

### 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.