M.Sc. (Agri.) Soil Science

(Two Year Master Degree Programme)

Course Curriculum and Syllabus

Faculty of Agriculture Science and Technology

AKS UNIVERSITY, SATNA

M.Sc. (Agri.) Soil Science

(Two Year Master Degree Programme)

Requirement of credit hours for award of the degree

S.No	Nature of Courses	Credit hours
(i)	**Course work**	
	Major courses	**22**
	Minor courses	**08**
	Supporting courses	**07**
	Common courses	**05**
	Seminar	**01**
(ii)	Thesis Research	**30**
	Total	**73**

Major Subject: The subject (Department/Discipline) in which a student takes admission

Minor Subject: The subject closely related to a student's major subject.

Supporting subject: The subject not related to the major subject. It could be any subject considered relevant for student's research work or necessary for building hisoverall competence.

Non-Credit compulsory Courses: Six courses are of general nature and are compulsory for Master's programme.

Common Courses: The following courses (one credit each) will be offered to all

students undergoing Master's degree programme:

1. Library and Information Services

2. Technical Writing and Communications Skills

3. Intellectual Property and its management in Agriculture

4. Basic Concepts in Laboratory Technique

5. Agricultural Research, Research Ethics and Rural Development Programmes

Detail of Course Distribution

S.N.	Course Code	Course Name	Credits offered	Semester
Major Course				
1.	Soil 501	Soil Physics	3(2+1)	2 Semester
2.	Soil 502	Soil Fertility and fertiliser Use	4(3+1)	1Semester
3.	Soil 503	Soil Chemistry	3(2+1)	2Semester
4.	Soil 504	Soil Mineralogy, Genesis and Classification	3(2+1)	2Semester
5.	Soil 506	Soil Biology and Biochemistry	3(2+1)	1Semester
6.	Soil 508	Soil, Water and Air Pollution	3(2+1)	1Semester
7.	Soil 511	Management of Problem Soils and Water	3(2+1)	3Semester
Miner Course				
8.	Soil 509	Remote Sensing and GIS Technique for Soil, Water and Crop Studies	3(2+1)	2Semester
9.	Soil 505	Soil Erosion and Conservation	3(2+1)	1Semester
10.	Soil 513	Soil Survey and Land Use Planning	2(2+0)	3Semester
Supporting Course				
11.	STAT 502	Statistical Methods for Applied Sciences	4(3+1)	1Semester
12.	STAT 511	Experimental Designs	3(2+1)	2Semester

Non Credits				
13.	PGS 503	Intellectual Property and Its management in Agriculture	1(1+0)	2Semester
14.	PGS 502	Technical Writing and Communications Skills	1(0+1)	1Semester
15.	PGS 501	Library and Information Services	1(0+1)	1Semester
16.	PGS 505	Agricultural Research, Research Ethics and Rural Development Programmes	1(1+0)	3Semester
17.	PGS 504	Basic Concepts in Laboratory Techniques 1(0+1)	1(0+1)	2 Semester
18.	Soil 591	Seminar	1(0+1)	3Semester
19.	Soil 599	Master Research	30(0+30)	3Semester/ 4 Semester

Detail of First Semester Course Distribution

S.N.	Course Code	Course Name	Credits offered	Semester
Major Course				
1.	Soil 502	Soil Fertility and fertiliser Use	4(3+1)	1Semester
2.	Soil 506	Soil Biology and Biochemistry	3(2+1)	1Semester
3.	Soil 508	Soil, Water and Air Pollution	3(2+1)	1Semester

Miner Course				
4.	Soil 505	Soil Erosion and Conservation	3(2+1)	1Semester
Supporting Course				
5.	STAT 502	Statistical Methods for Applied Sciences	4(3+1)	1Semester
Non Credits				
6.	PGS 502	Technical Writing and Communications Skills	1(0+1)	1Semester
7.	PGS 501	Library and Information Services	1(0+1)	1Semester

