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28/08/2011

M.Sc.(Ag.) IN SOIL SCIENCE AND AGRICULTURAL CHEMISTRY

COURSE NO.	COURSE TITLE	CREDITS
SSC-501	*SOIL PHYSICS	2+1
SSC-502	*SOIL FERTILITY AND FERTILIZER USE	3+1
SSC-503	*SOIL CHEMISTRY	2+1
SSC-504	*SOIL MINERALOGY, GENESIS, CLASSIFICATION AND SURVEY	2+1
SSC-505	*SOIL BIOLOGY AND BIOCHEMISTRY	3+1
SSC-506	SOIL EROSION AND CONSERVATION	2+1
SSC-507	RADIOISOTOPES IN SOIL AND PLANT STUDIES	1+0
SSC-508	SOIL, WATER AND AIR POLLUTION	2+1
SSC-509	ANALYTICAL TECHNIQUES AND INSTRUMENTAL METHODS IN SOIL AND PLANT ANALYSIS	1+2
SSC-510	CHEMISTRY OF PESTICIDES	1+1
SSC-511	MANAGEMENT OF PROBLEM SOILS	2+1
SSC-512	FERTILIZER TECHNOLOGY	1+1
SSC-513	LAND DEGRADATION AND RESTORATION	1+0

*CORE COURSE

Major Course : 25 credits

Minor : 9

Supporting : 5 (100)

Thesis : 1 credit

Thesis : 20 (Non credit)

SSC-501 SOIL PHYSICS (2+1)

Theory

Soil Physics as a branch of Soil Science, Soil as a three-phase system, volume and mass relationships of soil constituents.

Soil texture, textural classes, particle size distribution analysis, specific surface.

Soil consistence; dispersion and workability of soils; soil compaction and consolidation; soil strength; swelling and shrinkage - basic concepts.

Soil structure - genesis, types, characterization and management of soil structure; soil aggregation, aggregate stability; soil tilth, characteristics of good soil tilth; soil crusting - mechanism, factors affecting and evaluation; soil conditioners; puddling, its effect on soil physical properties; clod formation.

Soil water: content and potential, soil water retention, soil-water constants, measurement of soil water content, energy state of soil water, soil water potential, soil-moisture characteristic curve; hysteresis, measurement of soil-moisture potential.

Water flow in saturated and unsaturated soils, Poiseuille's law, Darcy's law; hydraulic conductivity, permeability and fluidity, hydraulic diffusivity; measurement of hydraulic conductivity in saturated and unsaturated soils.

Infiltration; internal drainage and redistribution; evaporation; hydrologic cycle, field water balance; soil-plant-atmosphere continuum.

Composition of soil air; renewal of soil air - convective flow and diffusion; measurement of soil aeration; aeration requirement for plant growth; soil air management.

Modes of energy transfer in soils; energy balance; thermal properties of soil; measurement of soil temperature; soil temperature in relation to plant growth; soil temperature management.

Practical

- Particle size distribution analysis by pipette and international methods
- Measurement of Atterburg limits
- Aggregate analysis - dry and wet
- Measurement of soil-water content by different methods
- Measurement of soil-water potential by using tensiometer and gypsum blocks
- Determination of soil-moisture characteristic curve and computation of pore-size distribution
- Determination of hydraulic conductivity under saturated and unsaturated conditions
- Determination of infiltration rate of soil
- Determination of aeration porosity and oxygen diffusion rate
- Soil temperature measurements by different methods
- Estimation of water balance components in bare and cropped fields

Theory

GK G Soil fertility and soil productivity; factors affecting soil fertility; nutrient sources – fertilizers and manures; essential plant nutrients - functions and deficiency symptoms. Criteria of essentiality of elements in plant nutrition. Mitcherlich's equation, Spillman's equation and baule unit; essentials of plant growth.

SM Chemistry and transformation of nutrient elements including micronutrients in soil and their role in plant nutrition-their sources, forms, retention behaviour and movement; correction of micronutrient deficiencies in plants.

Common soil test methods for fertilizer recommendations; quantity–intensity relationships; soil test crop response correlations and response functions.

PK B Principles of fertilizer application and residual effects of fertilizers and organic manures; Fertilizer use efficiency; blanket fertilizer recommendations – usefulness and limitations; site-specific nutrient management; plant need based nutrient management; integrated nutrient management.

MEK Soil fertility evaluation - biological methods, soil, plant and tissue tests; soil quality in relation to sustainable agriculture.

