DEPARTMENT OF AGRICULTURAL CHEMISTRY AND SOIL SCIENCE

PROGRAMMES

1. M. Sc.
2. Ph. D.

Course Requirement

M. Sc.

Field of specialization	Soil Chemistry, Soil Fertility and Fertilizer Use, Soil Mineralogy, Soil genesis and Soil survey, Basics of Soil Biology and Biochemistry, Soil, Water and Air Pollution, Soil Physical properties, Problem soils, Analytical techniques.
Core courses	SCHEM 511, SCHEM 512, SCHEM 513, SCHEM 521,
Optional courses	SCHEM 522, SCHEM 523, SCHEM 524, SCHEM 525, SCHEM 531, SCHEM 532, SCHEM 533, SCHEM 534, SCHEM 535, SCHEM 536
Minor & Supporting course	STAT 511, PPHYS 511, AGRON 521 or as per decision of advisory committee in view of research problem
Non-credit Compulsory courses	PGS 521
Deficiency courses	NIL or as deemed suitable by advisory committee

Ph. D.

Field of specialization	Soil Fertility and Nutrient use in Crop Production, Soil Physics, Physical Chemistry of Soils, Soil Organic Matter, Micropedology, Land Use Planning
Core courses	SCHEM 611, SCHEM 612
Optional courses	SCHEM 613, SCHEM 621, SCHEM 622, SCHEM 623
Minor & Supporting course	STAT 612, PPHYS 511, PPHYS 522 or as per decision of advisory committee in view of research problem
Non-credit Compulsory courses	NIL
Deficiency courses	NIL or as deemed suitable by advisory committee

SOIL SCIENCE

Course Structure – at a Glance

M. Sc. (Ag.) **I Semester**		
Code No.	Title	Credits
SCHEM 511*	SOIL CHEMISTRY	2+1
SCHEM 512*	SOIL FERTILITY AND FERTILIZER USE	3+1
SCHEM 513*	SOIL MINERALOGY, GENESIS, CLASSIFICATION AND SURVEY	2+1
SCHEM 514	RADIO ISOTOPES IN SOIL AND PLANT ANALYSIS	2+1
II Semester		
SCHEM 521*	SOIL BIOLOGY AND BIOCHEMISTRY	2+1
SCHEM 522	SOIL, WATER AND AIR POLLUTION	2+1
SCHEM 523	REMOTE SENSING AND GIS TECHNIQUES FOR SOIL AND CROP STUDIES	2+1
SCHEM 524	GEOMORPHOLOGY AND GEOCHEMISTRY	2+0
SCHEM 525	SOIL EROSION AND CONSERVATION	2+1
PGS507 NC	INTEGRAL AND DIFFERENTIAL CALCULUS (Pre-requisite for Soil Physics)	3+0
III Semester		
SCHEM 531	SOIL PHYSICS	2+1
SCHEM 532	MANAGEMENT OF PROBLEMATIC SOIL AND WATERS	2+1
SCHEM 533	ANALYTICAL TECHNIQUES AND INSTRUMENTAL METHODS IN SOIL AND PLANT ANALYSIS	0+2
SCHEM 534	FERTILIZER TECHNOLOGY	1+0
SCHEM 535	SYSTEM APPROACHES IN SOIL AND CROP STUDIES	2+1
SCHEM 536	LAND DEGRADATION AND RESTORATION	1+0
SCHEM 541	COMPREHENSIVE EXAMINATION (NC)	
SCHEM 591	MASTER'S SEMINAR	1+0
SCHEM 599	MASTER'S RESEARCH	20
Ph. D. **I Semester**		
SCHEM 611*	ADVANCES IN SOIL FERTILITY	2+1
SCHEM 612*	ADVANCES IN SOIL PHYSICS	2+0
SCHEM 613	PHYSICAL CHEMISTRY OF SOILS	2+0
II Semester		
SCHEM 621	SOIL GENESIS AND MICROPEDOLOGY	2+1
SCHEM 622	BIOCHEMISTRY OF SOIL ORGANIC MATTER	2+1
SCHEM 623	LAND USE PLANNING AND WATERSHED MANAGEMENT	2+0
SCHEM 641	PRELIMINARY -ORAL & WRITTEN (NC)	
SCHEM 691	DOCTORAL SEMINAR I	1+0
SCHEM 692	DOCTORAL SEMINAR II	1+0
SCHEM 699	DOCTORAL RESEARCH	45

***Core courses**.

POSTGRADUATE COURSES

SCHEM 511 SOIL CHEMISTRY 2+1

Objective

To introduce the classical concepts of soil chemistry and to familiarize students with modern developments in chemistry of soils in relation to using soils as a medium for plant growth.

Theory

UNIT I

Chemical (elemental) composition of the earth's crust and soils.

UNIT II

Elements of equilibrium thermodynamics, chemical equilibria, electrochemistry and chemical kinetics.

UNIT III

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.

UNIT IV

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.

UNIT V

Potassium, phosphate and ammonium fixation in soils covering specific and non-specific sorption; precipitation-dissolution equilibria; step and constant-rate K; management aspects.

UNIT VI

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

UNIT VII

Chemistry of salt-affected soils and amendments; soil pH, ECe, ESP, SAR and important relations; soil management and amendments.

UNIT VIII

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 organic matter fractions – HA, FA, Lignin & humus
- Adsorption-desorption of phosphate/sulphate by soil using simple adsorption isotherm
- Determination of titratable acidity of an acid soil by BaCl2-TEA method
- Determination of lime requirement of an acid soil by buffer method
- Determination of gypsum requirement of an alkali soil

Suggested Readings

Bear RE. 1964. *Chemistry of the Soil.* Oxford and IBH.

Bolt GH & Bruggenwert MGM. 1978. *Soil Chemistry*. Elsevier.

Greenland DJ & Hayes MHB. 1981. *Chemistry of Soil Processes*. John Wiley & Sons.