Detail of Second Semester Course Distribution

S.N.	Course Code	Course Name	Credits offered	Semester
Major Course				
1.	Soil 501	Soil Physics	3(2+1)	2 Semester
2.	Soil 503	Soil Chemistry	3(2+1)	2Semester
3.	Soil 504	Soil Mineralogy, Genesis and Classification	3(2+1)	2Semester
Miner Course				
4.	Soil 509	Remote Sensing and GIS Technique for Soil, Water and Crop Studies	3(2+1)	2Semester
Supporting Course				
5.	STAT 511	Experimental Designs	3(2+1)	2Semester
Non Credits				
6.	PGS 503	Intellectual Property and Its management in Agriculture	1(1+0)	2Semester

7.	PGS 504	Basic Concepts in Laboratory Techniques 1(0+1)	1(0+1)	2 Semester

Detail of Third Semester Course Distribution

S.N.	Course Code	Course Name	Credits offered	Semester
Major Course				
1.	Soil 511	Management of Problem Soils and Water	3(2+1)	3Semester
Miner Course				
2.	Soil 513	Soil Survey and Land Use Planning	2(2+0)	3Semester
Non Credits				
3.	PGS 505	Agricultural Research, Research Ethics and Rural Development Programmes	1(1+0)	3Semester
4.	Soil 591	Seminar	1(0+1)	3Semester
5.	Soil 599	Master Research	15(0+15)	3Semester

Detail of Fourth Semester Course Distribution

S.N.	Course Code	Course Name	Credits offered	Semester
1.	Soil 599	Master Research	15(0+15)	4Semester

Course contents M.Sc. in Soil Science

Course Title : Soil Physics

Course Code : Soil 501

Credit Hours : 2+1

Aim of the course

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

Theory

Unit I

Basic principles of physics applied to soils, soil as a three phase system.

Unit II

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

Unit III

Soil consistence; dispersion and workability of soils; soil compaction and consolidation; soil strength; swelling and shrinkage - basic concepts.Alleviation of soil physical constraints for crop production. Soil erosion and edibility

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 ofhydraulic conductivity in saturated and unsaturated soils.

Unit VII

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

Unit VIII

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; soiltemperature management.

Practical

- Determination of B.D, P.D and mass volume relationship of soil, Mechanical analysis by hydrometer and international pipette method,
- Measurement of Atterberg 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 characteristics 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.

Teaching methods/activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

Learning outcome

EXperience on the knowledge of soil physical properties and processes in relation to plant growth.

Suggested Reading

- Baver LD, Gardner WH and Gardner WR. 1972. *Soil Physics*. John Wiley & Sons.
- Ghildyal BP and Tripathi RP. 2001. *Soil Physics*. New Age International.
- Hanks JR and 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 and Powers WL. 1972. *Advanced Soil Physics*. Wiley-Interscience.
- Kohnke H. 1968. *Soil Physics*. McGraw Hill.
- Lal R and Shukla MK. 2004. *Principles of Soil Physics*. Marcel Dekker.
- Oswal MC. 1994. *Soil Physics*. OXford & IBH.

Course Title : Soil Fertility and Fertilizer Use

Course Code : Soil 502

Credit Hours : 3+1

Aim of the course

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; fertility status of major soils group of India; nutrient sources – fertilizers and manures; Criteria of essentiality, classification, law of minimum and maximum, essential plant nutrients - functions and deficiencysymptoms, Nutrient uptake, nutrient interactions in soils and plants; long term effect of manures and fertilizers on soil fertility and crop productivity.

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 andalkali soils; factors affecting phosphorus availability in soils; phosphatic fertilizers - behavior in soilsand management under field conditions. Potassium - forms, equilibrium in soils and its agriculturalsignificance; mechanism of potassium fixation; management of potassium fertilizers under fieldconditions.

Unit V

Sulphur - source, forms, fertilizers and their behavior in soils; roleincropsandhuman health; 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–intensityrelationships; soil test crop response correlations and response functions.

Unit VIII

Fertilizer use efficiency; site-specific nutrient management; plant need based nutrient management; integrated nutrient management; specialityfertilizersconcept, needand category.CurrentstatusofspecialityfertilizersuseinsoilsandcropsofIndia;

Unit IX

Soil fertility evaluation - biological methods, soil, plant and tissue tests; soilquality in relation to sustainable agriculture, Determination of critical limit, DRIS

Unit X

Definition and concepts of soil health and soil quality; Longterm effects of fertilizersand soil quality.

