

## Agricultural Engineering

### Section 1: Engineering Mathematics

**Linear Algebra:** Matrices and determinants, systems of linear equations, Eigen values and eigen vectors.

**Calculus:** Limit, continuity and differentiability; partial derivatives; maxima and minima; sequences and series; tests for convergence; Fourier series, Taylor series.

**Vector Calculus:** Gradient; divergence and curl; line; surface and volume integrals; Stokes, Gauss and Green's theorems.

**Differential Equations:** Linear and non-linear first order Ordinary Differential Equations (ODE); Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; 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; tests of significance, analysis of variance (ANOVA).

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

### 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, torque, speed, displacement and acceleration on machine elements.

**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, threshing and transport; testing of agricultural machinery and equipment; 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.

**Tractors and Powertillers:** Type, selection, maintenance and repair of tractors and powertillers; 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; mechanical steering and hydraulic control systems used in tractors; tractor tests and performance. Human engineering and safety 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; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy- Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

**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.

**Hydrology:** Hydrological cycle and components; meteorological parameters, their measurement and analysis of precipitation data; runoff estimation; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

**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; the odolite traversing; contouring; computation of areas and volume.

**Soil and Water Erosion:** Mechanics of soil erosion, soil erosion types, wind and water erosion, 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; land use capability classification; rain water harvesting structures, 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.

**Groundwater Hydrology:** Groundwater occurrence; Darcy's Law, steady flow in confined and unconfined aquifers, evaluation of aquifer properties; groundwater recharge.

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

## Section 6: Agricultural Processing Engineering

**Drying:** Psychrometry – properties of air-vapors mixture; concentration and drying of liquid foods – evaporators, tray, drum and spray dryers; hydrothermal treatment; drying and milling of cereals, pulses and oilseeds.

**Size Reduction and Conveying:** Mechanics and energy requirement in size reduction of granular solids; 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 grain cleaners; centrifugal separation of solids, liquids and gases.

**Processing and By-product Utilization:** Processing of seeds, spices, fruits and vegetables; By-product utilization from processing industries.

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

## 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.