

FACULTY OF AGRICULTURAL SCIENCES

ORDINANCE

**M.Sc. Agriculture Soil Science
(2023-24)**



**SHREE GURU GOBIND SINGH TRICENTENARY UNIVERSITY
GURUGRAM (DELHI-NCR)**

PREFACE

The curricula development is a part of the continued process and effort of the ICAR in this direction for dynamic improvement of national agricultural education system. In this resolve, the ICAR has constituted a National Core Group (NCG) for restructuring of Master's and Ph.D. curriculum, syllabi and academic regulations for the disciplines under agricultural sciences. On the recommendations of the NCG, 19 Broad Subject Matter Area (BSMA) Committees have been constituted by the ICAR for revising the syllabus. These Committees held discussions at length in the meetings and workshops organized across the country. The opinions and suggestions invited from institutions, eminent scientists and other stakeholders were also reviewed by the Committees. The respective BSMA Committees have examined the existing syllabus and analysed carefully in terms of content, relevance and pattern and then synthesized the new syllabus.

The revised curricula of 79 disciplines have been designed with a view to improve the existing syllabus and to make it more contextual and pertinent to cater the needs of students in terms of global competitiveness and employability. To mitigate the concerns related to agriculture education system in India and to ensure uniform system of education, several changes have been incorporated in common academic regulations in relation to credit load requirement and its distribution, system of examination, internship during Masters programme, provision to enroll for online courses and take the advantage of e-resources through e-learning and teaching assistantship for Ph.D. scholars. As per recommendations of the National Education Policy-2020, the courses have been categorized as Major and Minor/Optional courses. By following the spirit of Choice Based Credit System (CBCS), the students are given opportunity to select courses from any discipline/department enabling the multi-disciplinary approach.

The revised syllabi encompass transformative changes by updating, augmenting, and revising course curricula and common academic regulations to achieve necessary quality and need-based agricultural education. Many existing courses were upgraded with addition and deletion as per the need of the present situation. The new courses have been incorporated based on their importance and need both at national and international level.

{The syllabi of post graduate programmes is restructured and revised as per recommendations of ICAR Education Division, Agriculture and Allied Sciences, Volume 1 (ISBN: 978-81-7164-235-9) and 2 (ISBN: 978-81-7164-236-6), 2021}

DEAN

Syllabus of Common Courses for PG programmes:

11110101/11060141/11080101/11090101/11100101	:	Library and information services	0+1
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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 engines and its resources; e-resources access methods.

11110102/11100102/11090102/ 11080102/11060142	:	Technical writing and communications skills	0+1
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Objective

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

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

1. Barnes and Noble. Robert C. (Ed.). 2005. *Spoken English: Flourish Your Language*.
2. *Chicago Manual of Style*. 14th Ed. 1996. Prentice Hall of India.
3. *Collins' Cobuild English Dictionary*. 1995.
4. Harper Collins. Gordon HM and Walter JA. 1970. *Technical Writing*. 3rd Ed.
5. Holt, Rinehart and Winston. Hornby AS. 2000. *Comp. Oxford Advanced Learner's Dictionary of Current English*. 6th Ed. Oxford University Press.
6. James HS. 1994. *Handbook for Technical Writing*. NTC Business Books.
7. Joseph G. 2000. *MLA Handbook for Writers of Research Papers*. 5th Ed. Affiliated East-West Press.
8. Mohan K. 2005. *Speaking English Effectively*. MacMillan India.

9. Richard WS. 1969. *Technical Writing*.
10. Sethi J and Dhamija PV. 2004. *Course in Phonetics and Spoken English*. 2nd Ed. Prentice Hall of India.
11. Wren PC and Martin H. 2006. *High School English Grammar and Composition*. S. Chand & Co.

11110202/11100201/11090201/ 11080201/11060241	:	Intellectual property and its management in agriculture	1+0
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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 a tool for wealth and value creation in a knowledge based economy.

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

1. Erbisch FH and Maredia K. 1998. *Intellectual Property Rights in Agricultural Biotechnology*. CABI.
2. Ganguli P. 2001. *Intellectual Property Rights: Unleashing Knowledge Economy*. McGraw-Hill.
3. *Intellectual Property Rights: Key to New Wealth Generation*. 2001. NRDC and Aesthetic Technologies.
4. Ministry of Agriculture, Government of India. 2004. *State of Indian Farmer*. Vol. V. Technology Generation and IPR Issues. Academic Foundation.
5. Rothschild M and Scott N. (Ed.). 2003. *Intellectual Property Rights in Animal Breeding and Genetics*. CABI.
6. Saha R. (Ed.). 2006. *Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies*. Daya Publ. House.
7. 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.