Practical

- Soil and plant sampling and processing for chemical analysis
- Determination of soil pH, total and organic carbon in soil
- Chemical analysis of soil for total and available nutrients(major and micro)
- Analysis of plants for essential elements(major and micro)

Teaching methods/activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

Learning Out Comes :

Experience on the knowledge of soil fertility and fertilizers in relation to plant growth and development.

Suggested Reading

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

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

Course Title : Soil Chemistry

Course Code : Soil 503

Credit Hours : 2+1

Suggested Reading

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, soils, rocks and minerals

Unit II

Elements of equilibrium thermodynamics, chemical equilibria, electrochemistry andchemical 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, Characterization of OM; clay-organic interactions.

Unit IV

Ion exchange processes in soil; cation exchange- theories based on law of massaction (Kerr-Vanselow, Gapon equations, hysteresis, Jenny's concept), adsorptionisotherms, Donnan-membrane equilibrium concept, clay-membrane electrodes and ionicactivity measurement, thermodynamics, statistical mechanics; anion and ligand exchange–innersphere and outer-sphere surface complex formation, fixation of oxyanions,

hysteresisin 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 specificand non-specific sorption; precipitation-dissolution equilibria; Conceptof quantity/intensity(Q/ I)relationship; step and constant-rate K; managementaspects.

Unit VI

Chemistry of acid soils; active and potential acidity; lime potential, chemistry ofacid 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, geochemistry of micronutrients, environmental soil chemistry

Practical

Preparation of saturation extract, measurement of pH, EC, CO, HCO, Ca, Mg, Kand Na, Determination of CEC and AEC of soils, Analysis of equilibrium soil solution for pH, EC, Eh by the use of Eh-pH meter andconductivity meter, Determination of point of zero-charge and associated surface charge characteristics by the serial potentiometric titration method, Extraction of humic substances,

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 D (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 BaCl2-TEA method, Determination of Q/I relationship of potassium, Determination of lime requirement of an acid soil by buffer method, Determinationof gypsum requirement of an alkali soil.

Teaching methods/activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

Learning outcome

Experience on the knowledge of chemical behaviour of soil and their utility in research for solving field problem.

Suggested Reading

- Bear RE. 1964. *Chemistry of the Soil.* Oxford and IBH.
- Bolt GH and Bruggenwert MGM. 1978. *Soil Chemistry*. Elsevier.
- Greenland DJ and Hayes MHB. 1981. *Chemistry of Soil Processes*. John Wiley & Sons.
- Greenland DJ and Hayes MHB. *Chemistry of Soil Constituents*. John Wiley & Sons.
- McBride MB. 1994. *Environmental Chemistry of Soils.* Oxford University Press.
- Sposito G. 1981. *The Thermodynamics of Soil Solutions*. Oxford University Press.

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

- Sposito G. 1989. *The Chemistry of Soils*. Oxford University Press.
- Stevenson FJ. 1994. *Humus Chemistry*. 2nd Ed. John Wiley & Sons.
- Van Olphan H. 1977. *Introduction to Clay Colloid Chemistry*. John Wiley & Sons.

Course Title : Soil Biology and Biochemistry

Course Code : Soil 506

Credit Hours : 2+1

Aim of the course 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

Soilbiota, soil microbialecology, types of organisms indifferent soils; soil microbial biomass; microbial interactions; un-culturable soilbiota.

Unit II

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

activity of microflora; Root rhizosphere and PGPR.

Unit III

Microbial transformations of nitrogen, phosphorus, sulphur, iron and manganese in soil; biochemical composition and biodegradation of soil organic matter and crop

Unit IV

residues, microbiology and biochemistry of decomposition of carbonaceous and protenaceous materials, cycles of important organic nutrients.

Unit IV

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; FCO specifications and quality control of biofertilizers.

Unit VII

Biological indicators of soil quality; bioremediation of contaminated soils; microbial transformations of heavy metals in soil; role of soil organisms inpedogenesis – important mechanisms and controlling factors; soil genomics and bioprospecting; soil sickness due to biological agents; xenobiotics; antibiotic production in soil.

