.

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

ME 302 Machine Design 2+0 Sem. I

Design: introduction, phases and considerations. Common engineering materials and their mechanical properties. Types of loads and stresses, theories of failure, factor of safety, selection of allowable stress. Stress concentration. Elementary fatigue and creep aspects. Cotter joints, knuckle joint and pinned joints, turnbuckle. Design of welded joints subjected to static loads. Design of threaded fasteners subjected to direct static loads, bolted joints subjected to shear and eccentric loading. Design of shafts under torsion and combined bending and torsion. Design of keys. Design of muff, sleeve, and rigid flange couplings. Design of helical and leaf springs. Design of flat belt and V-belt drives and pulleys. Design of spur gear. Design of screw motion mechanisms like screw jack and lead screw etc. Selection of anti-friction bearings.

ME 305 Fluid Mechanics 2+1 Sem. II

(For students of College of Agriculture)

Fluid properties, compressible and non-compressible fluids, flow behavior of viscous

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

Practical: Study of different tools and fittings. Study on flow rate versus pressure drop with U-tube manometer. Verification of Bernoulli's theorem. Determination of discharge coefficient for venturi, orifice, V-notch and weir. Verification of emptying time formula for a tank. Determination of critical Reynold's number by Reynold apparatus. Study of reciprocating, centrifugal and gear pump. Calibration of rotameter. Study of different types of valves. Study of pumps for viscous fluid. Determination of meta-centric height. Determination of coefficient of friction in pipeline. Determination of coefficient of discharge of venturimeter and orificemeter.

Elective Course

ME 404 Mechatronics **2+1** **Sem. II**

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

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

optical sensors and transducers. Actuators, mechanical actuation systems, hydraulic & pneumatic actuation systems, electrical actuation systems, A.C. Motor, D.C. Motor, stepper motor. Signal conditioning process, filtering digital signal, multiplexers, data acquisition, digital signal processing, measurement system, pulse modulation, data presentation systems. System modelling& control, mathematical models, engineering systems, electro-mechanical & hydraulic-mechanical systems, modelling dynamic systems, transfer functions, control modes, PID controller. Micro-processor & computer, computer and interfacing, micro-computer structure, micro-controllers, application of microcontrollers, PLC. Robotics, robot components, robot classification and specification, work envelopes, other basic parameters of robots. Robot applications, robot applications in manufacturing, material transfer and machine loading/unloading, processing operations like welding & painting, assembly operations, inspection automation, future applications.

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

Postgraduate Courses

ME 501 Viscous Flow and Convective Heat Transfer 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; thermoelectric 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, Micro geometry of bearing surfaces, self-aligning, floating bushings, high speed and vibration-proof bearings, Lubricants and lubrication systems, types and properties of additives used in lubricants, antifriction (Rolling-elements) bearings, types of rolling element bearings, co-efficient of rolling friction, allowable peripheral speeds, load-carrying capacity and durability, selection of bearing series, high speed bearings, high temperature bearings, design of ball and roller bearings and their lubrication. Mounting of rolling bearings on shafts and installation in the housings.

ME 510 Industrial Heat Transfer 3+0 Sem. I

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, radial fins and fin optimization. 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, subcooling of condensate on COP and capacity, super heating, Single stage, multi- stage and cascade systems. Vapour absorption systems: Theory of mixtures, temp-concentration and enthalpy concentration diagrams, Adiabatic mixing of two systems,

Diabatic mixing, Throttling process, Ammonia water and water lithium bromide systems. Centrifugal and steam jet refrigeration systems. Thermoelectric refrigeration systems, its advantages, comparison with vapour compression system, Vortex tube refrigeration system, its thermodynamic analysis. Ultra low temp refrigeration. Centrifugal and steam jet refrigeration systems: Ejection and Centrifugal refrigeration. Water refrigeration and steam jet refrigeration, its characteristics, effect of boiler efficiency on overall COP actual steam jet system and two fluid jet refrigeration.