Practical

- Extraction and determination of available plant nutrients in soil
- Soil fertility evaluation by chemical and biological methods
- Analysis of plants for essential elements

SSC-503 SOIL CHEMISTRY (2+1)

Theory

Modern concept of soil; Chemical (elemental) composition of the earth's crust and soils.

Soil as a disperse system.

Concept and importance of soil solution; chemistry of soil water; dynamic nature of soil; soil and plant nutrition.

Thermodynamics, chemical equilibria, electrochemistry and chemical kinetics

Soil colloids: inorganic and organic colloids - origin of charge, concept of point of zero-charge (PZC) and its dependence on variable-charge soil components, surface charge characteristics of soils; diffuse double layer theories of soil colloids, zeta potential, stability, coagulation/flocculation and peptization of soil colloids; electrometric properties of soil colloids; sorption properties of soil colloids; soil organic matter - fractionation of soil organic matter and different fractions, clay-organic interactions.

Ion exchange processes in soil; cation exchange- theories based on law of mass action (Kerr-Vanselow, Gapon equations, hysteresis, Jenny's concept), adsorption isotherms, Donnan-membrane equilibrium concept, clay-membrane electrodes and ionic activity measurement, thermodynamics, statistical mechanics; anion and ligand exchange - innersphere and outer-sphere surface complex formation, fixation of oxyanions, hysteresis in sorption-desorption of oxy-anions and anions, shift of PZC on ligand exchange, AEC, CEC; experimental methods to study ion exchange phenomena and practical implications in plant nutrition.

Chemistry of acid soils; active and potential acidity; lime potential, chemistry of acid soils; sub-soil acidity, soil acidity reclamation.

Chemistry of salt-affected soils and amendments; soil pH, E_{Ce}, ESP, SAR and important relations; soil management and amendments.

Chemistry and electrochemistry of submerged soils.

Practical

- Determination of CEC and AEC of soils
- Analysis of equilibrium soil solution for pH, EC, Eh by the use of Eh-pH meter and conductivity meter
- Determination of point of zero-charge and associated surface charge characteristics by the serial potentiometric titration method
- Potentiometric and conductometric titration of soil humic and fulvic acids
- (E4/E6) ratio of soil humic and fulvic acids by visible spectrophotometric studies and the $\ddot{A}$ (E4/E6) values at two pH values
- Adsorption-desorption of phosphate/sulphate by soil using simple adsorption isotherm
- Construction of adsorption envelope of soils by using phosphate/fluoride/sulphate and ascertaining the mechanism of the ligand exchange process involved
- Determination of titratable acidity of an acid soil by BaCl_2 -TEA method
- Determination of lime requirement of an acid soil by buffer method
- Determination of gypsum requirement of an alkali soil

**SSC-504 SOIL MINERALOGY, GENESIS, CLASSIFICATION AND
SURVEY (2+1)**

Theory

Fundamentals of crystallography, space lattice, coordination theory, isomorphism and polymorphism.

Classification, structure, chemical composition and properties of clay minerals; genesis and transformation of crystalline and non-crystalline clay minerals; identification techniques; amorphous soil constituents and other non-crystalline silicate minerals and their identification; clay minerals in Indian soils.

Factors of soil formation, soil formation models; soil forming processes; weathering of rocks and mineral transformations; soil profile; weathering sequences of minerals with special reference to Indian soils.

Concept of soil individual; soil classification systems – historical developments and modern systems of soil classification with special emphasis on soil taxonomy; soil classification, soil mineralogy and soil maps – usefulness.

Soil survey and its types; soil survey techniques - conventional and modern; soil series – characterization and procedure for establishing soil series; benchmark soils and soil correlations; soil survey interpretations; soil mapping, thematic soil maps, cartography, mapping units, techniques for generation of soil maps.

Landform – soil relationship; major soil groups of India with special reference to West Bengal; land capability classification and land irrigability classification; land evaluation and land use type (LUT) – concept and application; approaches for managing soils and landscapes in the framework of agro-ecosystem.

Practical

- Identification and quantification of minerals in soil fractions
- Morphological properties of soil profile in different landforms- determination of soil texture by feel method, studies on soil structure, colour, pH (colorimetric method), consistence.
- Classification of soils using soil taxonomy
- Grouping soils using available data base in terms of soil quality

Theory

Soil biota; soil microbial ecology; types of organisms in different soils; soil microbial biomass; microbial interactions; un-cultivable soil biota.

Microbiology and biochemistry of root-soil interface; phyllosphere; soil enzymes – origin, activities and importance; soil characteristics influencing growth and activity of microflora.