Practical

Determination of soil microbial population

• Soil microbial biomass carbon

• 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, N2 fixation, S oxidation, P solubilization and mineralization of other micronutrients

Teaching methods/ activities Classroom teaching with AV aids, group discussion, oral presentation by students.

Learning outcome

Experience on the knowledge of soil microbes and their utility in research for solving field problem.

Suggested Reading

• Paul EA and Clark FE. Soil Microbiology and Biochemistry.

• Lynch JM. Soil Biotechnology
• Willey JM, Linda M. Sherwood and Woolverton CJ. Prescott's Microbiology.
• Subba Rao NS. Advances In Agricultural Microbiology.

Course Title : Soil Mineralogy, Genesis and Classification

Course Code : Soil 504

Credit Hours : 2+1

Aim of the course

To acquaint students with basic structure of alumino-silicate minerals and genesis of clay minerals; soil genesis interms of factors and processes of soil formation, and to enable students conduct soil survey and interpret soil survey reports in termsof 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 crystal line and non-crystal line clay minerals; identification techniques; amorphous soil constituents and other non-crystalline silicate minerals and their identification; clay minerals in Indian soils, role of clay minerals in plant nutrition, interaction of clay with humus, pesticides and heavy metals.

Unit III

Factors of soil formation, soil formation models; soil forming processes; weatheringof 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.

Practical

- Separation of sand, silt and clay fraction from soil
- Determination of specific surface area and CEC of clay
- Identification and quantification of minerals in soil fractions

- Morphological properties of soil profile in different land forms
- Classification of soils using soil taXonomy
- Calculation of weathering indices and its application in soil formation
- Grouping soil susing available database in terms of soil quality

Teaching methods/activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

Learning outcome

EXperience on the knowledge of soil taXonomy and genesis and and their utility inresearch for solving field problem.

- Brady NC and Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu. Buol EW, Hole ED, MacCracken RJ and Southard RJ. 1997. *Soil Genesis*
- *and Classification*. 4th Ed. Panima Publ.
- DiXon JB and 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 and MattoX RB. 1960. *Elements of Crystallography and Mineralogy*. OXford & IBH.
- Wilding LP and Smeck NE. 1983. *Pedogenesis and Soil Taxonomy*: II. *The Soil Orders*.

  Elsevier.

- Wilding NE and Holl GF. (Eds.). 1983. *Pedogenesis and Soil Taxonomy*.

Course Title : Soil Biology and Biochemistry

Course Code : Soil 506

Credit Hours : 2+1

Aim of the course 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

Soilbiota, soil microbialecology, types of organisms indifferent soils; soil microbial biomass; microbial interactions; un-culturable soilbiota.

Unit II

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

Unit III

Microbial transformations of nitrogen, phosphorus, sulphur, iron and manganese in soil; biochemical composition and biodegradation of soil organic matter and crop residues, microbiology and biochemistry of decomposition of carbonaceous and

protenaceous materials, cycles of important organic nutrients.

Unit IV

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; FCO specifications and quality control of biofertilizers.

Unit VII

Biological indicators of soil quality; bioremediation of contaminated soils; microbial

transformations of heavy metals in soil; role of soil organisms inpedogenesis –

important mechanisms and controlling factors; soil genomics and bioprospecting;

soil sickness due to biological agents; xenobiotics; antibiotic production in soil.

Practical

• Determination of soil microbial population

• Soil microbial biomass carbon

• 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, N2 fixation, S oxidation, P solubilization and mineralization of other micronutrients

Teaching methods/ activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

Learning outcome

Experience on the knowledge of soil microbes and their utility in research for solving field problem.

Suggested Reading

• Paul EA and Clark FE. Soil Microbiology and Biochemistry.

• Lynch JM. Soil Biotechnology

• Willey JM, Linda M. Sherwood and Woolverton CJ. Prescott's Microbiology.

• Subba Rao NS. Advances In Agricultural Microbiology.

Course Title : Soil, Water and Air Pollution

Course Code : Soil 508

Credit Hours : 2+1

Aim of the course

To make the student saw are 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 effecton soil properties/ health, and plant growth and humanbeings; soil as sink for waste disposal.

Unit IV

Pesticides–their classification, behaviour in soil and effecton soil microorganisms.

