DEPARTMENT OF HIGHER EDUCATION

RAJA MAHENDRA PRATAP SINGH UNIVERSITY, ALIGARH

AS PER THE ICAR-Sixth Deans' Committee

Course Curriculum of M.Sc. (Ag.) AG. CHEMISTY & SOIL SCIENCE

Course Curriculum of M.Sc. (Ag.) M.Sc. AG. CHEMISTY & SOIL SCIENCE
(Based on Restructured and Revised Syllabi of PG Programme by ICAR)

1st Year (1st Semester)			Evaluation Marks			
Code No.	**Course Title**	**Credit Hours**	**Mid Term (Internal)**	**Practical (External)/ Assignment (Internal 2)**	**End term/Final (External)**	**Total**
SSC 501	Management of Problematic Soils and Water	3(2+1)	20	30	50	100
SSC 502	Soil Physics	3(2+1)	20	30	50	100
SSC 503	Soil Fertility and Fertilizer Use	3(2+1)	20	30	50	100
	Elective Paper	3(2+1)	20	30	50	100
AST 501	Experimental Design	3(2+1)	20	30	50	100
PGS 501	Basic Concepts in Laboratory Technique	1(0+1)	40	10	-	50
PGS 502	Intellectual Property and Its Management in Agriculture	1(1+0)	-	-	50	50
	Total Credit	**17**				**600**
1st Year (2nd Semester)			**Evaluation Marks**			
SSC 504	Soil Water and Air pollution	3(2+1)	20	30	50	100
SSC 505	Analytical Technics and Instrumental Methods in Soil and Plant Analysis	2(0+2)	-	100	-	100
SSC 506	Soil Survey and Land Use Planning	3(2+1)	20	30	50	100
	Elective Paper	3(2+1)	20	30	50	100
AST 502	Date Analysis Using Statistical Packages	3(2+1)	20	30	50	100
PGS 503	Agriculture Research, Research Ethic and Rural Development Programmes	1(1+0)	-	-	50	50
PGS 504	Library and Information Services	1(0+1)	40	10	-	50
	Total credit	**16**				**600**
2nd Year (3rd Semester)			**Evaluation Marks**			
SSC 507	Fundamentals of Agricultural Meteorology	2(1+1)	20	30	50	100
SSC 508	Remote Sensing and GIS Technique for Soil and Crop Studies	3(2+1)	20	30	50	100

SSC 509	Soil Chemistry	3(2+1)	20	30	50	100
	Elective Paper	2(1+1)	20	30	50	100
PGS 505	Technical Writing and Communications Skills	1(0+1)	20	30	50	100
	Total Credit	**11**				**500**
4th Semester			**Evaluation Marks**			
SSC 510	Master' Seminar	1(0+1)				100
SSC 517	Master Research (Thesis)	30	Satisfactory/Unsatisfactory			
Or						
AGR- 511 B	IDEA (Internship for Development of Entrepreneurship In Agriculture)	30	Satisfactory/Unsatisfactory			
SSC 517	Master Research (Thesis)	30	Satisfactory/Unsatisfactory			
	Total Credit	**1+30**				**100**
	Grand total credit hours	**45+30=75**				**1800**

M.Sc. AG. CHEMISTY & SOIL SCIENCE

The following nomenclature and Credit Hrs. are following while structuring Syllabus:

A. Course Work	Course Code	Allotted Credit Hours
1. Major Course	SSC- 501 To – SSC-509	25
2. Minor Course	Elective	08
3. Supporting Course	AST-501 & AST-502	06
4. Common Course	PGS-501 To PGS-505	05
5. Seminar	SSC- 510	01
B. 1.Thesis Research/ IDEA	Master Research or IDEA	30
Total		**75**

List of Minor Papers for Other Departments

Sr. No.	**Course Code**	**Course Name**	**Allotted Credit Hours**	Sem.
1	SSC 501	Management of Problematic Soils and Water	3(2+1)	1st
2	SSC 504	Soil Water and Air pollution	3(2+1)	2nd
3	SSC 507	Fundamentals of Agricultural Meteorology	2(1+1)	3rd

Note: - 1. The student has to opt. Minor Courses of Minimum 8 credit hours offer by other department

2. The first course of every semester from the respective department is treated as a Minor for other department.

1st Semester

(SSC-501) MANAGEMENT OF PROBLEMATIC SOILS AND WATER 3(2+1)

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 anility 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 sulphate, 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 waters and soil samples, Lime and gypsum requirements of acid and sodic soils

(SSC-502) SOIL PHYSICS 3(2+1)

Theory

Unit I

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

Soil texture, textural classes, mechanical analysis, specific surface. Infiltration; internal drainage and redistribution; evaporation; hydrologic cycle, field water balance; soil-plant-atmosphere continuum

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

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.illel 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 Physic*s. 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.