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

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

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

Solar radiation: 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, general description, top loss coefficient, heat removal factor, performance of flat plate collectors, all glass collectors. Evacuated solar collector, solar air heating systems, 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+1** **Sem. II**

Combustion: 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 waterheaters, 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 sugarmill. 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 Besseland 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 ductflow. Transition to turbulence. Wall turbulence; internal and external flow. Laminar natural convection. Natural convection in enclosures. Influence of temperature-dependent fluid properties. Forced convection through porous media. Special heat transfer problems; heat transfer in liquid metals and heat transfer with phase change.

ME 603 Design of Solar Energy Systems 3+0 Sem. I

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

ME 604 Advanced Combustion 3+0 Sem. II

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, flames hape and flame height. Laminar diffusion flamejets and laminar Jetmixing. 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

SCHOOL OF RENEWABLE ENERGY ENGINEERING

PROGRAMME

Ph.D.

COURSE REQUIREMENTS

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

DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

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

Concept and limitations of Renewable Energy Sources (RES), potential and classification of RES. Solar, wind, geothermal, biomass and ocean energy sources. Comparison of renewable energy sources with non-renewable sources. Solar energy: energy available, solar radiation data, solar energy conversion into heat through flat plate and concentrating collectors. Different solar thermal devices, principle of natural and forced convection drying system and green house. Solar photovoltaic: p-n junctions, solar cells, SPV systems, stand-alone and grid connected solar power station, calculation of energy through photovoltaic power generation and cost economics. Wind energy: energy available, general formula, lift and drag, coefficient of performance, basis of wind energy conversion, effect of density, frequency variances, angle of attack and wind speed, types of wind mill rotors. Bioenergy: characteristics of biomass, pyrolysis of biomass to produce solid, liquid and gaseous fuels. Introduction to biomass gasification and gasifiers. Biomass cook-stoves. Biogas: fundamentals, biochemistry and factors affecting biogas generation, types and design consideration of domestic biogas plants, uses, applications and handling of bio-digested slurry.

Practical: Study of solar devices: cookers, water heating system, dryers, desalination unit and green house for agriculture production. Study and performance evaluation of different biogas plants and biomass gasifiers (throat less and downdraft). Study of biomass improved cook-stoves. Estimation of calorific value of biomass, biogas and producer gas.

EST 202 Renewable Energy and Green Technology 1+1 Sem. II

(For students of Agriculture Students)

Classification of energy sources, renewable energy sources and its contribution in agricultural sector, familiarization with biomass utilization for biofuel production and their applications. Biogas, familiarization with types of biogas plants and gasifiers, Gasification and gasifiers. Biomass briquetting. Bio-alcohol, biodiesel and bio-oil production and their utilization. Introduction of solar energy, collection and applications. Familiarization with solar energy gadgets: solar cooker, solar water heater, application of solar energy: solar drying, solar pond, solar distillation and solar photovoltaic system. Introduction to wind energy and its applications.

Practical: Familiarization with renewable energy gadgets. Study of biogas plants, gasifiers, production process of bio-fuels and briquetting machine. Familiarization with different solar energy gadgets. Study of solar photovoltaic system: solar light, solar pumping, solar fencing and solar rooftop. Study of solar cooker, solar dryer, solar distillation, solar pond and solar water heater.

EST 301 Renewable Power Sources **2+1** **Sem. I**

Energy consumption pattern and resources in India. Design and use of different commercial sized biogas plants, generation of power from biogas. Power generation from urban, municipal and industrial waste. Purification and bottling of biogas. History of small gas producer engine system. Power generation from biomass (gasification and Dendro thermal). Shaft power generation, thermal application. Solar thermal and photovoltaic systems for power generation, central receiver (Chimney) and distributed type solar power plants. Ocean thermal energy conversion (OTEC), magneto hydrodynamic generator (MHD). Hydrogen and fuel cell technology. Fuel cells and its associated parameters. Introduction of wind energy generators, working principle of wind power plants, wind farms. Mini, micro and small hydel plants. Cost economics of power generation.