Unit V

Toxic elements–their sources, behaviour 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 green house gases–carbondioxide, methane and nitrous oxide.

Unit VII

Risk assessment of polluted soil, Remediation/ amelioration of contaminated soil and water; remote sensing applications in monitoring and management of soil andwater pollution.

Practical

Sampling of sewage waters, sewage sludge, solid/ liquid industrial wastes, polluted soils and plants and their processing, Estimation of dissolved and suspended solids, chemical oxygen demand (COD), biological demand (BOD), measurement of coliform (MPN), 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 safe guard food safety, Air sampling and determination of particulate matter and oxides of sulphur, NO_2 and O_2 conc**.** Visit to various industrial sites to study the impact of pollutants on soil and plants.

Teaching methods/activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

Learning outcome

Management of soil and water pollution

Suggested Reading

- Lal R, Kimble J, Levine E and 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 and Pierce 1983. *Environmental Pollution and Control*. Ann Arbor Science Publ

Course Title : Management of Problem Soils and Water

Course Code : Soil 511

Credit Hours : 2+1

Aim of the course

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; salt stress meaning and its effect on crop growth, monitoring of soils alinity in the field; management principles for sandy, clayey, red lateritic and dryland 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. Agronomic practices in relation to problematic soils; cropping pattern for utilizing poor quality groundwaters.

Practical

Characterization of acid, acid sulfate, salt-affected and calcareous soils, Determination of cations (Na+, K+, Ca++ and Mg++) in groundwater and soil samples, Determination of an ions (Cl^-, SO_4^-, CO_3^- and HCO_{3-}) in ground watersand soil samples, Lime and gypsum requirements of acid and sodic soils.

Teaching methods/activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

Learning outcome

EXperience on solving field problem of problem soil and waters.

Resources

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

Minor Courses : 08 Credits

I. Course Title : Remote Sensing and GIS Technique for Soil, Water and Crop Studies

Course Code : Soil 509

Credit Hours : 2+1

Aim of the course

To impart knowledge about the basic concepts of remote sensing, aerial photographs and imageries, and their interpretation; application of remote sensing 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, basic concepts and principles; hardware and software requirements; common terminologies of geographic information system (GIS)

Unit II

Sensor systems-camera, microwave radio meters and scanners; fundamentals of aerial photographs and multispectral imaging, hyperspectral imaging, thermal imaging; image processing and interpretations.

Unit III

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

Unit IV

Significance and sources of the spatial and temporal variability in soils; variabilityin relation to size of sampling; classical and geo-statistical techniques of evolutionof soil variability.

Unit V

Applications of GIS for water resources, agriculture, precision farming, disaster management, e-governance, Agricultural Research Information System (ARIS).

Practical

Familiarization with different remote sensing equipments and data products, Interpretation of aerial photo graphs and satellite data for mapping of land resources, Analysis of variability of different soil properties with classical and geostatistical techniques, Creation of datafiles in a database programme, Use of GIS for soilspatial simulation and analysis, To enable the students to conduct soil survey and interpret soil survey reports in terms of land use planning.

Teaching methods/activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

Learning outcome

EXperience on the knowledge of remote sensing and their utility in research for solving field problem.

- Brady NC and 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 and Kiefer RW. 1994. *Remote Sensing and Image Interpretation*. 3rd Ed. Wiley.
- Nielsen DR and Wendroth O. 2003. *Spatial and Temporal Statis*tics. Catena Verloggmbh.
- Star J and Esles J. 1990. *Geographic Information System: An Introduction*. Prentice Hall.

Course Title : Soil Erosion and Conservation

Course Code : Soil 505

Credit Hours : 2+1

Aim of the course

To enable students to understand various types of soil erosion and measures to betaken for controlling soil erosion to conserve soil and water.

Theory

Unit I

History, distribution, identification and description of soil erosionproblems in India.

Unit II

Forms of soil erosion; effects of soil erosion and factors affecting soilerosion; types and mechanisms of water erosion; raindrops and soil erosion; rainfall erosivity - estimation as EI30 indeX and kinetic energy; factors affectingwater erosion; empirical and quantitative estimation of water erosion; methods of measurement and prediction of runoff; soil losses in relation to soil properties andprecipitation.