11110203/11100202/11090202/ 11080202/11060242	:	Basic concepts in laboratory techniques	0+1
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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 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

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

11110301/11100301/11060341/ 11080301/11090301	:	Agricultural research, research ethics and rural development programme	1+0
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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.

16.2 Supporting Courses

The following courses are being offered by various disciplines (The list is only indicative). Based on the requirement, any of the following courses may be opted under the supporting courses. The syllabi of these courses are available in the respective disciplines. If required, the contents may be modified to suit the individual discipline with approval of the concerned BoS:

Course Code	University Code	Course title	Credit hours
STAT 511		Experimental Designs	2+1
STAT 512		Basic Sampling Techniques	2+1
STAT 521		Applied Regression Analysis	2+1
STAT 522		Data Analysis Using Statistical Packages	2+1

Syllabus of Sporting Courses for PG programmes

11100221/11110216/11060253/ 11080217/11090219	:	Experimental Designs	2+1
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Aim of the course

This course is meant for students of agricultural and animal sciences other than Agricultural 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 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, Lattice design, alpha design - concepts, randomization procedure, analysis and interpretation of results. Response surfaces. Combined analysis.

VI. 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.

VII. 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.

11090312/11080309/11060253/ 11110306/11100312	:	Basic Sampling Techniques	2+1
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Aim of the course

This course is meant for students of agricultural and animal sciences other than Statistics. The students would be exposed to elementary sampling techniques. It would help them in understanding the concepts involved in planning and designing their surveys, presentation of survey data analysis of survey data and presentation of results. This course would be especially important to the students of social sciences.

Theory

Unit I

Concept of sampling, sample survey vs complete enumeration, planning of sample survey, sampling from a finite population.

Unit II

Simple random sampling with and without replacement, sampling for proportion, determination of sample size, inverse sampling, Stratified sampling.

Unit III

Cluster sampling, Multi-stage sampling, systematic sampling; Introduction to PPS sampling,

Unit IV

Use of auxiliary information at estimation, Ratio product and regression estimators. Double Sampling, sampling and non-sampling errors.

Practical

- Random sampling ~ use of random number tables, concepts of unbiasedness, variance, etc.;
- Simple random sampling, determination of sample size, inverse sampling, stratified sampling, cluster sampling and systematic sampling;
- Estimation using ratio and regression estimators;
- Estimation using multistage design, double sampling.

Suggested Reading

- Cochran WG. 1977. *Sampling Techniques*. John Wiley.
- Murthy MN. 1977. *Sampling Theory and Methods*. 2nd Ed. Statistical Publ. Soc., Calcutta.
- Singh D, Singh P and Kumar P. 1982. *Handbook on Sampling Methods*. IASRI Publ.
- Sukhatme PV, Sukhatme BV, Sukhatme S and Asok C. 1984. *Sampling Theory of Surveys with Applications*. Iowa State University Press and Indian Society of Agricultural Statistics, New Delhi.
- Cochran WG. 2007. *Sampling Techniques*, 3rd Edition. John Wiley & Sons Publication

	: Applied Regression Analysis	2+1
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Aim of the course

This course is meant for students of all disciplines including agricultural and animal sciences. The students would be exposed to the concepts of correlation and regression. Emphasis will be laid on diagnostic measures such as autocorrelation, multi collinearity and heteroscedasticity. This course would prepare students to handle their data for analysis and interpretation.

Theory

Unit I

Introduction to correlation analysis and its measures, Correlation from grouped data, correlation, Rank correlation, Testing of population correlation coefficients; Multiple and partial correlation coefficients and their testing.

Unit II

Problem of correlated errors; Auto correlation; Heteroscedastic models, Durbin Watson Statistics; Removal of auto correlation by transformation; Analysis of collinear data; Detection and correction of multi collinearity, Regression analysis; Method of least squares for curve fitting; Testing of regression coefficients; Multiple and partial regressions.

Unit III

Diagnostic of multiple regression equation; Concept of weighted least squares; regression equation on grouped data; Various methods of selecting the best regression equation.

Unit IV

Concept of nonlinear regression and fitting of quadratic, exponential and power curves; Economic and optimal dose, Orthogonal polynomial.