Practical: Performance evaluation of solar water heater, solar cooker and solar air heater/dryer. Solar photovoltaic system and its characteristics. Effect of shading on photovoltaic panel. Diesel engine operation using dual fuel (diesel and biogas) and biogas alone. Visit to commercial/ institutional power generation biogas plant and biogas bottling plant.

EST 302 Bio-Energy Systems: Design and Applications **2+1** **Sem. II**

Assessment of available biomass and its analysis for bio-energy production, biomass preparation techniques for harnessing (size reduction, densification and drying). Fermentation processes and its general requirements, an overview of aerobic and anaerobic fermentation processes and their industrial applications. Heat transfer processes in anaerobic digestion systems, benefits and problems of anaerobic digestion, land fill gas technology and potential. Biomass Production: Wastelands, classification and their use through energy plantation, selection of species, methods of field preparation and transplanting. Harvesting of biomass and coppicing characteristics. Thermo-chemical degradation of biomass, principles of combustion, concept of excess air and chemistry of gasification. Gasifier fuels, properties, preparation and conditioning of producer gas. Trans-esterification for biodiesel production, Bio-hydrogen production routes, Environmental aspect of bio-energy, assessment of greenhouse gas mitigation potential.

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

Postgraduate Courses

EST 501/FMP 511 Agro-energy Audit and Management **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 modelling.

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 SO_2 and NOx; Efficient/ cleaner transport options and their effects on energy use; Other options to improve energy use and environment in urban areas.

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

Energy requirements for agricultural inputs like Fertilizers and manures, Pesticides, Machinery and fuel, Irrigation, Labour, Land, Transportation, Draft animals etc.; Agricultural energetic factors, energy norms and their computations; energy analysis: methods, problems and limitations; energy analysis of household activities, crop and

livestock production systems including poultry and piggery; use of alternate energy sources for agricultural purposes; Evaluation of alternate energy sources and specific practices, substitution of energetic factors amongst themselves.

EST 602 Biomass Energy Conversion 2+1 Sem. I

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

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

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

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

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

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

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

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

Energy management activities and approaches, Trends in computer based energy management, Philosophy of control for energy processes, Design procedure for an

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

EST 591 Seminar

EST 700 Doctoral Research

ELECTRICAL ENGINEERING AND INFORMATION TECHNOLOGY

A. ELECTRICAL ENGINEERING

PROGRAMMES

M.Tech.

Ph.D.

COURSE REQUIREMENTS

M. Tech.

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

Ph. D.

Field of Specialization	Electrical Engineering
Required Courses	EE 601
Supporting Courses	MGT 511 or as recommended by the student's Advisory Committee
Minor Field	Computer Science and Engineering or any other appropriate field as recommended by the student's Advisory Committee
Deficiency Courses	As recommended by the student's Advisory Committee and approved by the Dean, Postgraduates Studies

DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

EE 101 Electrical Engineering 2+1 Sem. I

(For students in College of Agriculture)

AC Fundamentals: Definitions of cycle, frequency, time period, amplitude, Peak value, RMS value, Average value, Electro motive force, reluctance etc, laws of magnetic circuits, Phase relations and vector representation, AC through resistance, inductance and capacitance, A.C. series and parallel circuits, Simple R-L, R-C and R-L-C circuits, 3 Phase Systems: Star and Delta connections, Relationship between line and phase voltages and currents in Star and Delta connections, various methods of single and three phase power measurement. Transformer : Principle of working, construction of single phase transformer, emf equation, Phasor diagrams, Ideal transformer, transformer on no load, Transformer under load, Equivalent circuits, Transformer losses, efficiency, Regulation, Open and short circuit test. Single phase induction motor: double field revolving theory, equivalent circuit, characteristics, phase split, shaded pole motors. Poly-phase induction motor: Construction, operation, equivalent circuit, phasor diagram, effect of rotor resistance, torque equation, starting and speed control methods, D.C. Machine (generator and motor): Types, Construction and Operation, EMF equation, armature reaction, commutation of D.C. generator and their characteristics, D.C. Motors, their starting, speed controls and characteristics.

