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; Physicalproperties 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 pressurise 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; Solutetransport in soils, Movement of pollutant through soil to ground water, Soil quality indices, Soil physical constraints and their management. Soil tilth 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, CO_2, 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.