(SSC-503) Soil Fertility and Fertilizer Use 3(2+1)

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 deficiency symptoms, 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 and alkali soils; factors affecting phosphorus availability in soils; phosphatic fertilizers - behavior in soils and management under field conditions. Potassium forms, equilibrium in soils and its agricultural significance; mechanism of potassium fixation; management of potassium fertilizers under field conditions.

Unit IV

Sulphur - source, forms, fertilizers and their behavior in soils; role in crops and human health; calcium and magnesium– factors affecting their availability in soils; management of Sulphur, calcium and magnesium fertilizers. Common soil test methods for fertilizer recommendations; quantity– intensity relationships; soil test crop response correlations and response functions

Unit V

Micronutrients – critical limits in soils and plants; factors affecting their availability and correction of their deficiencies in plants; role of chelates in nutrient availability. Soil fertility evaluation - biological methods, soil, plant and tissue tests; soil quality in relation to sustainable agriculture, Determination of critical limit, DRIS, Fertilizer use efficiency; site-specific nutrient management; plant need based nutrient management; integrated nutrient management; specialty fertilizers concept, need and category. Current status of specialty fertilizers uses in soils and crops of India; Definition and concepts of soil health and soil quality; Longterm effects of fertilizers and 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)

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.

(AST 501) Experimental Designs 3(2+1)

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 randomized design, randomized block design and Latin square design.

Unit III

Factorial experiments, (symmetrical as well as asymmetrical). orthogonality and partitioning of degrees of freedom. Concept of confounding.

Unit IV

Split plot and strip plot designs, analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, Balanced Incomplete Block Design, resolvable designs and their applications,

Unit V

Lattice design, alpha design - concepts, randomization procedure, analysis and interpretation of results. Response surfaces. Combined analysis.

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,
- Analysis with missing data,
- Split plot and strip plot designs.

Suggested Reading

- Cochran WG and Cox GM. 1957. *Experimental Designs*. 2nd Ed. John Wiley.
- Dean AM and Voss D. 1999. *Design and Analysis of Experiments*. Springer.
- Montgomery DC. 2012. *Design and Analysis of Experiments*, 8th Ed. John Wiley.
- Federer WT. 1985. *Experimental Designs*. MacMillan.
- Fisher RA. 1953. *Design and Analysis of Experiments*. Oliver & Boyd.
- Nigam AK and 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.

(PGS 501) BASIC CONCEPTS IN LABORATORY TECHNIQUES 1(0+1)

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 different strengths and their dilution;
- Handling techniques of solutions;
- Preparation of different agro-chemical doses in field and pot applications;
- Preparation of solutions of acids;
- Neutralisation 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, sandbath, waterbath, oilbath
- Electric wiring 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 relation to taxonomy.

Suggested Readings

- Furr AK. 2000. *CRC Hand Book of Laboratory Safety*. CRC Press
- Gabb MH and Latchem WE. 1968. *A Handbook of Laboratory Solutions*. Chemical Publ. Co.

(PGS 502) Intellectual Property and Its Management In Agriculture 1(1+0)

Theory

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, 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 and 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 and Aesthetic Technologies.
- Ministry of Agriculture, Government of India. 2004. *State of Indian Farmer*. Vol. V.Technology Generation and IPR Issues. Academic Foundation.
- Rothschild M and 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; The Biological Diversity Act, 2002

2nd SEMESTER

(SSC-504) SOIL WATER AND AIR POLLUTION 3(2+1)

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, behaviour in soil and effect on soil microorganisms. methane and nitrous oxide.Risk assessment of polluted soil, Remediation/ amelioration of contaminated soil and water; remote sensing applications in monitoring and management of soil and water pollution.

Unit V

Toxic elements–their sources, behaviour in soils, effect on nutrients availability, effect on plant and human health.Pollution of water resources due to leaching of nutrients and pesticides from soil; emission of greenhouse gases–carbon dioxide,

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, NO2 and O2 conc. Visit to various industrial sites to study the impact of pollutants on soil and plants.

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

(SSC-505) Analytical Technique and Instrumental Methods in Soil and Plant Analysis 2 (0+2)

Practical

Unit I

Preparation of solutions for standard curves, 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, ultra violet and infrared spectrophotometer, atomic absorption, flame-photometry, inductively coupled plasma spectrometry; chromatographic techniques, mass spectrometry and X-ray diffractometer; identification of minerals by X-ray by different methods, CHNS analyzer.