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

EE 204 Electrical Machines and Power Utilization 2+1 Sem. I

Various methods of three phase power measurement. Power factor, reactive and apparent power, Concept and analysis of balanced poly-phase circuits. Series and parallel resonance. Electromotive force, reluctance, laws of magnetic circuits, determination of ampere-turns for series and parallel magnetic circuits, hysteresis and eddy current losses. Transformer: principle of working, construction of single phase transformer, emf equation, phasor diagram on load, leakage reactance, voltage regulation, power and

energy efficiency, open circuit and short circuit tests. Principle, 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. Poly-phase induction motor: construction, operation, phasor diagram, effect of rotor resistance, torque equation, condition for maximum torque, starting and speed control methods. Single phase induction motor: double field revolving theory, equivalent circuit, characteristics, phase split, shaded pole motors and fractional horsepower motors.

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

EE 206 Electronics and Instrumentation 2+1 Sem. II

(For students in College of Agriculture Engineering & Technology and College of Agriculture)

Semiconductors. P-N junction. V-I characteristics of P-N junction. Diode as a circuit element: rectifier, clipper, clamper, voltage multiplier, filter circuits, diode circuits for OR and gates (both positive and negative logic). Bipolar junction transistor, operating point, classification (A, B and C) of amplifier, characteristics of common emitter NPN transistor, various biasing methods (fixed, self, potential divider bias). Coupling of amplifiers, h-parameter model of a transistor: Analysis of small signal Common Emitter amplifier, analysis of differential amplifier using transistor. Ideal Operational Amplifier characteristics, linear and non-linear applications of OP-AMP as adder, subtractor, integrator, active rectifier, comparator, differentiator, differential amplifier, instrumentation amplifier and oscillator. Zener diode as voltage regulator. Transistor series regulator: Current limiting, OP-AMP voltage regulator. Basic theorems of Boolean algebra. Combinational logic circuits (basic gates, Sum of Product rule and K-map). Binary ladder D/A converter, successive approximation A/D converter. Generalized instrumentation system. Measurement of displacement, temperature, velocity, force and pressure using potentiometer, resistance thermometer, thermocouples, Bourden tube, LVDT, Strain gauge and tacho-generator.

Practical: Study of diode characteristics. Study of Zener diode. Study of V-I characteristics of P-N junction diode. Study of RC coupled amplifier. Study of full wave rectifier. Verification of logic gates. Determination of energy gap in a junction diode. Study of transistor characteristics in CE configuration. Study of OP-AMP IC 741 as differential amplifier. Study of half wave rectifier. Study of OP-AMP IC 741 as active rectifier, inverting and non- inverting amplifier, differentiator, integrator and comparator. Study of transistor characteristics. Study of temperature characteristics of resistor. Study of diode as clipper and clamper.

EE 304 Instrumentation and Process Control in Food Industry 2+1 Sem. II

(For students in College of Agriculture)

Introduction, definitions, characteristics of instruments. Temperature and temperature scales. Various types of thermometers: thermocouples, resistance thermometers and pyrometers. Pressure and pressure scales, manometers, pressure elements, differential pressure. Liquid level measurement. Flow measurement: kinds of flow, rate of flow, total flow. Variable area meters, food flow metering. Weight measurement: mechanical scale, electronic tank scale, conveyor scale. Measurement of moisture content, specific gravity, humidity, viscosity, turbidity, color, density, brix, pH. Enzyme sensors, automatic valves. Transmission: pneumatic, control elements, control actions, pneumatic control systems. Process control: definition, simple system analysis. Transducers: classification, self-generating transducers, variable parameter type, digital, actuating and controlling devices. Controllers and indicators: temperature control, electronic controllers, flow ratio control, atmosphere control, timers and indicators, food sorting and grading control. Introduction to controllers, computer-based monitoring and control, examples in food processing.

Practical : Study on instrumentation symbols; Determination of relative humidity by wet and dry bulb thermometer; Measurement of wind velocity by anemometer; Measurement of intensity of sun shine by sunshine recorders; Study of characteristics of pressure transducers, characteristics of IC temperature sensor, characteristics of platinum RTD, temperature controlled alarm system; Study of water level to current conversion; Study of characteristics of capacitive transducer.

