

AG Agricultural Engineering**Section 1: Engineering Mathematics**

Linear Algebra: Matrices and determinants, linear and orthogonal transformations, Cayley-Hamilton theorem; Eigenvalues and eigenvectors, system of linear equations.

Calculus: Limit, continuity and differentiability; Partial derivatives; Homogeneous functions – 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 (ODEs); 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; Biofuels.

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; Stream flow 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 agricultural 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 agricultural 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 Agricultural Produce: Processing of seeds, spices, fruits and vegetables; Value addition of agricultural 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.