Unit IV

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

Unit V

Wet digestion/fusion/extraction of soil with aquilegia with soil for elemental analysis; triacid/di-acid digestion of plant samples; determination of available and total nutrients (N, P, K, S, Ca, Mg, Zn, Cu, Fe, Mn, B, Mo) in soils; determination of total nutrients (N, P, K, S, Ca, Mg, Zn, Cu, Fe, Mn, B, Mo) in plants
Drawing normalized exchange isotherms; measurement of redox potential.

Suggested Reading

- 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 and Keeney DR. 1982. Methods of Soil Analysis. Part II. SSSA, Madison.
- Piper CE. Soil and Plant Analysis. Hans Publ.
- Singh D, Chhonkar PK and 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 Waters. FDCO, New Delhi.
- Vogel AL. 1979. A Textbook of Quantitative Inorganic Analysis. ELBS Longman.

(SSC-506) SOIL SURVERY AND LAND USE PLANNING 2(0+2)

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 sensing and 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;

Unit IV

Land capability classification and constraints in application.

Unit V

Argo-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 different scales
- Land use planning exercises using conventional and RS tools

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.

(AST 502) Data Analysis Using Statistical Packages 3(2+1)

Theory

Unit I

Introduction to various statistical packages: Excel, R, SAS, SPSS. Data Preparation; Descriptive statistics; Graphical representation of data, Exploratory data analysis.

Unit II

Test for normality; Testing of hypothesis using chi-square, t and F statistics and-Ztest.

Unit III

Data preparation for ANOVA and ANCOVA, Factorial Experiments, contrast analysis, multiple comparisons, Analyzing crossed and nested classified designs.

Unit IV

Analysis of mixed models; Estimation of variance components; Correlation and regression analysis, Probit, Logit and Tobit Models.

Unit V

Discriminant function; Factor analysis; Principal component analysis; Analysis of time series data, Fitting of non-linear models; Neural networks.

Practical

- Use of software packages for summarization and tabulation of data, obtaining descriptive statistics, graphical representation of data
- Testing the hypothesis for one sample t-test, two sample t-test, paired t-test, test for
- large samples - Chi-squares test, F test, one-way analysis of variance;
- Designs for Factorial Experiments, fixed effect models, random effect models, mixed
- effect models, estimation of variance components;
- Linear regression, Multiple regression, Regression plots
- Discriminant analysis - fitting of discriminant functions, identification of important
- variables
- Factor analysis. Principal component analysis - obtaining principal component.

Suggested Reading

- Anderson C.W. and Loynes R.M. 1987. The Teaching of Practical Statistics. John Wiley.
- Atkinson A.C. 1985. Plots Transformations and Regression. Oxford University Press.
- Chambers J.M., Cleveland W.S., Kleiner B and Tukey P.A. 1983. Graphical Methods for Data Analysis. Wadsworth, Belmont, California.
- Chatfield C. 1983. Statistics for Technology. 3rd Ed. Chapman & Hall. Chatfield C. 1995. Problem Solving: A Statistician's Guide. Chapman & Hall.
- Cleveland W.S. 1985. The Elements of Graphing Data. Wadsworth, Belmont, California.
- Ehrenberg ASC. 1982. A Primer in Data Reduction. John Wiley.
- Erickson B.H. and Nosan Chuk T.A. 1992. Understanding Data. 2nd Ed. Open University Press, Milton Keynes.
- Snell E.J. and Simpson HR. 1991. Applied Statistics: A Handbook of GENSTAT Analyses. Chapman and Hall.
- Sprent P. 1993. Applied Non-parametric Statistical Methods. 2nd Ed. Chapman & Hall.
- Tufte ER. 1983. The Visual Display of Quantitative Information. Graphics Press, Cheshire, Conn.
- Velleman PF and Hoaglin DC. 1981. Application, Basics and Computing of Exploratory Data Analysis. Duxbury Press.
- Weisberg S. 1985. Applied Linear Regression. John Wiley.
- Wetherill GB. 1982. Elementary Statistical Methods. Chapman & Hall.

(PGS 503)- Agricultural Research, Research Ethics and Rural Development Programmes 1 (1+0)

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;

UNIT II

Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centers (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 III

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

UNIT IV

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 Organizations.

UNIT V

Critical evaluation of rural development policies and Programmes. Constraints in implementation of rural policies and Programmes.

Suggested Readings

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

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(PGS 504)-Library and Information Services 1(0+1)

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 engines and its resources; eresourcesaccess methods.

3rd Semester

(SSC-507) Fundamentals of Agricultural Meteorology 2(1+1)

Theory

Unit I

Meaning and scope of agricultural meteorology; components of agricultural meteorology; role and responsibilities of agricultural meteorologists.