Postgraduate Courses

EE 501 Applied Electronics 2+1 Sem. II

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

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 254 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, frequencydomain 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. MagnetoHydrodynamic 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 **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

PROGRAMME

M. Tech.

COURSE REQUIREMENTS

M. Tech.

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

DESCRIPTION OF COURSE CONTENTS

Undergraduate Courses

CSE 101 Information and Communication Technology in Agriculture 1+2 Sem. I & II

(All degree programmes except B.Tech-Agril. Engg.)

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

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

CSE 204 Computer Programming & Data Structures 1+2 Sem. I & II

Introduction to high level languages, Primary data types and user defined data types, Variables, typecasting, Operators, Building and evaluating expressions, Standard library functions, Managing input and output, Decision making, Branching, Looping, Arrays, User defined functions, passing arguments and returning values, recursion, scope and visibility of a variable, String functions, Structures and union, Pointers, Stacks, Push/Pop operations, Queues, Insertion and deletion operations, Linked lists.

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

CSE 205 Web Designing and Internet Applications 1+1 Sem. II

Basic principles in web designing, planning process, rules of web designing, designing navigation bar, page design, homepage layout, design concept. Basics in Web Design: basic HTML tags, attributes and elements, adding images, creating tables, developing web pages, changing layout using cascading style sheets. Brief history of Internet, World Wide Web, creation of a web site, Web standards. Introduction to JavaScript, variables and functions, working with alert, confirm and prompt. Basic concepts of database.

Practical: Use of available software for: Animation concept, understanding animation for web, animation interface, working with animation tools. Exploring web development software interface, planning & setting website structure, working with panels, understanding and switching views, using property inspector, formatting text. Java Script: working with alert, confirm and prompt, understanding loop, arrays, creating rollover image, working with operators. File Transfer Protocol: learning to use FTP, setting up FTP server, uploading of site, using control panel. Understanding GIF animation interface, knowing GIF file format, creating basic web banners, creating web banners with effects, creating animated web buttons. Project.

CSE 102 Basics of Computer Science and Bio-informatics in Agriculture 1+2 Sem. I

Information Technology (IT) and its importance. IT Tools. IT-enabled services and their impact on society: Introduction to computers, hardware and software, input and output devices, word and character representation: features of machine language, assembly language, high-level language and their advantages and disadvantages: Operating System, definitions and types. Applications of word processing/Spreadsheet/Presentation: document creation and editing, data presentation, interpretation and graph creation, statistical analysis, mathematical expressions. Introduction to Local area network (LAN), Wide area network (WAN), Internet and World Wide Web, HTL and IP and Video Conferencing, Introduction to e-Agriculture concepts and applications, Use of ICT in Agriculture.

Bio-Informatics: Introduction to Bioinformatics and its application in Agriculture, Database concepts and types, uses of DBMA in Agriculture: Biological databases: NCBI searching.

Practical: Practice with latest operating system for creating Files and Folders, File Management, Use of Word Processing/Spreadsheet/Presentation with latest software packages: Creating spreadsheet, use of statistical tools, writing expressions, creating graphs, analysis of scientific data. Creation and operation of Email account: demonstration of Agri-information system using Mobile Apps, Internet Applications: Web Browsing, Creation and operation of Email account: handling of audio-visual equipment’s. Planning preparation, presentation of Posters, charts, Searching and retrieval of information from biological databases, Sequence alignment using BLAST.

Postgraduate Courses

CSE 501 Computer Engineering 2+1 Sem. I

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, inter-processor 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. 259 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 approved by the Dean, Postgraduates Studies.