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 specialproblem 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, sediment measurement

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
- Land capability classification of a watershed
- Visits to a watersheds

Teaching methods/activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

Learning outcome

Experience on the knowledge of soil conservation and their utility in research forsolving field problem.

Suggested Reading

- Biswas TD and Narayanasamy G. (Eds.) 1996. *Soil Management in Relation to LandDegradation and Environment*. Bull. Indian Society of Soil Science No. 17.
- Doran JW and 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 and Joshi BP. 1990. *Manual of Soil and WaterConservation Practices*. Oxford & IBH.
- Hudson N. 1995. *Soil Conservation*. Iowa State University Press.
- Indian Society of Soil Science 2002. *Fundamentals of Soil Science*. ISSS, New Delhi.
- Oswal MC. 1994. *Soil Physics*. Oxford & IBH.

Course Title : Soil Survey and Land Use Planning

Course Code : Soil 513

Credit Hours : 2+0

Aim of the course

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

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; thematic soil maps, cartography, mapping units, techniques for gene ration of soil maps, application of remote sensingand GIS in soil survey and mapping of major soil group of

India

Unit II

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.

Unit III

Concept and techniques of land use planning; factors governing present land use; Land evaluation method sand soil-site suitability evaluation for different crops;land capability classification and constraints in application.

Unit IV

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

Practical

- 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 differentscales
- Land use planning exercises using conventional and RS tools

Teaching methods/activities

Classroom teaching with AV aids, group discussion, field visit and exposure visit Planning for land use in proper way for higher crop productivity.

Suggested Reading

- Boul SW, Hole ED, MacCraken RJ and Southard RJ. 1997. *Soil Genesis and Classification.*
  4th Ed. Panima Publ.

Brewer R. 1976. *Fabric and Mineral Analysis of Soils.* John Wiley & Sons

STAT 502 STATISTICAL METHODS FOR APPLIED SCIENCES 3(2+1)

Objective It would also help them in understanding the concepts involved in data presentation, analysis and interpretation. The students would get an exposure to presentation of data, probability distributions, parameter estimation, tests of significance, regression and multivariate analytical techniques.

Theory

Unit I

Classification, tabulation and graphical, representation of data. Box-plot, Descriptive statistics. Exploratory data analysis;

Unit II

Measures of central tendancy- Mean, Median, Mode, Geometric mean, Harmonic mean.

Unit III

Measures of Dispersion- Range, Quartile deviation, Mean deviation, Standard deviation.

Unit IV

Theory of probability. Random variable and mathematical expectation. Discrete and continuous probability distributions. Correlation and regression.

Unit V

Binomial, Poisson, Negative Binomial, Normal distribution, Beta and Gamma distributions and their applications. Concept of sampling distribution: chi-square, t and Fdistributions. Tests of significance based on Normal, chi-square, t and F distributions.

Practical

Exploratory data analysis, Box-Cox plots; Fitting of distributions~Binomial, Poisson, Negative Binomial, Normal; Large sample tests, testing of hypothesis based on exact sampling distributions-chi square, t and F; Confidence interval estimation and point estimation of parameters of binomial, Poisson and Normal distribution; Correlation and regression analysis, fitting of orthogonal polynomial regression; applications of dimensionality reduction and discriminant function analysis; Nonparametric tests.

Suggested Readings

- Anderson TW. 1958. An Introduction to Multivariate Statistical Analysis. John Wiley.
- Goon AM, Gupta MK & Dasgupta B. 1977. An Outline of Statistical Theory. Vol. I
- Goon AM, Gupta MK & Dasgupta B. 1983. Fundamentals of Statistics. Vol. I.
- Hoel PG. 1971. Introduction to Mathematical Statistics. John Wiley.

STAT 511: EXPERIMENTAL DESIGNS 3 (2+1)

Objective

This course is meant for students of agricultural and animal sciences other than Statistics. Designing an experiment is an integrated component of research in almost all sciences. The students would be exposed to concepts of Design of Experiments so as to enable them to understand the concepts involved in planning, designing their experiments and analysis of experimental data.

Theory

UNIT I Need for designing of experiments, characteristics of a good design. Basic principles of designs-randomization, replication and local control.

