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| <b>Section 1:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Engineering Mathematics</b> |
| <p><b>Linear Algebra:</b> Matrices and determinants, linear and orthogonal transformations, Caley Hamilton theorem; Eigen values and Eigen vectors, solutions of linear equations.</p> <p><b>Calculus:</b> 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.</p> <p><b>Vector Calculus:</b> 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.</p> <p><b>Differential Equations:</b> 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.</p> <p><b>Probability and Statistics:</b> Mean, median, mode and standard deviation; random variables; Poisson, normal and binomial distributions; correlation and regression analysis.</p> <p><b>Numerical Methods:</b> Solutions of linear and non-linear algebraic equations; numerical integration - trapezoidal and Simpson’s rule; numerical solutions of ODEs.</p> |                                |
| <b>Section 2:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Farm Machinery</b>          |
| <p><b>Machine Design:</b> 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.</p> <p><b>Farm Machinery:</b> 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, tractor and renewable energy operated equipment for tillage, sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting and threshing, calculation of performance parameters - field capacity, efficiency, performance index, application rate and losses; cost analysis of implements and tractors, equipment for precision agriculture.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                |
| <b>Section 3:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Farm Power</b>              |
| <p><b>Sources of Power:</b> Sources of power on the farm — human, animal, mechanical, electrical, wind, solar and biomass; bio-fuels and their use in farm mechanization.</p> <p><b>Farm Power:</b> 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, engine performance curves; calculation of power, torque, fuel consumption, heat load and power losses;</p> <p><b>Tractors and Power tillers:</b> 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;</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                |

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; 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, Soil compaction and Proctor test, 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 levelling; chain surveying, methods of traversing; measurement of angles and bearings, plane table surveying; types of levelling; the 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; ground water movement; 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.

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| <b>Section 6:</b> | <b>Agricultural Process Engineering</b> |
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**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; osmotic dehydration and freeze drying; 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.

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| <b>Section 7:</b> | <b>Dairy and Food Engineering</b> |
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**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.

**Unit operations in Dairy and Food engineering:** Blanching, homogenization, pasteurization, sterilization.

**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.