PGDCA

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

DESCRIPTION OF COURSE CONTENTS

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

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

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

IT 502 Operating System 3+1 Sem. I

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

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

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

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, passingarrays 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/OHandling, 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

		Cr. Hrs.
I. College of Agriculture		
Agron. 102	Principles of Agronomy	1+1
ENV 101	Environmental studies and Disaster Management	2+0
Soils 102	Principles of Soil Science	1+1
Hort. 203	Principles of Horticultural Crops and Plant Protection	1+1
II. College of Basic Sciences & Humanities		
Eng. 101	General English	1+1
Eng. 201	Communication Skills and Personality Development	1+1
Phys. 203	Engineering Physics	2+1
Mgt. 201	Entrepreneurship Development and Business Management	2+1
Chem. 205	Engineering Chemistry	2+1
Math. 201	Engineering Mathematics-I	2+1
Math. 202	Engineering Mathematics-II	2+1
Math. 301	Engineering Mathematics-III	2+1
Pbi 101	Basic Punjabi	0+2
PbiCul. 101	Punjabi Culture	2+0
III. College of Home Science		
HDFS 106	Human Values	1+0
IV. College of Agricultural Engineering and Technology		
CE 105	Soil Mechanics	2+1
CE 106	Surveying and Levelling	1+2
CE 108	Engineering Mechanics	2+1
CE 207	Watershed Hydrology	1+1
CE 208	Strength of Materials	2+1
CE 306	Building Construction and Cost Estimation	2+0
CE 307	Design of Structures	2+1
FMP 201	Tractor and Farm Machinery Operation	0+1
FMP 203	Farm Machinery and Equipment- I	2+1
FMP 302	Tractor and Automotive Engines	2+1
FMP 306	Farm Machinery and Equipment-II	2+1
FMP 307	Tractor Systems and Controls	2+1
FMP 311	Tractor and Farm Machinery Maintenance	0+1
ME 103	Engineering Drawing	0+2
ME 104	Workshop Technology and Practice	1+2
ME 108	Heat and Mass Transfer	2+0
ME 202	Fluid Mechanics and Open Channel Hydraulics	2+1
ME 207	Theory of Machines	2+0
ME 208	Thermodynamics, Refrigeration and Air Conditioning	2+1
ME 302	Machine Design	2+0

PFE 204	Engineering Properties of Agricultural Produce	1+1
PFE 304	Agricultural Structures and Environmental Control	2+1
PFE 305	Post Harvest Engineering of Cereals, Pulses and Oil Seeds	2+1
PFE 306	Post Harvest Engineering of Horticultural Crops	2+1
PFE 307	Dairy and Food Engineering	2+1
CSE 204	Computer Programming and Data Structures	1+2
CSE 205	Web Designing and Internet Applications	1+1
EE 204	Electrical Machines and Power Utilization	2+1
EE 206	Electronics and Instrumentation	2+1
EST 201	Fundamentals of Renewable Energy Sources	2+1
EST 301	Renewable Power Sources	2+1
EST 302	Bio-energy Systems: Design and Applications	2+1
SWE 201	Irrigation Engineering	2+1
SWE 202	Soil and Water Conservation Engineering	2+1
SWE 203	Sprinkler and Micro Irrigation Systems	1+1
SWE 301	Water Harvesting and Soil Conservation Structures	2+1
SWE 302	Drainage Engineering	1+1
SWE 303	Watershed Planning and Management	2+1
SWE 304	Groundwater, Wells and Pumps	2+1

Project and Practical Training Courses

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

Elective Courses

Each student has to register three elective courses out of the courses listed below:

FMP 411	Tractor Design and Testing	2+1
FMP 412	Farm Machinery Design and Production	2+1
FMP 413	Mechanics of Tillage and Traction	2+1
FMP 414	Ergonomics and Safety	2+1
FMP 415	Hydraulic Drives and Controls	2+1
FMP 416	Precision Agriculture and System Management	2+1
FMP 417	Machinery for Crop Residue and Fodder Management	2+1
FMP 418	Farm Power and Machinery Management	2+1
PFE 401	Development of Processed Products	2+1
PFE 402	Food Quality and Control	2+1
PFE 403	Process Equipment Design	2+1
PFE 404	Food Plant Design and Management	2+1
PFE 405	Food Packaging Technology	2+1
PFE 406	Waste and By-Product Utilization	2+1
SWE 401	Floods and Control Measures	2+1
SWE 402	Wasteland Development	2+1
SWE 403	Information Technology for Land and Water Management	2+1
SWE 404	Remote Sensing and Geographic Information System	2+1
SWE 405	Design and Management of Canal Irrigation System	2+1