Biochemical composition and biodegradation of soil organic matter, carbohydrates, protein, lipid and nucleic acids; humus formation; cycles of important organic nutrients.

Organic wastes and their use for production of biogas and manures; biotic factors in soil development; microbial toxins in the soil.

Preparation and preservation of farmyard manure, animal manures, rural and urban composts and vermicompost.

Biofertilizers-definition, classification, specification, method of production and role in crop production.

Practical

- Determination of soil microbial population
- Soil microbial biomass
- Elemental composition, fractionation of organic matter and functional groups
- Decomposition of organic matter in soil
- Soil enzymes
- Measurement of important soil microbial processes such as ammonification, nitrification, N_2 fixation, S oxidation, P solubilization and mineralization of other micronutrients.

SSC-506 SOIL EROSION AND CONSERVATION (2+1)

Theory

History, distribution, identification and description of soil erosion problems in India.

Forms of soil erosion; effects of soil erosion and factors affecting soil erosion; types and mechanisms of water erosion; raindrops and soil erosion; rainfall erosivity - estimation as EI30 index and kinetic energy; factors affecting water erosion; empirical and quantitative estimation of water erosion; methods of measurement and prediction of runoff; soil losses in relation to soil properties and precipitation. Wind erosion- types, mechanism and factors affecting wind erosion; extent of problem in the country.

Principles of erosion control; erosion control measures – agronomical and engineering; erosion control structures - their design and layout.

Soil conservation planning; land capability classification; soil conservation in special problem areas such as hilly, arid and semi-arid regions, waterlogged and wet lands.

Watershed management - concept, objectives and approach; water harvesting and recycling; run-off and flood control in watershed management areas; safe drainage of excess water; socioeconomic aspects of watershed management; case studies in respect to monitoring and evaluation of watersheds; catchment and concentrate areas and their treatments for improving efficiencies; use of remote sensing in assessment and planning of watersheds.

Practical

- Determination of different soil erodibility indices - suspension percentage, dispersion ratio, erosion ratio, infiltration and run-off ratio, clay ratio, clay/moisture equivalent ratio, percolation ratio, raindrop erodibility index
- Computation of kinetic energy of falling rain drops
- Computation of rainfall erosivity index (EI30) using rain gauge data
- Visits to areas having watersheds, water harvesting and erosion control structures.

SSC-507 RADIOISOTOPES IN SOIL AND PLANT STUDIES (1+0)

Theory

Atomic structure, radioactivity and units; radioisotopes - properties and decay principles; nature and properties of nuclear radiations; interaction of nuclear radiations with matter

Principles and use of radiation monitoring instruments - proportional, Geiger Muller counter, solid and liquid scintillation counters; neutron moisture meter, mass spectrometry, auto radiography

Isotopic dilution techniques used in soil and plant research; use of stable isotopes; application of isotopes in studies on organic matter, nutrient transformations, ion transport, rooting pattern and fertilizer use efficiency; carbon dating

Doses of radiation exposure, radiation safety aspects, regulatory aspects, collection, storage and disposal of radioactive wastes

SSC-508 SOIL, WATER AND AIR POLLUTION (2+1)

Theory

Soil, water and air pollution problems associated with agriculture, nature and extent.

Nature and sources of pollutants – agricultural, industrial, urban wastes, fertilizers and pesticides, acid rains, oil spills etc.; air, water and soil pollutants - their CPC standards and effect on plants, animals and human beings.

Sewage and industrial effluents – their composition and effect on soil properties/health, and plant growth and human beings; soil as sink for waste disposal.

Pesticides – their classification, behavior in soil and effect on soil microorganisms.

Toxic elements – their sources, behavior in soils, effect on nutrients availability, effect on plant and human health.

Pollution of water resources due to leaching of nutrients and pesticides from soil; emission of greenhouse gases – carbon dioxide, methane and nitrous oxide.

Remediation/amelioration of contaminated soil and water; remote sensing applications in monitoring and management of soil and water pollution.