Greenland DJ & Hayes MHB. *Chemistry of Soil Constituents*. John Wiley & Sons.

McBride MB. 1994. *Environmental Chemistry of Soils.* Oxford Univ. Press.

Sposito G. 1981. *The Thermodynamics of Soil Solutions*. Oxford Univ. Press.

Sposito G. 1984. *The Surface Chemistry of Soils*. Oxford Univ. Press.

Sposito G. 1989. *The Chemistry of Soils*. Oxford Univ. Press.

Stevenson FJ. 1994. *Humus Chemistry*. 2nd Ed. John Wiley & Sons.

Van Olphan H. 1977. *Introduction to Clay Colloid Chemistry*. John Wiley & Sons.

SCHEM 512 SOIL FERTILITY AND FERTILIZER USE 3+1

Objective

To impart knowledge about soil fertility and its control, and to understand the role of fertilizers and manures in supplying nutrients to plants so as to achieve high fertilizer use efficiency.

Theory

UNIT I

Soil fertility and soil productivity; nutrient sources – fertilizers and manures; essential plant nutrients - functions and deficiency symptoms.

UNIT II

Soil and fertilizer nitrogen – sources, forms, immobilization and mineralization, nitrification, denitrification; biological nitrogen fixation - types, mechanism, microorganisms and factors affecting; nitrogenous fertilizers and their fate in soils; management of fertilizer nitrogen in lowland and upland conditions for high fertilizer use efficiency.

UNIT III

Soil and fertilizer phosphorus - forms, immobilization, mineralization, reactions in acid and alkali soils; factors affecting phosphorus availability in soils; phosphatic fertilizers - behavior in soils and management under field conditions.

UNIT IV

Potassium - forms, equilibrium in soils and its agricultural significance; mechanism of potassium fixation; management of potassium fertilizers under field conditions.

UNIT V

Sulphur - source, forms, fertilizers and their behavior in soils; calcium and magnesium– factors affecting their availability in soils; management of sulphur, calcium and magnesium fertilizers.

UNIT VI

Micronutrients – critical limits in soils and plants; factors affecting their availability and correction of their deficiencies in plants; role of chelates in nutrient availability.

UNIT VII

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

UNIT VIII

Fertilizer use efficiency; blanket fertilizer recommendations – usefulness and limitations; site-specific nutrient management; plant need based nutrient management; integrated nutrient management.

UNIT IX

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

UNIT X

Principles and application of colorimeter, Flame-photometry and atomic absorption spectroscopy

Practical

- Chemical analysis of soil for total and available nutrients (Total and available N, P, K, Cu, Mn, Zn, Fe and S)
- Analysis of plants for essential elements (N, P, K, Cu, Mn, Zn, Fe and S)

Suggested Readings

Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.
Kabata-Pendias A & Pendias H. 1992. *Trace Elements in Soils and Plants*.C RC Press.
Kannaiyan S, Kumar K & Govindarajan K. 2004. *Biofertilizers Technology*. Scientific Publ.
Leigh JG. 2002. *Nitrogen Fixation at the Millennium*. Elsevier.
Mengel K & Kirkby EA. 1982. *Principles of Plant Nutrition*. International Potash Institute, Switzerland.
Mortvedt JJ, Shuman LM, Cox FR & Welch RM. 1991. *Micronutrients in Agriculture*. 2nd Ed. SSSA, Madison.
Pierzinsky GM, Sims TJ & Vance JF. 2002. *Soils and Environmental Quality*. 2nd Ed. CRC Press.
Stevenson FJ & Cole MA. 1999. *Cycles of Soil: Carbon, Nitrogen, Phosphorus, Sulphur, Micronutrients*. John Wiley & Sons.
Tisdale SL, Nelson SL, Beaton JD & Havlin JL. 1999. *Soil Fertility and Fertilizers.* 5th Ed. Prentice Hall of India.
Troeh FR & Thompson LM. 2005. *Soils and Soil Fertility*. Blackwell.

SCHEM 513 SOIL MINERALOGY, GENESIS, CLASSIFICATION AND SURVEY 2+1

Objective

To acquaint students with basic structure of alumino-silicate minerals and genesis of clay minerals; soil genesis in terms of factors and processes of soil formation, and to enable students conduct soil survey and interpret soil survey reports in terms of land use planning.

Theory

UNIT I

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

UNIT II

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.

UNIT III

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

UNIT IV

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.

UNIT V

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.

UNIT VI

Landform – soil relationship; major soil groups of India with special reference to respective states; 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

- Morphological properties of soil profile in different landforms
- Classification of soils using soil taxonomy
- Calculation of weathering indices and its application in soil formation
- Grouping soils using available data base in terms of soil quality
- Aerial photo and satellite data interpretation for soil and land use
- Cartographic techniques for preparation of base maps and thematic maps, processing of field sheets, compilation and obstruction of maps in different scales
- Land use planning exercises using conventional and RS tools

Suggested Readings

Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.

Buol EW, Hole ED, MacCracken RJ & Southard RJ. 1997. *Soil Genesis and Classification*. 4th Ed. Panima Publ.

Dixon JB & Weed SB. 1989. *Minerals in Soil Environments*. 2nd Ed. Soil Science Society of America, Madison.

Grim RE. 1968. *Clay Mineralogy*. McGraw Hill.

Indian Society of Soil Science 2002. *Fundamentals of Soil Science*. ISSS, New Delhi.

Sehgal J. 2002. *Introductory Pedology: Concepts and Applications*. New Delhi

Sehgal J. 2002. *Pedology - Concepts and Applications*. Kalyani.