SWE 406	Minor Irrigation and Command Area Development	2+1
SWE 407	Precision Farming Techniques for Protected Cultivation	2+1
SWE 408	Water Quality and Management Measures	2+1
SWE 409	Landscape Irrigation Design and Management	2+1
SWE 410	Plastic Applications in Agriculture	2+1
ME 404	Mechatronics	2+1

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

FIRST YEAR

Semester I			Semester II		
Course No.	**Title of the Course**	**Credit Hour**	**Course No.**	**Title of the Course**	**Credit Hour**
Math. 201	Engineering Mathematics-I	3(2+1)	CE 106	Surveying and Levelling	3(1+2)
Phys. 203	Engineering Physics	3(2+1)	CE108	Engineering Mechanics	3(2+1)
Chem. 205	Engineering Chemistry	3(2+1)	ME 104	Workshop Technology and Practice	3(1+2)
Soils 102	Principles of Soil Science	2(1+1)	ME 108	Heat and Mass Transfer	2(2+0)
CSE 204	Computer Programming and Data Structures	3(1+2)	Agron. 102	Principles of Agronomy	2(1+1)
CE 105	Soil Mechanics	3(2+1)	Math 202	Engineering Mathematics-II	3(2+1)
ME 103	Engineering Drawing	2(0+2)	ENV 101	Environmental studies and Disaster Management	2(2+0)
Pbi 101/Pbicul 101	Basic Punjabi / Punjabi Culture	2(0+2)/ 2+0(NC)	HDFS 106	Human Values	1(1+0)
NSS/NCC/NSO	NSS/NCC/NSO	1(0+1)NC	Eng. 101	General English	2(1+1)
				NSS/NCC/NSO	1(0+1)NC
	Total 20(10+10)/ 22(10+12)/ 22(12+10)			Total 22(13+9)	

SECOND YEAR

Semester III			Semester IV		
CE 207	Watershed Hydrology	2(1+1)	CSE 205	Web Designing and Internet Applications	2(1+1)
CE 208	Strength of Materials	3(2+1)	ME 207	Theory of Machines	2(2+0)
Hort. 203	Principles of Horticultural Crops and Plant Protection	2(1+1)	ME 202	Fluid Mechanics and Open Channel Hydraulics	3(2+1)
FMP 201	Tractor and Farm Machinery Operation	1(0+1)	EE 206	Electronics and Instrumentation	3(2+1)
Math. 301	Engineering Mathematics-III	3(2+1)	SWE 202	Soil and Water Conservation Engineering	3(2+1)
ME 208	Thermodynamics, Refrigeration and Air Conditioning	3(2+1)	Mgt. 201	Entrepreneurship Development and Business Management	3(2+1)
EE 204	Electrical Machines and Power Utilization	3(2+1)	SWE 203	Sprinkler and Micro Irrigation Systems	2(1+1)
EST 201	Fundamentals of Renewable Energy Sources	3(2+1)	FMP 203	Farm Machinery and Equipment- I	3(2+1)
SWE 201	Irrigation Engineering	3(2+1)	PFE 204	Engineering Properties of Agricultural Produce	2(1+1)
NSS/ NCC/ NSO	NSS/ NCC/ NSO	1(0+1)NC	NSS/ NCC/ NSO	NSS/ NCC/ NSO	1(0+1)NC
	Total 24(14+10)			Total 24(15+9)	