Unit II

Importance of meteorological parameters in agriculture; efficiency of solar energy conversion into dry matter production; meteorological factors in photosynthesis, respiration and net assimilation; basic principles of water balance in ecosystems; soil-water balance models and water production functions.

Unit III

Crop weather calendars; weather forecasts for agriculture at short, medium and long range levels; agromet advisories, preparation, dissemination and economic impact analysis; use of satellite imageries in weather forecasting; synoptic charts and synoptic approach to weather forecasting.

Unit IV

Concept, definition, types of drought and their causes; prediction of drought; crop water stress index, crop stress detection; air pollution and its influence on vegetation, meteorological aspects of forest fires and their control.

Unit V

Climatic change, green house effect, CO2 increase, global warming and their impact on agriculture; climate classification, agro-climatic zones and agro-ecological regions of India.

Practical

- Preparation of crop weather calendars
- Development of simple regression models for weather, pest and disease relation in different crops.
- Preparation of weather based agro-advisories
- Use of automated weather station (AWS)

Suggested Reading

- Bishnoi OP. 2007. Principles of Agricultural Meteorology. Oxford Book Co.
- Kakde JR. 1985. Agricultural Climatology. Metropolitan Book Co.
- Mahi and Kingra. 2014. Fundamentals of agrometeorology. Kalyani publishers.
- Mavi HS and Tupper. 2004. Principles and applications of climate studies in agriculture. CRC Press
- Varshneya MC and Pillai PB. 2003. Text Book of Agricultural Meteorology. ICAR. Journals
- Journal of Agrometeorology
- Italian Journal of Agrometeorology
- Agricultural and Forest Meteorology
- Current Science

(SSC-508) REMOTE SENSING AND GIS TECHNIQUE FOR SOIL AND CROP STUDIES 3(2+1)

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; variability in relation to size of sampling; classical and geo-statistical techniques of evolution of 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 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 Reading

- 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.

(SSC-509) SOIL CHEMISTRY 3(2+1)

Theory

Unit I

Chemical (elemental) composition of the earth's crust, soils, rocks and minerals

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, Characterization of OM; clay-organic interactions.

Unit IV

Ion exchange processes in soil; cation exchange- theories based on law of mass action (Kerr-Vanselow, Gabon 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– inner sphere 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 nonspecific sorption; precipitation-dissolution equilibria; Conceptor quantity/intensity(Q/ I)relationship; step and constant-rate K; management aspects. Chemistry of acid soils; active and potential acidity; lime potential, chemistry of acid soils; sub-soil acidity. Chemistry of salt-affected soils and amendments; soil pH, ECe, ESP, SAR and important relations; soil management and amendments. 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, K and Na, Determination of CEC and AEC of soils,Analysis of equilibrium soil solution for pH, EC, Eh by the use of Eh-pH meter and conductivity meter, Determination of point of zero-charge and associated surface charge characteristics by the serial potentiometric titration method, 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, Determination of gypsum requirement of an alkali soil.

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.

(PGS 505) Technical Writing and Communications Skills 1(0+1)

Practical (Technical Writing)

- Various forms of scientific writings- theses, technical papers, reviews, manuals, etc.;
- Various parts of thesis and research communications (title page, 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

- Barnes and Noble. Robert C. (Ed.). 2005. *Spoken English: Flourish Your Language*.
- *Chicago Manual of Style*. 14th Ed. 1996. Prentice Hall of India.
- *Collins' Cobuild English Dictionary*. 1995.
- Harper Collins. Gordon HM and Walter JA. 1970. *Technical Writing*. 3rd Ed.
- Holt, Rinehart and Winston. Hornby AS. 2000. *Comp. Oxford Advanced Learner's Dictionary of Current English*. 6th Ed. Oxford University Press.
- James HS. 1994. *Handbook for Technical Writing*. NTC Business Books.
- Joseph G. 2000. *MLA Handbook for Writers of Research Papers*. 5th Ed. Affiliated East-West Press.
- Mohan K. 2005. *Speaking English Effectively*. MacMillan India.
- Richard WS. 1969. *Technical Writing.*
- Sethi J and Dhamija PV. 2004. *Course in Phonetics and Spoken English*. 2nd Ed. Prentice Hall of India.
- Wren PC and Martin H. 2006. *High School English Grammar and Composition*. S.

4th Semester

(SSC-510)	**Master Seminar**	**1(0+1)**
(SSC- 511 A)	**Master Research (Thesis)**	**30**

Or

(SSC - 511 B) IDEA (Internship for Development of Entrepreneurship in Agriculture) 30