USDA. 1999. *Soil Taxonomy*. Hand Book No**.** 436. 2nd Ed. USDA NRCS, Washington.
Wade FA & Mattox RB. 1960. *Elements of Crystallography and Mineralogy*. Oxford & IBH.
Wilding LP & Smeck NE. 1983. *Pedogenesis and Soil Taxonomy*: II. *The Soil Orders*. Elsevier.
Wilding NE & Holl GF. (Eds.). 1983. *Pedogenesis and Soil Taxonomy*. I. *Concept and Interaction*. Elsevier.

SCHEM 514 RADIOISOTOPES IN SOIL AND PLANT STUDIES 2+1

Objective

To train students in the use of radioisotopes in soil and plant research

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

Practical

• Storage and handling of radioactive materials
• Determination of half life and decay constant
• Preparation of soil and plant samples for radioactive measurements
• Setting up of experiment on fertilizer use efficiency and cation exchange equilibria using radioisotopes
• Determination of A, E and L values of soil using 32P/ 65Zn
• Use of neutron probe for moisture determination
• Sample preparation and measurement of 15N enrichment by mass spectrophotometery/ emission spectrometry

Suggested Readings

Comer CL. 1955. *Radioisotopes in Biology and Agriculture: Principles and Practice*. Tata McGraw Hill.

Glasstone S. 1967. *Source Book on Atomic Energy*. East West Press.

Michael FL & Annunziata. 2003. *Handbook of Radioactivity Analysis*. Academic Press.

SCHEM 521 SOIL BIOLOGY AND BIOCHEMISTRY 2+1

Objective

To teach students the basics of soil biology and biochemistry, including biogeochemical cycles, plant growth promoting rhizobacteria, microbial interactions in soil and other soil activities.

Theory

UNIT I

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

UNIT II

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

UNIT III

Microbial transformations of nitrogen, phosphorus, sulphur, iron and manganese in soil; biochemical composition and biodegradation of soil organic matter and crop residues, humus formation; cycles of important organic nutrients.

UNIT IV

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

UNIT V

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

UNIT VI

Biofertilizers – definition, classification, specifications, method of production and role in crop production. BIS standards for quality control.

Practical

- Determination of soil microbial population
- Soil microbial biomass (C, N and P)
- Fractionation of organic matter and functional groups
- Soil enzymes
- Measurement of soil microbial processes such as nitrification, N2 fixation, S oxidation, P solubilization

Suggested Readings

Alexander M. 1977. *Introduction to Soil Microbiology*. John Wiley & Sons.
Burges A & Raw F. 1967. *Soil Biology*. Academic Press.
McLaren AD & Peterson GH. 1967. *Soil Biochemistry*. Vol. XI. Marcel Dekker.
Metting FB. 1993. *Soil Microbial Ecology – Applications in Agricultural and Environmental Management*. Marcel Dekker.
Paul EA & Ladd JN. 1981. *Soil Biochemistry*. Marcel Dekker.
Reddy MV. (Ed.). *Soil Organisms and Litter in the Tropics*. Oxford & IBH.
Russel RS. 1977. *Plant Root System: Their Functions and Interaction with the Soil*. LBS & McGraw Hill.
Stotzky G & Bollag JM. 1993. *Soil Biochemistry.* Vol. VIII. Marcel Dekker.
Sylvia DN. 2005. *Principles and Applications of Soil Microbiology*. Pearson Edu.
Wild A. 1993. *Soil and the Environment - An Introduction*. Cambridge Univ. Press.

SCHEM 522 SOIL, WATER AND AIR POLLUTION 2+1

Objective

To make the students aware of the problems of soil, water and air pollution associated with use of soils for crop production.

Theory

UNIT I

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

UNIT II

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.

UNIT III

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

UNIT IV

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

UNIT V

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

UNIT VI

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

UNIT VIII

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

Suggested Readings

Lal R, Kimble J, Levine E & Stewart BA. 1995. *Soil Management and Greenhouse Effect.* CRC Press.

Middlebrooks EJ. 1979. *Industrial Pollution Control*. Vol. I. *Agro-Industries*. John Wiley Interscience.

Ross SM. *Toxic Metals in Soil Plant Systems*. John Wiley & Sons.

Vesilund PA & Pierce 1983. *Environmental Pollution and Control*. AnnArbor Science Publ.

SCHEM 523 REMOTE SENSING AND GIS TECHNIQUES FOR SOIL, WATER AND CROP STUDIES 2+1

Objective

To impart knowledge about the basic concepts of remote sensing, aerial photographs and imageries, and their interpretation; application of remotesensing in general and with special reference to soil, plants and yield forecasting; to impart knowledge about geo-statistical techniques with special reference to krigging, and GIS and applications in agriculture.

Theory

UNIT I

Introduction and history of remote sensing; sources, propagation of radiations in atmosphere; interactions with matter.

UNIT II

Sensor systems - camera, microwave radiometers and scanners; fundamentals of aerial photographs and image processing and interpretations.

UNIT III

Application of remote sensing techniques - land use soil surveys, crop stress and yield forecasting, prioritization in watershed and drought management, wasteland identification and management.

UNIT IV

Significance and sources of the spatial and temporal variability in soils; variability in relation to size of sampling; classical and geo-statisticaltechniques of evolution of soil variability. 95

UNIT V

Introduction to GIS and its application for spatial and non-spatial soil and land attributes.

Practical

- Familiarization with different remote sensing equipments and data products
- Interpretation of aerial photographs and satellite data for mapping of land resources
- Analysis of variability of different soil properties with classical and geostatistical techniques
- Creation of data files in a database programme
- Use of GIS for soil spatial simulation and analysis
- To enable the students to conduct soil survey and interpret soil survey

reports in terms of land use planning

Suggested Readings

Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.

Elangovan K. 2006. *GIS Fundamentals, Applications and Implementations*. New India Publ. Agency.

Lillesand TM & Kiefer RW. 1994. *Remote Sensing and Image Interpretation*. 3rd Ed. Wiley.

Nielsen DR & Wendroth O. 2003. *Spatial and Temporal Statis*tics. Catena Verloggmbh.