THIRD YEAR

Semester V			Semester VI		
ME 302	Machine Design	2(2+0)	SWE 303	Watershed Planning and Management	3(2+1)
CE 306	Building Construction and Cost Estimation	2(2+0)	SWE 304	Groundwater, Wells and Pumps	3(2+1)
PFE 304	Agricultural Structures and Environmental Control	3(2+1)	FMP 307	Tractor Systems and Controls	3(2+1)
PFE 305	Post Harvest Engineering of Cereals, Pulses and Oil Seeds	3(2+1)	FMP 311	Tractor and Farm Machinery Maintenance	1(0+1)
FMP 302	Tractor and Automotive Engines	3(2+1)	PFE 306	Post Harvest Engineering of Horticultural Crops	3(2+1)
SWE301	Water Harvesting and Soil Conservation Structures	3(2+1)	PFE 307	Dairy and Food Engineering	3(2+1)
SWE 302	Drainage Engineering	2(1+1)	EST 302	Bio-energy Systems: Design and Applications	3(2+1)
EST 301	Renewable Power Sources	3(2+1)	Eng.201	Communication Skills and Personality Development	2(1+1)
FMP 306	Farm Machinery and Equipment-II	3(2+1)	CE 307	Design of Structures	3(2+1)
EDT 391*	Educational Tour	2(0+2) NC			
	Total 26(17+9)			Total 24(15+9)	

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

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

FOURTH YEAR

Semester VII Student READY			Semester VIII Student READY		
IAP 491*	Industrial Attachment for Agricultural Engineering	10(0+10) NC	I	Elective course	3(2+1)
SDT 491**	Skill Development Training in Agricultural Engineering	10(0+10)	II	Elective course	3(2+1)
ELP 491***	Experiential Learning Program in Agricultural Engineering	10(0+10)	III	Elective course	3(2+1)
			PPR 491	Project Planning and Report Writing	10(0+10)
	Total	30(0+30)		Total	19(6+13)

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

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

***Each student will choose one out of four modules ELP-1, ELP-2, ELP-3, ELP-4

Skill Development Training in Agricultural Engineering (SDT 491)
Four Modules (all are compulsory for every student)

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

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

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

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

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

Basic Concepts: An introduction to domain names, web servers, and website hosting, Building your first web page: The structure of an HTML page, HTML tags, HTML code examples, Introduction to website, Absolute vs Relative URL, basic layout, basic color scheme and fonts. An Introduction to CSS: Tags used in this CSS based layout, Basic concepts in Java Script programming.

SDT-4 Campus to Corporate (1 week) – Training Unit and Placement

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

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

Each student will choose one of the following

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

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

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

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

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

Design, installation and operation of micro irrigation system: orientation, components, design of main, sub main, and lateral, selection of pipe and emitter, material

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

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

Hands on learning of the lab scale biogas production from untreated and pretreated biomass, training on construction of Cattle dung /poultry dropping based Biogas plant, training on construction of crop residue / paddy straw based dry fermentation biogas plant, testing of Solar Photovoltaic, fabrication and Testing of Solar Thermal Gadgets, introduction to Various Thermo-chemical Conversion Processes, hands on Learning of Torification Process, Pyrolysis Process and Charcoal Making Process, hands on Learning of the Pellets and Briquetting Process, an Introduction to liquid biofuels and hands on experience of biodiesel preparation from plant oils at laboratory scale, energy Management and Auditing.

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

Semester	Credit Hours including NC	Theory	Practical	NC
Sem 1	20*	10	10	1 NC
Sem 2	22	13	9	1 NC
Sem 3	24	14	10	1 NC
Sem 4	24	15	9	1 NC
Sem 5	26	17	9	2 NC
Sem 6	24	15	9	
Sem 7	30	0	30	10 NC
Sem 8	19	6	13	
Total	**189**	**90**	**99**	**16 NC**

*Students who do not opt Basic Punjabi and Punjabi Culture

Credit Load of Students with Basic Punjabi

Semester	Credit hours including NC	Theory	Practical	NC
Sem 1	22	10	12	3NC
Total	**191**	**90**	**101**	**18 NC**

Credit Load of Students with Punjabi Culture

Semester	Credit hours including NC	Theory	Practical	NC
Sem 1	22	12	10	3NC
Total	**191**	**92**	**99**	**18 NC**