

Section 1: Engineering Mathematics

Linear Algebra: Matrices and determinants, linear and orthogonal transformations, Caley-Hamilton theorem; Eigenvalues and Eigenvectors, solutions of linear equations.

Calculus: Limit, continuity and differentiability; partial derivatives; homogeneous function – Euler’s theorem on homogeneous functions, total differentiation; maxima and minima of function with several independent variables; sequences and series – infinite series, tests for convergence; Fourier, Taylor and MacLaurin series.

Vector Calculus: Vector differentiation, scalar and vector point functions, vector differential operators – del, gradient; divergence and curl; physical interpretations-line, surface and volume integrals; Stokes, Gauss and Green’s theorems.

Differential Equations: Linear and non-linear first order Ordinary Differential Equations (ODE); homogeneous differential equations, higher order linear ODEs with constant coefficients; Laplace transforms and their inverse; Partial Differential Equations - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; random variables; Poisson, normal and binomial distributions; correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; numerical integration - trapezoidal and Simpson’s rule; numerical solutions of ODEs.

Section 2: Farm Machinery

Machine Design: Design and selection of machine elements – gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, stress, torque, speed, displacement and acceleration on machine elements - shafts, couplings, keys, bearings and knuckle joints.

Farm Machinery: Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage, sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting and threshing calculation of performance parameters - field capacity, efficiency, application rate and losses; cost analysis of implements and tractors.

Section 3: Farm Power

Sources of Power: Sources of power on the farm - human, animal, mechanical, electrical, wind, solar and biomass; bio-fuels.

Farm Power: Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems – fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C. engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses; performance index, cost analysis of implements and tractors.

Tractors and Power tillers: Type, selection, maintenance and repair of tractors and power tillers; tractor clutches and brakes; power transmission systems – gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches - free link and restrained link operations; steering and hydraulic control systems used in tractors; tractor tests and performance; human engineering and safety considerations in design of tractor and agricultural implements.

Section 4: Soil and Water Conservation Engineering

Fluid Mechanics: Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; continuity equation, kinematics and dynamics of flow; Bernoulli’s theorem; laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody’s diagram; flow through orifices, weirs and notches; flow in open channels, dimensional analysis – concepts of geometric dimensionless numbers.

Soil Mechanics: Engineering properties of soils; fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr’s circle of stress, active and passive earth pressures; stability of slopes, Terzaghi’s one dimensional soil consolidation theory.

Hydrology: Hydrological cycle and measurement of its components; meteorological parameters and their measurement; analysis of precipitation data; runoff estimation; hydrograph analysis, unit hydrograph theory and application; streamflow measurement; flood routing, hydrological reservoir and channel routing, Infiltration – indices and equations, drought and its classification.

Surveying and Leveling: Measurement of distance and area; instruments for surveying and leveling; chain surveying, methods of traversing; measurement of angles and bearings, plane table surveying; types of leveling; theodolite traversing; contouring; total station, introduction to GPS survey, computation of areas and volume.

Soil and Water Erosion: Mechanics of soil erosion - wind and water erosion: soil erosion types, factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion; terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; earthen dams.

Watershed Management: Watershed characterization and land use capability classification; water budgeting in watershed, rainwater harvesting, check dams and farm ponds.

Section 5: Irrigation and Drainage Engineering

Soil-Water-Plant Relationship: Water requirement of crops; consumptive use and evapotranspiration; measurement of infiltration, soil moisture and irrigation water infiltration.

Irrigation Water Conveyance and Application Methods: Design of irrigation channels and underground pipelines; irrigation scheduling; surface, sprinkler and micro irrigation methods, design and evaluation of irrigation methods; irrigation efficiencies.

Agricultural Drainage: Drainage coefficient; planning, design and layout of surface and sub-surface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality and reuse; non-conventional drainage system.

Groundwater Hydrology: Groundwater occurrence; Darcy's Law, steady and unsteady flow in confined and unconfined aquifers, groundwater exploration techniques; overview of groundwater recharge estimation and artificial recharge techniques.

Wells and Pumps: Types of wells, steady flow through wells; design and construction of water wells; classification of pumps; pump characteristics; pump selection and installation.

Section 6: Agricultural Process Engineering

Engineering properties of agriculture produce: Physical, thermal, frictional, rheological and electrical properties.

Evaporation and Drying: Concentration and drying of liquid foods – evaporators, tray, drum and spray dryers; hydrothermal treatments; drying and milling of cereals, pulses and oilseeds; drying kinetics; psychrometry – properties of air-water vapor mixture.

Size Reduction and Material Handling: Mechanics and energy requirement in size reduction of agriculture produce; particle size analysis for comminuted solids; size separation by screening; fluidization of granular solids-pneumatic, bucket, screw and belt conveying; cleaning and grading; effectiveness of separation; centrifugal separation of solids, liquids and gases; homogenization; filtration and membrane separation.

Processing of Agriculture Produce: Processing of seeds, spices, fruits and vegetables; value addition of agriculture produce.

Storage Systems: Controlled and modified atmosphere storage; perishable food storage, godowns, bins and grain silos, packaging material and machines.

Section 7: Dairy and Food Engineering

Heat and Mass Transfer: Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations; material and energy balances in food processing systems; water activity, sorption and desorption isotherms.

Preservation of Food: Kinetics of microbial death – pasteurization and sterilization of milk and other liquid foods; preservation of food by cooling and freezing; refrigeration and cold storage basics and applications.