Star J & Esles J. 1990. *Geographic Information System: An Introduction*.

Prentice Hall.

SCHEM 524 GEOMORPHOLOGY AND GEOCHEMISTRY 2+0

Objective

To impart knowledge about the landforms, physiography and morphology of the earth surface, and distribution and weathering elements in the earth crust.

Theory

UNIT I

General introduction to geology and geochemistry, major and minor morphogenic and genetic landforms, study of schematic landforms and their elements with special reference to India.

UNIT II

Methodology of geomorphology, its agencies, erosion and weathering; soil and physiography relationships; erosion surface of soil landscape.

UNIT III

Geochemical classification of elements; geo-chemical aspects of weathering and igration of elements; geochemistry of major and micronutrients and trace elements.

Suggested Readings

Brikland PW. 1999. *Soils and Geomorophology*. 3rd Ed. Oxford Univ. Press.
Likens GE & Bormann FH. 1995. *Geochemistry*. 2nd Ed. Springer Verlag.
Mortvedt JJ, Shuman LM, Cox FR & Welch RM. 1991. *Micronutrients in Agriculture*. 2nd Ed. SSSA, Madison.

SCHEM 525 SOIL EROSION AND CONSERVATION 2+1

Objective

To enable students to understand various types of soil erosion and measure to be taken for controlling soil erosion to conserve soil and water.

Theory

UNIT I

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

UNIT II

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.

UNIT III

Wind erosion- types, mechanism and factors affecting wind erosion; extent of problem in the country.

UNIT IV

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

UNIT V

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

UNIT VI

Watershed management - concept, objectives and approach; water harvesting and recycling; flood control in watershed management; socioeconomic aspects of watershed management; case studies in respect to monitoring and evaluation of watersheds; use of remote sensing in assessment and planning of watersheds.

Practical

• Determination of different soil erodibility indices - suspension percentage, dispersion ratio, erosion 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 a watersheds

Suggested Readings

Biswas TD & Narayanasamy G. (Eds.) 1996. *Soil Management in Relation to Land Degradation and Environment*. Bull. Indian Society of Soil Science No. 17.
Doran JW & Jones AJ. 1996. *Methods of Assessing Soil Quality*. Soil Science Society of America, Spl Publ. No. 49, Madison, USA.
Gurmal Singh, Venkataramanan C, Sastry G & Joshi BP. 1990. *Manual of Soil and Water Conservation Practices*. Oxford & IBH.
Hudson N. 1995. *Soil Conservation*. Iowa State Univ. Press.
Indian Society of Soil Science 2002. *Fundamentals of Soil Science*. ISSS, New Delhi.
Oswal MC. 1994. *Soil Physics*. Oxford & IBH.

SCHEM 531 SOIL PHYSICS 2+1

Objective

To impart basic knowledge about soil physical properties and processes in relation to plant growth.

Theory

UNIT I

Scope of soil physics and its relation with other branches of soil science; soil as a three phase system.

UNIT II

Soil texture, textural classes, mechanical analysis, specific surface.

UNIT III

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

UNIT IV

Soil structure - genesis, types, characterization and management 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.

UNIT V

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.

UNIT VI

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.

UNIT VII

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

UNIT IX

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

UNIT X

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

- Mechanical analysis by pipette and international methods
- Measurement of Atterberg limits
- Aggregate analysis - dry and wet
- Measurement of soil-water content by different methods (Gravemetric & Moisture meter)
- Measurement of soil-water potential by using tensiometer and gypsum blocks
- Determination of hydraulic conductivity under saturated and unsaturated conditions
- Determination of infiltration rate of soil
- Determination of bulk density by core sampler methods
- Soil temperature measurements.
- Estimation of water balance components in bare and cropped fields.

Suggested Readings

Baver LD, Gardner WH & Gardner WR. 1972. *Soil Physics*. John Wiley & Sons.

Ghildyal BP & Tripathi RP. 2001. *Soil Physics*. New Age International.

Hanks JR & Ashcroft GL. 1980. *Applied Soil Physics*. Springer Verlag.

Hillel D. 1972. *Optimizing the Soil Physical Environment toward Greater Crop Yields*. Academic Press.

Hillel D. 1980. *Applications of Soil Physics*. Academic Press.

Hillel D. 1980. *Fundamentals of Soil Physics*. Academic Press.

Hillel D. 1998. *Environmental Soil Physi*cs. Academic Press.

Hillel D. 2003. *Introduction to Environmental Soil Physics*. Academic Press.

Indian Society of Soil Science. 2002. *Fundamentals of Soil Science*. ISSS, New Delhi.

Kirkham D & Powers WL. 1972. *Advanced Soil Physics*. Wiley- Interscience.
Kohnke H. 1968. *Soil Physics*. McGraw Hill.
Lal R & Shukla MK. 2004. *Principles of Soil Physics*. Marcel Dekker.
Oswal MC. 1994. *Soil Physics*. Oxford & IBH.
Saha AK. 2004. *Text Book of Soil Physics*. Kalyani.

SCHEM 532 MANAGEMENT OF PROBLEM SOILS AND WATERS 2+1

Objective

To educate students about basic concepts of problem soils and brackish water, and their management. Attention will be on management of problem soils and safe use of brackish water in relation to crop production.

Theory

UNIT I

Area and distribution of problem soils – acidic, saline, sodic and physically degraded soils; origin and basic concept of problematic soils, and factors responsible**.**

UNIT II

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

UNIT III

Management of salt-affected soils; salt tolerance of crops - mechanism and ratings; monitoring of soil salinity in the field; management principles for sandy, clayey, red lateritic and dry land soils.