Practical

- Correlation coefficient, various types of correlation coefficients, partial and multiple, testing of hypotheses;
- Multiple linear regression analysis, partial regression coefficients, testing of hypotheses, residuals and their applications in outlier detection;
- Handling of correlated errors, multi collinearity;
- Fitting of quadratic, exponential and power curves, fitting of orthogonal polynomials.

Suggested Reading

- Kleinbaum DG, Kupper LL, Nizam A. 2007. *Applied Regression Analysis and Other Multivariable Methods* (Duxbury Applied) 4th Ed.
- Draper NR and Smith H. 1998. *Applied Regression Analysis*. 3rd Ed. John Wiley.
- Ezekiel M. 1963. *Methods of Correlation and Regression Analysis*. John Wiley.
- Koutsoyiannis A. 1978. *Theory of Econometrics*. MacMillan.

- Kutner MH, Nachtsheim CJ and Neter J. 2004. *Applied Linear Regression Models*. 4th Ed. With Student CD. McGraw Hill.

	: Data Analysis Using Statistical Packages	2+1
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Aim of the course

This course is meant for exposing the students in the usage of various statistical packages for analysis of data. It would provide the students a hands on experience in the analysis of their research data. This course is useful to all disciplines.

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 Z-test.

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 Nosanchuk 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. Restructured and Revised Syllabi of Post-graduate
- Wetherill GB. 1986. *Regression Analysis with Applications*. Chapman & Hall.
- Cleveland WS. 1994. *The Elements of Graphing Data*, 2nd Ed., Chapman & Hall

COURSE ORDINANCE

M.Sc. Ag. (Soil Science)

Preamble

Soils comprise a multiple phase system consisting of numerous solid phases (about 50%), a liquid phase (about 25%) and a gas phase (about 25%). The solids include rock consisting of many different primary and secondary minerals. Superimposed on this inorganic matrix is what Truog (1951) described as the 'living phase' which includes bacteria, fungi, actinomycetes, algae, protozoa, nematodes and other forms of life. These living organisms are continuously breaking down organic residues and synthesizing many of the products into body tissues while others are released to the surroundings many physical, chemical and biological changes continually take place in soils. Physical processes such as wetting, drying, freezing, thawing changing temperatures and leaching modify the surface areas of soil particles. Primary minerals change to secondary minerals as ionic species in solution seek lower free energy levels. In addition, plants capture energy from sun and store in the form of organic compounds. Because of dynamic nature of soils, various changes take place regularly in soils and therefore, it is very essential to know the behaviour of soil solution, matrix potential so that proper technology can be achieved through research works. Our knowledge has increased rapidly during the last decade concerning the role of macro and micro nutrients in soils, plants, animal nutrition and in food for man. The skills of several scientific disciplines, combined with sophisticated instruments, have extended our knowledge about nutrients in plants and soils to molecular level and to microenvironments of roots in soil. One of the cherished objectives of the salient feature of the revised syllabi is to foster high standard in education system of soil science. A paradigm shift is necessary in education prioritization to meet the challenges of the present and future in soil science. Students, therefore have to be acquainted with the modern concepts of different processes, concepts and development so as to develop competencies on the area of specialization of the subject. For the purpose, it is proposed to revise the course syllabus of Soil Science in the light of the present days need incorporating the basic concepts, developments of the discipline. The existing M.Sc. (Ag) courses of soil science have been modified taking into account of present day need by incorporating the necessary and important topics in the respective courses such as basic principle of physics applied to soils, fertility status of major soil groups of India, Long term effect of manures and fertilizers on soil fertility and crop productivity, Soil health quality in relation to human health, Specialty fertilizers, Concept of quantity/intensity relationship, Soil mapping, Interaction of clay with humus, pesticides and heavy metals, Soil enzyme, Humus formation, Root rhizosphere and Biodegradation of pesticide. The new topics are covered in Ph.D courses as Soil-plant-atmospheric continuum (SPAC), Kinetics studies of nutrients in soils, Climate change on soil properties and Carbon sequestration. Major changes have been made in some of the existing courses like soil fertility and fertilizer uses, soil biology and biochemistry and Analytical technique and instrumental methods in soil and plant analysis under MSc programme and Biochemistry of soil organic matter under PhD programme. As a part of course curriculum, M. Sc.(Ag) soil science was restructured to equip students to tackle emerging issues by inclusion of two new courses on (i) Soil survey and land use planning (ii) Introduction to nanotechnology.