UNIT II Uniformity trials, size and shape of plots and blocks; Analysis of variance; Completely randomizeddesign, randomized block design and Latin square design.

UNIT III Factorial experiments, (symmetrical as well as asymmetrical). orthogonality and partitioning ofdegrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with controltreatment.

UNIT IV Split plot and strip plot designs; Analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, crossover designs, balanced incomplete blockdesign, resolvable designs and their applications ~ Lattice design, alpha design-concepts, randomisation procedure, analysis and interpretation of results. Response surfaces. Experiments with mixtures.

UNIT V Bioassays- direct and indirect, indirect assays based on quantal dose response, parallel line and slope ratio assays potency estimation.

Practical

Uniformity trial data analysis, formation of plots and blocks, Fairfield Smith Law; Analysis of data obtained from CRD, RBD, LSD; Analysis of factorial experiments without and with confounding; Analysis with missing data; Split plot and strip plot designs; Transformation of data; Analysis of resolvable designs; Fitting of response surfaces.

Suggested Readings

Cochran WG & Cox GM. 1957. Experimental Designs. 2nd Ed. John Wiley. Dean AM & Voss D. 1999. Design and Analysis of Experiments. Springer. Federer WT. 1985. Experimental Designs. MacMillan.

Fisher RA. 1953. Design and Analysis of Experiments. Oliver & Boyd. Nigam AK & Gupta VK. 1979. Handbook on Analysis of Agricultural Experiments. IASRI Publ. Pearce SC. 1983. The

Agricultural Field Experiment: A Statistical Examination of Theory and Practice. John Wiley.
Design Resources Server: www.iasri.res.in/design.

PGS 502: Technical Writing and Communications Skills 1(0+1)

Objective To equip the students/scholars with skills to write dissertations, research papers, etc. Toequip the students/scholars with skills to communicate and articulate in English (verbal as well aswriting).

Practical

Technical Writing Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (titlepage, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.

Communication Skills - Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers.

Suggested Readings

- English Dictionary. 1995. Harper Collins. Gordon HM & Walter JA. 1970.
- Technical Writing. 3rd Ed. Holt, Rinehart & Winston. Hornby AS. 2000. Comp.
- James HS. 1994. Handbook for Technical Writing. NTC
- Mohan K. 2005. Speaking English Effectively.
- High School English Grammar and Composition. S. Chand & Co.

PGS 503 Intellectual Property and Its management in Agriculture 1(1+0)

Objective

The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as atool for wealth and value creation in a knowledgebased economy.

Theory

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPsand various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property ights(IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs andlayout, trade secrets and traditional knowledge, trademarks, protection of plant varieties
and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings

Erbisch FH & Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI. Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill. Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC & Aesthetic Technologies. Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation. Rothschild M & Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI. Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ.

House. The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000;Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design

Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.

PGS 501: Library and Information Services 1(0+1)

Objective:

To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.

Practical:

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources;

Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search enginesand its resources; ere sources access methods.

PGS 504: Basic Concepts in Laboratory Techniques 1(0+1)

Objective:

To acquaint the students about the basics of commonly used techniques in laboratory.Practical:

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; washing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of solutions of differentstrengths

and their dilution; Handling techniques of solutions; Preparation of different agrochemical doses in field and pot applications; Preparation of solutions of acids; Neutralization of acid and bases; Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sand bath, water bath, oil bath; Electricwiring and earthing. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relationto taxonomy

Suggested Readings

Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press. Gabb MH & Latchem WE.1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.8. FMPE 503: Testing and Evaluation of Tractors and Farm Equipment

PGS 505 AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES (1+0)

Objective

To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

Theory

UNIT I History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

UNIT II Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

UNIT III Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/ Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings

1. Bhalla GS and Singh G. 2001. *Indian Agriculture - Four Decades of Development*. Sage Publ.
2. Punia MS. *Manual on International Research and Research Ethics.* CCS Haryana Agricultural University, Hisar.
3. Rao BSV. 2007. *Rural Development Strategies and Role of Institutions - Issues,Innovations and Initiatives*. Mittal Publ.
4. Singh K. 1998. *Rural Development - Principles, Policies and Management*. Sage Publ.