UNIT IV

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

UNIT V

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

UNIT VI

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

Practical

- Characterization of acid, acid sulfate, salt-affected and calcareous soils
- Determination of cations (Na^{+}, K^{+}, Ca^{++} and Mg^{++}) in ground water and soil samples
- Determination of anions (Cl^{-}, $SO4^{--}$, $CO3^{--}$ and $HCO3^{-}$) in ground waters and soil samples

• Lime and gypsum requirements of acid and sodic soils

Suggested Readings

Bear FE. 1964. *Chemistry of the Soil*. Oxford & IBH.
Jurinak JJ. 1978. *Salt-affected Soils*. Department of Soil Science & Biometeorology. Utah State Univ.
USDA Handbook No. 60. 1954. *Diagnosis and improvement of Saline and Alkali Soils*. Oxford & IBH.

SCHEM 533 ANALYTICAL TECHNIQUES AND INSTRUMENTAL METHODS IN SOIL AND PLANT ANALYSIS 0+2

Objective

To familiarize the students with commonly used instruments – their working, preparations of common analytical reagents for qualitative and quantitative analysis of both soil as well as plant samples.

Practical

UNIT I

Preparation of solutions for standard curves, analytical reagents, qualitative reagents, indicators and standard solutions for acid-base, oxidation reduction and complexometric titration; soil, water and plant sampling techniques, their processing and handling.

UNIT II

Determination of nutrient potentials and potential buffering capacities of soils for phosphorus and potassium; estimation of phosphorus, ammonium and potassium fixation capacities of soils.

UNIT III

Principles of visible, ultraviolet and infrared spectrophotometery, atomic absorption, flame-photometry, inductively coupled plasma spectrometry; chromatographic techniques, mass spectrometry and X-ray defractrometery; identification of minerals by X-ray by different methods.

UNIT IV

Electrochemical titration of clays; determination of cation and anion exchange capacities of soils; estimation of exchangeable cations (Na, Ca, Mg, K); estimation of root cation exchange capacity.

UNIT V

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.

Suggested Readings

Hesse P. 971. *Textbook of Soil Chemical Analysis*. William Clowes & Sons.
Jackson ML. 1967. *Soil Chemical Analysis*. Prentice Hall of India.
Keith A Smith 1991. *Soil Analysis; Modern Instrumental Techniques*. Marcel Dekker.
Kenneth Helrich 1990. *Official Methods of Analysis*. Association of Official Analytical Chemists.
Page AL, Miller RH & Keeney DR. 1982. *Methods of Soil Analysis*. Part II. SSSA, Madison.
Piper CE. *Soil and Plant Analysis*. Hans Publ.
Singh D, Chhonkar PK & Pandey RN. 1999. *Soil Plant Water Analysis – A Methods Manual*. IARI, New Delhi.
Tan KH. 2003. *Soil Sampling, Preparation and Analysis*. CRC Press/Taylor & Francis.
Tandon HLS. 1993. *Methods of Analysis of Soils, Fertilizers and Wat*ers. FDCO, New Delhi.
Vogel AL. 1979. *A Textbook of Quantitative Inorganic Analysis*. ELBS Longman.

SCHEM 534 FERTILIZER TECHNOLOGY 1+0

Objective

To impart knowledge about how different fertilizers are manufactured using different kinds of raw materials and handling of fertilizers and manures.

Theory

UNIT I

Fertilizers – production, consumption and future projections with regard to nutrient use in the country and respective states; fertilizer control order.

UNIT II

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

UNIT III

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

UNIT IV

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

Suggested Readings

Brady NC & Weil RR. 2002. *The Nature and Properties of Soils.* Pearson Edu.
Fertilizer (Control) Order, 1985 and the Essential Commodities Act. FAI New Delhi.
Kanwar JS. (Ed.). 1976. *Soil Fertility: Theory and Practice*. ICAR.
Olson RA, Army TS, Hanway JJ & Kilmer VJ. 1971. *Fertilizer Technology and Use.* 2nd Ed. Soil Sci. Soc. Am. Madison.
Prasad R & Power JF. *Soil Fertility Management for Sustainable Agriculture*. CRC Press.

Tisdale SL, Nelson SL, Beaton JD & Havlin JL. 1999. *Soil Fertility and Fertilizers.* McMillan Publ.Vogel AI. 1979. *Textbook of Quantitative Inorganic Analysis*. ELBS.

SCHEM 535 SYSTEM APPROACHES IN SOIL AND CROP STUDIES 2+1

Objective

To train the students in concepts, methodology, technology and use of systems simulation in soil and crops studies.

Theory

UNIT I

Systems concepts - definitions, general characteristics; general systems theory; systems thinking, systems dynamics, systems behavior and systems study.

UNIT II

Model: definition and types; mathematical models and their types; modeling: concepts, objectives, processes, abstraction techniques; simulation models, their verification and validation, calibration; representation of continuous systems simulation models - procedural and declarative.

UNIT III

Simulation - meaning and threats; simulation experiment, its design and analysis.

UNIT IV

Application of simulation models in understanding system behavior, optimizing system performance, evaluation of policy options under different soil, water, nutrient, climatic and cultural conditions; decision support system, use of simulation models in decision support system.

Practical

• Use of flow chart or pseudo-code in the program writing

• Writing a small example simulation model program - declarative (in Vensim PLE, Stella or Simile) and procedural (in Java, Fortran, QBasic or V Basic)

• Conducting simulation experiments in DSSAT, WOFOST or EPIC with requirement of report and conclusion

Suggested Readings

Benbi DK & Nieder R. (Eds.). 2003. *Handbook of Processes and Modelling in the Soil - Plant System*. Haworth Press.

Hanks J & Ritchie JT. (Eds.). 1991. *Modelling Plant and Soil System Agronomy***.** Bull. No 31. Soil Sci. Society of America, Madison.

Rajaraman V. 2004. *Computer Programming in Fortran 90 and 95*. PHI.