**Course Title with Credit Load
M.Sc. in Soil Science**

Course Code ICAR	Course Code SGTU	Course title	Credit hours
*Soil 501	11110103	Soil physics	(2+1)
*Soil 502	11110105	Soil fertility and fertilizer use	(2+1)
*Soil 503	11110107	Soil chemistry	(2+1)
*Soil 504	11110109	Soil mineralogy, genesis and classification	(2+1)
Soil 505	11110111	Soil erosion and conservation	(2+1)
Soil 506	11110113	Soil Biology and Biochemistry	(2+1)
Soil 507	11110115	Radioisotopes in soil and plant studies	(1+1)
Soil 508	11110204	Soil, water and air pollution	(2+1)
Soil 509	11110206	Remote sensing and GIS technique for soil and crop studies	(2+1)
Soil 510	11110208	Analytical technique and instrumental methods in soil and plant analysis	(0+2)
Soil 511	11110209	Management of problematic soils and water	(1+1)
Soil 512	11110302	Land degradation and restoration	(1+0)
Soil 513	11110303	Soil Survey and Land use Planning	(2+0)
Soil 514	11110304	Introduction to nanotechnology	(2+1)
Soil 591	11110215	Master's Seminar	(1+0)
Soil 599	11110401	Master's Research	-30

COURSE CONTENTS

11110103	:	Soil Physics	3(2+1)
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Aim of the course

To impart basic knowledge about soil physical properties and processes in relation to 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 consistency; 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 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 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.

Unit IX

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.

III. 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.

IV. Teaching methods/activities

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

V. Learning outcome

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

VI. 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 Physics. 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.

11110105	:	Soil Fertility and Fertilizer Use	3(2+1)
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I. 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 to achieve high fertilizer use efficiency.

II. 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.

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.

Unit VI

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

Unit VII

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 fertilizer uses in soils and crops of India.

Unit VIII

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

Unit IX

Definition and concepts of soil health and soil quality; Long-term effects of fertilizers and soil quality.

III. 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)

IV. Teaching methods/activities

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

V. Learning outcome

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

VI. 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.

11110107	:	Soil Chemistry	3(2+1)
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I. 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.

II. 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, 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- 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 non-specific sorption; precipitation-dissolution equilibria; Concept of quantity/intensity (Q/ I) relationship; 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, E_c, ESP, SAR and important relations; soil management and amendments.

Unit VIII

Chemistry and electrochemistry of submerged soils, geochemistry of micronutrients, environmental soil chemistry.

III. Practical

Preparation of saturation extract, measurement of pH, EC, CO₃, HCO₃, 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.

IV. Teaching methods/activities

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

VI. Learning outcome

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

IX. 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.

11110109	:	Soil Mineralogy, Genesis and Classification	3(2+1)
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I. Aim of the course

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.

II. 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; 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.

III. 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 using available database in terms of soil quality

IV. Teaching methods/activities

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

V. Learning outcome

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

VI. Suggested Reading

- 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. Handbook 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. I.

11110111	:	Soil Erosion and Conservation	3(2+1)
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I. Aim of the course

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

II.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 wetlands.

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

III. 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

IV. Teaching methods/activities

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

V. Learning outcome

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

VI. Suggested Reading

- Biswas TD and Narayanasamy G. (Eds.) 1996. Soil Management in Relation to Land Degradation 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.
- Gurnal Singh, Venkataramanan C, Sastry G and Joshi BP. 1990. Manual of Soil and Water Conservation 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.

11110113	:	Soil Biology and Biochemistry	3(2+1)
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I. 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.

II. Theory

Unit I

Soil biota, soil microbial ecology, types of organism's indifferent soils; soil microbial biomass; microbial interactions; un-culturable soil biota.

Unit II

Microbiology and biochemistry of root-soil interface; phyllo sphere; 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 proteinaceous 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 manure, 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 in pedogenesis – important mechanisms and controlling factors; soil genomics and bioprospecting; soil sickness due to biological agents; Xenobiotics; antibiotic production in soil.

I. 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

II. Teaching methods/ activities

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

III. Learning outcome

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

VI. 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.

11110115	:	Radioisotopes in Soil and Plant Studies	2(1+1)
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I. Aim of the course

To train students in the use of radio isotopes in soil and plant research.

II. Theory

Unit I

Atomic structure, radio activity and units; radio isotopes-properties and decay principles; nature and properties of nuclear radiations; interaction of nuclear radiations with matter, artificial radioactivity

Unit II

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

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

III. 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 radio isotopes
- Determination of A, E and L values of soil using $^{32}\text{P}/^{65}\text{Zn}$
- Use of neutron probe for moisture determination
- Sample preparation and measurement of ^{15}N enrichment by mass spectro photometry/ emission spectrometry

IV. Teaching methods/ activities

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

V. Learning outcome

Experience on the knowledge of radio activity and their utility in research for solving field problems.

