
AGRICULTURAL PHYSICS (58)

Unit 1: Basic agricultural Physics

Conservation of mass, energy and momentum; Forces in nature; Measurement of heat, specific heat, heat transfer processes; Huygens' principle, reflection, refraction, diffraction, polarization, interference and scattering of light waves; Optics theory, principles of optical instruments; Change of phase and polarization, electricity and magnetism; Elasticity, stress-strain relationship, moduli of elasticity, Hook's law and strength of materials; Hydrostatic pressure, surface tension, capillary rise and contact angle, Hydrodynamics- laminar and streamline flow, Poiseuille's equation, Stoke's law, equations of state, Laws of thermodynamics; Free energy, Entropy and concept of negative entropy; Van't Hoff Equation;

Unit 2: Soil Physics

Factors and processes of soil formation; Physical properties of soils; Soil texture, mass- volume relationship; Soil structure, aggregation, porosity, pore size distribution; Soil water measurements, Soil water potential; Soil water retention and movement under saturated and unsaturated conditions; Characterization of the Vadoze zone, Infiltration, redistribution and evaporation of soil water; Field water balance and water use efficiency; Irrigation methods : surface and pressurised irrigation systems-Merits and demerits; Groundwater recharging; Soil aeration; Thermal properties of soil and heat transport and measurement techniques; Influence of soil water, temperature and aeration on crop growth and their management; Solute transport in soils, Movement of pollutant through soil to ground water, Soil quality indices, Soil physical constraints and their management. Soil tillage and tillage, Resource conserving technologies and Conservation agriculture; Dynamics of soil physical environment under diverse soil and crop management.

Unit 3: Soil and water conservation and watershed management

Hydrologic cycle, precipitation, infiltration and surface runoff; Measurement and analysis of hydrological data; Probability concepts, intensity, duration and frequency analysis; Rainfall-runoff relationships; runoff measurement, surface runoff estimation, hydrographs; Soil erosion- its types, extent & control options; Soil loss measurement and estimation, Universal Soil Loss Equation and its modifications; principles of soil and water conservation; Soil and water conservation measure for arable and non-arable land; Watershed - its concept, characterization and management, Integrated watershed management; land capability classification; Rainwater harvesting and recycling;

Unit 4: Radiation Physics

Basics of electromagnetic spectrum and its interaction with matter; Laws of radiation: scattering, reflection, transmission, absorption, emission; Diffuse and specular radiations; Photo-electric effects ;Radiation units, flux, intensity, emittance, inter conversion of radiometric units; Energy balance of land surfaces.Atomic Theory;Radioactivity and radioactive laws , alpha-, beta-, and gamma- rays, detection and measurement of radiation; Properties of X-rays; Bragg's law; Nuclear fission, fusion, nuclear reactions, neutron moderation, nuclear energy, atomic power;; Isotopes and its application ; UV-Visible, IR, NMR, EPR spectroscopy, X-ray diffraction ; Applications of radioactivity in agriculture.

Unit 5: Plant Biophysics and Nanotechnology

Introduction and scope of plant biophysics; Structure and properties of water; Experimental techniques used for separation and characterization of biomolecules sedimentation, ultra-centrifugation, diffusion, osmosis, viscosity, polarization and electrophoresis, chromatography; Fibre physics; Basic spectroscopic techniques, Chlorophyll fluorescence; Applications of electromagnetic field in agriculture; Nanostructures, Properties and characterization of nanomaterials; Nanoformulations, Nanobiology, hazards of nanomaterials; Application of nanotechnology in agriculture.

Unit 6: Remote Sensing

Principles of remote sensing, remote sensing systems – active and passive, sensors and platforms; Imaging and non-imaging systems; satellite characteristics, spatial, spectral, radiometric and temporal resolutions, multispectral, hyperspectral, thermal and microwave remote sensing; spectral signatures of natural targets and its physical basis, spectral indices;; Air borne remote sensing; Digital image processing; – formats, pre-processing, enhancement, classification; National and International satellite systems for land, weather, ocean and other observations; Applications of remote sensing in agriculture and natural resource management; – crop acreage, crop yield, irrigation management, soil type and properties, abiotic/biotic stress in crops, precision agriculture, soil and water conservation and watershed management, management of degraded, waterlogged and other problematic soils .

Unit 7: Geo-informatics

Principles and concepts: Hardware and software requirements; Geographic information system (GIS) -Definition, components; Maps and projections, principles of cartography; Basic geodesy: Geoid /Datum/Ellipsoid; Projections and coordinate systems, types and scales; Accuracy of maps; Raster and Vector data models; DBMS and RDBMS; Geostatistical analyses; Spatial interpolation - Thiessen polygon; Inverse square distance; , Kriging; Digital Elevation Model;Different spatial analysis and modelling; Principles of GPS, DGPS; Errors in GPS data and correction; GPS constellations; Geoinformatics applications in agriculture and natural resource management.

Unit 8: Atmospheric physics

Weather and climate: atmosphere and its constituents; Meteorological elements and their measurements; Heat balance of the earth and atmosphere; Climatic classification systems; Climatology of India, agro-ecological regions; Monsoon, western disturbances, cyclones, droughts; Wind system, precipitation, cloud, pressure pattern; Atmospheric stability; Weather forecasting: numerical weather prediction; El Nino, La Nina and ENSO; Greenhouse gases, Global warming, and climate change; Impacts, adaptation and mitigation of climate change in agriculture; Physiological response of crop plants to weather (light, temperature, CO₂, moisture and solar radiation); Heat units, thermal time and thermal use-efficiency and their applications; Micro-, meso- and macro-climates; Modification of microclimate; Exchange of mass, momentum and energy between surface and atmosphere, exchange coefficients; Richardson number & Reynolds' analogy; Boundary layer; Eddy covariance techniques; Wind profile; Radiation distribution within plant canopy; Air pollution, classification and sources of air pollutants, their effects on crops, Air Quality Index. Role of surface albedo, photo-chemical pollution and aerosols in modifying micro-climate, Boundary layer; Ozone pollution and climate change. Concept of evapotranspiration: potential, reference and actual evapotranspiration, crop coefficient; measurement of evapotranspiration. Energy balance of land surfaces;

Unit 9: Mathematical modelling and Data Analytics

Applications of matrices, determinants, differentiation and integration; Numerical modelling: finite difference and finite element; Iterative technique, Fourier analysis, Infinite series and Taylor series; Probability, probability distribution and applications in agriculture; Measures of central tendency and dispersion; correlation and regression, Spatial statistics: Variogram and interpolation techniques; Analysis of Variance (ANOVA) and Covariance; Statistical Design of Agricultural Experiments ; Test of Significance (t-Test, F test, Chi-square test). Surface modelling; Fundamentals of dynamic simulation, systems, models and simulation; Mechanistic, stochastic and deterministic models; Model calibration, validation and sensitivity analysis; Simulation models for water, heat, and solute movement in two- and three dimensional porous media; Modelling root water uptake; Crop weather models and its use in crop yield estimation; Advantage and limitations of modelling.