Tsuji GY, Gerrit H & Philip T. 1998. *Understanding Options for Agricultural Production.* Kluwer.

von Bertalanffy Ludwig 1969. *General Systems Theory: Foundation Development and Application*. Revised Ed. George Braziller. Reprint 1998.

Web sites

1. Documentation of the respective models. (http://www.simulistics.com/for Simile; http://www.iseesystems.com for Stella; and http://www.vensim.com/software.html for vensim PLE)
2. http://www.icasa.net/dssat/index.html for DSSAT; http://www.brc.tamus.edu/epic/ for EPIC
3. http://www.nrel.colostate.edu/projects/century/ for Century
4. http://www.alterra.wur.nl/NL/for WOFOST
5. http://www.apsru.gov.au/ apsru/Default.htm for APSIM
6. http://eco.wiz.uni-kassel.de/ecobas.html online Register of ecological models
7. Plentinger MC Penning de Vries FWT, Editors (1996) CAMASE Register of Agro-ecosystems Models. DLO-Research Institute for Agrobiology and Soil Fertility (AB-DLO)
8. Agricultural Systems – Elsevier at http://www.elsevier.com/wps/product/cws_home /405851
9. Ecological Modeling – Elsevier at http://www.elsevier.com/locate/ecolmodel

SCHEM 536 LAND DEGRADATION AND RESTORATION 1+0

Objective

To impart knowledge related to various factors and processes of land degradation and their restoration techniques.

Theory

UNIT I

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

UNIT II

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

UNIT III

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

Suggested Readings

Biswas TD & Narayanasamy G. (Eds.). 1996. *Soil Management in Relation to Land Degradation and Environment. Bull. Indian Soc. Soil Sci.* 17, New Delhi.

Doran JW & Jones AJ. 1996. *Methods of Assessing Soil Quality*. Soil Science Society of America, Madison.

Greenland DJ & Szabolcs I. 1994. *Soil Resilience and Sustainable Land Use*. CABI.

Lal R, Blum WEH, Vailentine C & Stewart BA. 1997. *Methods for Assessment of Soil Degradation.* CRC Press.
Sehgal J & Abrol IP. 1994. *Soil Degradation in India - Status and Impact*. Oxford & IBH.

SCHEM 611 ADVANCES IN SOIL FERTILITY 2+1

Objective

To provide knowledge of modern concepts of soil fertility and nutrient use in crop production.

Theory

UNIT I

Modern concepts of nutrient availability; soil solution and plant growth; nutrient response functions and availability indices.

UNIT II

Nutrient movement in soils; nutrient absorption by plants; mechanistic approach to nutrient supply and uptake by plants; models for transformation and movement of major micronutrients in soils.

UNIT III

Chemical equilibria (including solid-solution equilbria) involving nutrient ions in soils, particularly in submerged soils.

UNIT IV

Modern concepts of fertilizer evaluation, nutrient use efficiency and nutrient budgeting.

UNIT V

Modern concepts in fertilizer application; soil fertility evaluation techniques; role of soil tests in fertilizer use recommendations; site-specific nutrient management for precision agriculture.

UNIT VI

Monitoring physical, chemical and biological changes in soils; permanent manurial trials and long-term fertilizer experiments; soil productivity under long-term intensive cropping; direct, residual and cumulative effect of fertilizer use.

Practicals

- Determination of Q/I relationship of Phosphorus.
- Determination of Q/I relationship of Potassium.
- Determination of root cation exchange capacity of cereals and legumes.
- Study of mobility of nutrient P and metallic cations in soil column.
- Incubation studies on the solubilization of rock phosphate using chemical and biological agents.
- Determination of phosphate potential in soil.

Suggested Readings

Barber SA. 1995. *Soil Nutrient Bioavailability*. John Wiley & Sons.
Barker V Allen & Pilbeam David J. 2007. *Handbook of Plant Nutrition*. CRC / Taylor & Francis.
Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Educ.
Cooke GW. 1979. *The Control of Soil Fertility*. Crossby Lockwood & Sons.
Epstein E. 1987. *Mineral Nutrition of Plants - Principles and Perspectives*. International Potash Institute, Switzerland.
Kabata- Pendias Alina 2001. *Trace Elements in Soils and Plants*. CRC /Taylor & Francis.
Kannaiyan S, Kumar K & Govindarajan K. 2004. *Biofertilizers Technolo*gy. Scientific Publ.
Mortvedt JJ, Shuman LM, Cox FR & Welch RM. (Eds.). 1991. *Micronutrients in Agriculture*. 2nd Ed. Soil Science Society of America, Madison.
Prasad R & Power JF. 1997. *Soil Fertility Management for Sustainable Agriculture*. CRC Press.
Stevenson FJ & Cole MA. 1999. *Cycles of Soil: Carbon, Nitrogen, Phosphorus, Sulphur, Micronutrients.* John Wiley & Sons.
Stevenson FJ. (Ed.). 1982. *Nitrogen in Agricultural Soils*. Soil Science Society of America, Madison.
Tisdale SL, Nelson WL, Beaton JD & Havlin JL. 1990. *Soil Fertility and Fertilizers.* 5th Ed. Macmillan Publ.
Wild A. (Ed.). 1988. *Russell's Soil Conditions and Plant Growth*. 11th Ed. Longman.

SCHEM 612 ADVANCES IN SOIL PHYSICS 2+0

Objective

To provide knowledge of modern concepts in soil physics.

Theory

UNIT I

Soil-water interactions, soil water potential, free energy and thermodynamic basis of potential concept, chemical potential of soil water and entropy of the system.

UNIT II

Fundamentals of fluid flow, Poiseuilles law, Laplace's equation, Darcy's law in saturated and unsaturated flows; development of differential equations in saturated and unsaturated water flow, capillary conductivity and diffusivity; limitations of Darcy's law; numerical solution for one dimensional water flow.

UNIT III

Theories of horizontal and vertical infiltration under different boundary conditions.