Practical

- Sampling of sewage waters, sewage sludge, solid/liquid industrial wastes, polluted soils and plants
- Estimation of dissolved and suspended solids, chemical oxygen demand (COD), biological demand (BOD), nitrate and ammoniacal nitrogen and phosphorus, heavy metal content in effluents
- Heavy metals in contaminated soils and plants
- Management of contaminants in soil and plants to safeguard food safety
- Air sampling and determination of particulate matter and oxides of sulphur
- Visit to various industrial sites to study the impact of pollutants on soil and plants

SSC-509

ANALYTICAL TECHNIQUES AND INSTRUMENTAL METHODS IN
SOIL AND PLANT ANALYSIS (1+2)

Theory

Chemical analysis-concept of chemical analysis

Volumetric analysis-principles of acid-base titration, neutralization indicators; redox titration-permanganometry, dichrometry, iodometry, use of redox indicators; precipitation titration, argentometric titration, use of adsorption indicators; complexometric titration, metal ion indicators, concept of masking and demasking reactions

Principles of conductometry and potentiometric titrations

Principles of colorimetry, flame photometry, and atomic absorption spectrophotometry

Radiotracer technique and its methodology

Practical

- Preparation of solutions for standard solutions
- Titrimetric analysis- acid-base, redox, complexometric, potentiometric and precipitation titrations
- Use of pH meter, conductivity meter, visible, ultraviolet and infrared spectrophotometer, atomic absorption spectrophotometer, flame-photometer,
- Analysis of soil and plant samples for N, P, K, Ca, Mg, S, Zn, Cu, Fe, Mn, B and Mo; analysis of plant materials by digesting plant materials by wet and dry ashing and soil by wet digestion methods.

SSC-510 CHEMISTRY OF PESTICIDES

(1+1)

Theory

Classification of pesticides with respect to chemical composition, chemistry of some commonly used pesticides.

Fate and behaviour of pesticides in soil, plant and water bodies.

Pesticide residues and their impact on environment, pesticide contamination of food.

Mineralization and metabolism of pesticides, bound pesticides.

Effect of concentration on pesticide transport, retention and leaching.

Biodegradation of pesticides, effect on microbial activity, microbial adaptation.

Toxicological properties of pesticides and nutrient transformations, precautions in pesticide use.

Biotechnology in pest management

Practical

- Estimation of active ingredients in different pesticides by chemical methods
- Extraction, isolation and purification of pesticide residues on soil and plants.
- Techniques of GC and HPLC analysis of pesticide residues, Immuno assays , ELISA test.

SSC-511. MANAGEMENT OF PROBLEM SOILS (2+1)

Theory

Area and distribution of problem soils-acidic, saline, sodic and physically degraded soils: origin and basic concept of problem soils and factors responsible.

Morphological features of saline and saline-sodic soils; characterization of salt-affected soils; soluble salts, ESP, pH; physical, chemical and microbiological properties

Management of salt-affected soils; quality of irrigation water; salt balance under irrigation; characterization of brackish waters, area and extent; relationship in water use and quality; management of brackish water for irrigation.

Salt tolerance of crops- mechanism and ratings; monitoring of soil salinity in the field; management principles for sandy, clayey, red lateritic and dryland soils.

Acid soils- nature of soil acidity, sources of soil acidity; effect on plant growth; lime requirement of acid soils; management of acid soils.

Agronomic practices in relation to problem soils; cropping pattern for utilizing poor quality ground waters.

Practical

- Characterization of acid, acid sulphate, salt-affected and calcareous soils.
- Determination of cations (Na^+ , K^+ , Ca^{++} and Mg^{++}) in ground water and soil.
- Determination of anions (Cl^- , SO_4^{--} , CO_3^{---} and HCO_3^-) in ground water and soil.
- Lime and gypsum requirements of acid sodic soils.

SSC-512 FERTILIZER TECHNOLOGY (1+1)

Theory

Fertilizers- production, consumption and future projects with regard to nutrient use in the country and respective states: fertilizer control order.

Manufacturing process for different fertilizers using various raw materials, characteristics and nutrient contents

Recent developments in secondary and micronutrient fertilizers and their quality control as per fertilizer control order.

New and emerging issues in fertilizer technology- production and use of slow and controlled release fertilizers, super granules fertilizers and fertilizers for specific crops/situations.

Practical

- Identification of fertilizers
- Nutrient contents in nitrogenous, phosphatic and potassic fertilizers
- Determination of biureate content in urea.

SSC-513

LAND DEGRADATION AND RESTORATION (1+0)

Theory

Type, factors and processes of soil/land degradation and its impact on soil productivity, including soil fauna; biodegradation and environment.

Land restoration and conservation techniques- erosion control, reclamation of salt-affected soils, mine land reclamation, afforestation, organic products.

Extent, diagnosis and mapping of conventional and modern RS-GIS tools, monitoring land degradation by fast assessment, land use policy, incentives and participatory approach for reversing land degradation; global issues for twenty first century.