UNIT IV

Movement of salts in soils, models for miscible-immiscible displacement, diffusion, mass flow and dispersion of solutes and their solutions through differential equations; break-through curves.

UNIT V

Soil air and aeration, mass flow and diffusion processes; thermal properties of soil, heat transfer in soils, differential equation of heat flow, measurement of thermal conductivity of soil.

UNIT VI

Soil crust and clod formation; structural management of puddled rice soils; soil conditioning-concept, soils conditioners - types, characteristics, working principles, significance in agriculture.

UNIT VII

Solar and terrestrial radiation measurement, dissipation and distribution in soil-crop systems; prediction of evapotranspiration using aerodynamic and canopy temperature-based models; canopy temperature and leaf diffusion resistance in relation to plant water deficit; evaluation of soil and plant water status using infra-red thermometer.

Suggested Readings

Baver LD, Gardner WH & Gardner WR. 1972. *Soil Physics*. John Wiley & Sons.

Hanks and Ascheroft. 1980. *Applied Soil Physics*. Springer Verlag.

Hillel D. 1980. *Applications of Soil Physics*. Academic Press.

Hillel D. 1980. *Environmental Soil Physic*s. Academic Press.

Indian Society of Soil Science 2002. *Fundamentals of Soil Science*. ISSS, New Delhi.

Kirkham D & Powers WL. 1972. *Advanced Soil Physics*. Wiley Interscience.

Lal R & Shukla MK. 2004. *Principles of Soil Physics*. Marcel Dekker.

Oswal MC.1994. *Soil Physics*. Oxford & IBH.

SCHEM 613 PHYSICAL CHEMISTRY OF SOILS 2+0

Objective

To impart knowledge about modern concepts of physical chemistry of soils and clays, with emphasis on understanding the processes involved with practical significance.

Theory

UNIT I

Colloidal chemistry of inorganic and organic components of soils – their formation, clay organic interaction.

UNIT II

Predictive approaches for cation exchange equilibria - thermodynamics, empirical and diffuse double layer theory (DDL) - relationships among different selectivity coefficients; structure and properties of diffuse double layer.

UNIT III

Thermodynamics of nutrient transformations in soils; cationic and anionic exchange and their models, molecular interaction.

UNIT IV

Adsorption/desorption isotherms - Langmuir adsorption isotherm, Freundlich adsorption isotherm, normalized exchange isotherm, BET equation; selective and non-selective adsorption of ions on inorganic surfaces and organic surfaces of soil materials (citation of utility in agricultural system).

UNIT V

Common solubility equilibria - carbonates, iron oxide and hydroxides, aluminum silicate, aluminum phosphate; electrochemical properties of clays (citation of examples from agricultural use).

Suggested Readings

Bear RE. 1964. *Chemistry of the Soil.* Oxford & IBH.

Bolt GH & Bruggenwert MGM. 1978. *Soil Chemistry*. Elsevier.

Fried M & Broeshart H. 1967. *Soil Plant System in Relation to Inorganic Nutrition.* Academic Press.

Greenland DJ & Hayes MHB. 1981. *Chemistry of Soil Processes*. John Wiley & Sons.

Greenland DJ & Hayes MHB. 1978. *Chemistry of Soil Constituents*. John Wiley & Sons.

Jurinak JJ. 1978. *Chemistry of Aquatic Systems*. Dept. of Soil Science & Biometeorology, Utah State Univ.

McBride MB. 1994. *Environmental Chemistry of Soils.* Oxford Univ. Press.

Sparks DL. 1999. *Soil Physical Chemistry*. 2nd Ed. CRC Press.

Sposito G. 1981. *The Thermodynamics of Soil Solutions*. Oxford Univ.Press.

Sposito G. 1984. *The Surface Chemistry of Soils*. Oxford Univ. Press.

Sposito G. 1989. *The Chemistry of Soils*. Oxford Univ. Press.

Stevenson FJ. 1994. *Humus Chemistry*. 2nd Ed. John Wiley.

van Olphan H. 1977. *Introduction to Clay Colloid Chemistry*. John Wiley & Sons.

SCHEM 621 SOIL GENESIS AND MICROPEDOLOGY 2+1

Objective

To impart knowledge about the pedogenic processes in soils and to acquaint with the micro-pedological study of soil profile.

Theory

UNIT I

Pedogenic evolution of soils; soil composition and characterization.

UNIT II

Weathering and soil formation – factors and pedogenic processes; stability and weathering sequences of minerals.

UNIT III

Assessment of soil profile development by mineralogical and chemical analysis.

UNIT IV

Micro-pedological features of soils – their structure, fabric analysis, role in genesis and classification.

Practicals:
• Total elemental analysis of soil
• Separation and elemental analysis of clay
• Determination of weathering indices

Suggested Readings
Boul SW, Hole ED, MacCraken RJ & Southard RJ. 1997. *Soil Genesis and Classification.* 4th Ed. Panima Publ.
Brewer R. 1976. *Fabric and Mineral Analysis of Soils.* John Wiley & Sons.

SCHEM 622 BIOCHEMISTRY OF SOIL ORGANIC MATTER 2+1

Objective
To impart knowledge related to chemistry and reactions of organic substances and their significance in soils.

Theory
UNIT I
Organic matter pools in soil; composition and distribution of organic matter in soil and its functions; environmental significance of humic substances; decomposition of organic residues in soil in relation to organic matter pools.
UNIT II
Biochemistry of the humus formation; different pathways for humus synthesis in soil; soil carbohydrates and lipids.
UNIT III
Nutrient transformation – N, P, S; trace metal interaction with humic substances, significance of chelation reactions in soils.
UNIT IV
Reactive functional groups of humic substances, adsorption of organic compounds by clay and role of organic substances in pedogenic soil aggregation processes; clay-organic matter complexes.
UNIT V
Humus - pesticide interactions in soil, mechanisms.

Practicals:
• Determination of soil organic carbon by dry combustion and colorimetric methods
• Fractions of soil organic matter
• Estimation of hymatomelanic, humic acid, ß humus and fulvic acid

• Determination of CEC and functional group of humic substances
• Elemental composition of organic matter

Suggested Readings

Beck AJ, Jones KC, Hayes MHB & Mingelgrin U. 1993. Organic *Substances in Soil and Water: Natural Constituents and their Influences on Contaminant Behavior*. Royal Society of Chemistry, London.

Gieseking JE. 1975. *Soil Components*. Vol. 1. *Organic Components*. Springer-Verlag.

Kristiansen P, Taji A & Reganold J. 2006. *Organic Agriculture: A Global Perspective.* CSIRO Publ.

Magdoff F & Weil RR 2004. *Soil Organic Matter in Sustainable Agriculture*. CRC Press.

Mercky R & Mulongoy K. 1991. *Soil Organic Matter Dynamics and Sustainability of Tropical Agriculture.* John Wiley & Sons.

Paul EA. 1996. *Soil Microbiology and Biochemistry*. Academic Press.

Stevenson FJ. 1994. *Humus Chemistry – Genesis, Composition and Reactions.* John Wiley & Sons.

SCHEM 623 LAND USE PLANNING AND WATERSHED MANAGEMENT 2+0

Objective

To teach the better utilization of land for agricultural purposes, and better management of run-off or surplus/excessive rain-water in the catchment area for agricultural purposes in a watershed.

Theory

UNIT I

Concept and techniques of land use planning; factors governing present land use.

UNIT II

Land evaluation methods and soil-site suitability evaluation for different crops; land capability classification and constraints in application.

UNIT III

Agro-ecological regions/sub-regions of India and their characteristics in relation to crop production.

UNIT IV

Water harvesting - concept, significance, types, methodology; use of harvested water in agriculture to increase water productivity.

UNIT V

Watershed development/management - concept, objectives, characterization, planning, execution, community participation and evaluation; rehabilitation of watershed; PRA; developing economically and ecologically sustainable agro-forestry systems for watershed; case studies.

Suggested Readings

All India Soil and Land Use Survey Organisation 1970. *Soil Survey Manual*. IARI, New Delhi.
FAO. 1976. *A Framework for Land Evaluation*, Handbook 32. FAO.
Sehgal JL, Mandal DK, Mandal C & Vadivelu S. 1990. *Agro-Ecological Regions of India*. NBSS & LUP, Nagpur.
Soil Survey Staff 1998. *Keys to Soil Taxonomy*. 8th Ed. USDA & NRCS, Washington, DC.
USDA 1974. *A Manual on Conservation of Soil and Water Handbook of Professional Agricultural Workers*. Oxford & IBH.

SOIL SCIENCE

List of Journals

1. Advances in Agronomy
2. Annals of Arid Zone
3. Australian Journal of Agricultural Research
4. Australian Journal of Soil Research
5. Biology and Fertility of Soils
6. Communications in Soil Science and Plant Analysis
7. Clays and Clay minerals
8. European Journal of Soil Science
9. Geoderma
10. Indian Journal of Agricultural Sciences
11. Journal of Plant Nutrition and Soil Science
12. Journal of the Indian Society of Soil Science
13. Nutrient Cycling in Agroecosystems
14. Plant and Soil
15. Soil and Tillage Research
16. Soil Biology and Biochemistry
17. Soil Science
18. Soil Science Society of America Journal
19. Soil Use and Management
20. Water, Air and Soil Pollution
21. Water Resources Research

Suggested Broad Topics for Master's and Doctoral Research

- Degradation and restoration of soil as natural resource
- Biochemistry of processes at the soil-root interface
- Impact of current agricultural practices and agrochemicals on soil quality/biodiversity
- Integrated nutrient management for sustainable agriculture
- Fertilizer use efficiency in different soil conditions/cropping systems
- Use of remote sensing and GIS as diagnostic tool for natural resource management
- Role of biological agents in soil productivity
- Modeling solute (salt, fertilizer, pesticides) transport in soil

• Use of poor quality waters in Agriculture
• Soil testing and crop response
• Site-specific nutrient management and precision agriculture
• Nutrient dynamics in soil-plant system and modeling nutrient uptake
• Tillage and crop residue management in crop production
• Utilization of urban and industrial wastes/effluents in Agriculture
• Management of problematic soils
• Impact of climate change on soil processes
• Micronutrients in soil, plant and human health
• Water management strategies in different cropping systems
• Simulation models for growth and production of different crops
• Varietals response to soil salinity/ sodicity/ nutrients/ pollutants, etc
• Soil and water pollution - monitoring and control
• Genesis, formation and classification of soils
• Soil conservation, preservation and management for sustainable agriculture
• Remediation of polluted and contaminated soils

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PGS 521 (NC) Integral and Differential Calculus 3+0

Meanings of a derivate, Derivatives of algebric functions, derivates of Trigonometric functions. Derivation of inverse Trigonometric functions. Differentiation of log x, a^x, e^x, differentiation of products and quotient, functions, Logarithmic differentiation, Differentiation of implicit functions, Successive differentiation; Maxima and Minima, Meanings of Integration, Integrals of sone functions: Define integral ux + substitution method, integral of a linear factor raised to any power; Integration by parts, Integration of e^{ax} Sin X and e^{ax}. Cos X, Integration of trignometric functions; Differntial equations: (i) Equation in which the variable are separable Mdx + May = 0 (ii) Auxillary equations having roots equal.

Minor and supporting course for PG (M. Sc. / Ph. D.) students of Department of Agricultural Chemistry and Soil Science.

A PG student of Soil Science has to take 9 credit hours courses as minor / supporting in any of the following discipline:

1. Agronomy
2. Plant Physiology
3. Horticulture
4. Statistics
5. Bio-Chemistry