VI. Suggested Reading

- 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 and Annunziata. 2003. Handbook of Radioactivity Analysis. Academic Press.

11110204	:	Soil, Water and Air Pollution	3(2+1)
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I. Aim of the course

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

II. 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 VII

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

III. 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 safeguard 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.

IV. Teaching methods/activities

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

V. Learning outcome

Management of soil and water pollution

VI. Suggested Reading

- o 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.

11110206	:	Remote Sensing and GIS Technique for Soil, Water and Crop Studies	3(2+1)
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I. 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.

II. 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-land use 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).

III. 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 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.

IV. Teaching methods/activities

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

V. Learning outcome

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

VI. Suggested Reading

- Elangovan K. 2006. GIS Fundamentals, Applications and Implementations. New India Publ. Agency.
- Brady NC and Weil RR. 2002. The Nature and Properties of Soils. 13th Ed. Pearson Edu.
- Lilles and TM and Kiefer RW. 1994. Remote Sensing and Image Interpretation. 3rd Ed. Wiley.
- Nielsen DR and Wendroth O. 2003. Spatial and Temporal Statistics. Catena Verlogmbh.
- Star J and Esles J. 1990. Geographic Information System: An Introduction. Prentice Hall.

11110208	:	Analytical Technique and Instrumental Methods in Soil and Plant Analysis	2(0+2)
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I. Aim of the course

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.

II. 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, ultraviolet and infrared spectrophotometry, atomic absorption, flame-photometry, inductively coupled plasma spectrometry; chromatographic techniques, mass spectrometry and X-ray diffractometry; 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 aquaregia 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

Unit VI

Drawing normalized exchange isotherms; measurement of redox potential.

III. Teaching methods/activities

Classroom teaching and laboratory practical's

IV. Learning outcome

Development of confidence for setting soil testing laboratory.

V. Suggested Reading

- Hesse P. 1971. 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.

11110209	:	Management of Problematic Soils and Water	3(2+1)
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Aim of the course

To educate students about basic concepts of problem soils and brackish water, and their management. Attention will be to 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 salinity 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.

Unit VI

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 anions (Cl⁻, SO₄⁻, CO₃⁻ and HCO₃⁻) in ground waters and 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. Utah State University
- USDA Handbook No. 60. 1954. Diagnosis and improvement of Saline and Alkali Soils. Oxford & IBH.

11110302	:	Land Degradation and Restoration	1(1+0)
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Aim of the course

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; management and 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.

Teaching methods/activities

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

Learning outcome

Experience on restoration of degraded soil for optimization of crop yield.

Suggested Reading

- Biswas TD and Narayanasamy G. (Eds.). 1996. Soil Management in Relation to Land Degradation and Environment. Bull. Indian Soc. Soil Sci. 17, New Delhi.
- Doran JW and Jones AJ. 1996. Methods of Assessing Soil Quality. Soil Science Society of America, Madison.
- Greenland DJ and Szabolcs I. 1994. Soil Resilience and Sustainable Land Use. CABI.
- Lal R, Blum WEH, Vailentine C and Stewart BA. 1997. Methods for Assessment of Soil Degradation. CRC Press.
- Sehgal J and Abrol IP. 1994. Soil Degradation in India - Status and Impact. Oxford & IBH.

11110303	:	Soil Survey and Land Use Planning	2 (2+0)
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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 generation 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 and 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 different scales
- Land use planning exercises using conventional and RS tools.

Teaching methods/activities

Classroom teaching with AV aids, group discussion, field visit and exposure visit

Learning outcome

Planning for land use in proper way for higher crop productivity.

Suggested Reading

- Boul SW, Hole ED, MacCracken 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.

11110304	:	Introduction to Nanotechnology	3(2+1)
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Aim of the course

To impart basic knowledge about nanoscience, properties of nanoparticles and their applications in biology.

Theory

Unit I

General introduction: Basics of quantum mechanics, harmonic oscillator, magnetic phenomena, band structure in solids, Mossbauer effect and spectroscopy, optical phenomena, bond in solids, and isotropy.

Unit II

Nanostructures: growth of compound semiconductors, super lattices, self-assembled quantum dots, nanoparticles, nano tubes and nanowires, fullerenes (buckballs, graphene). Nanofabrication and nanopatterning: Optical, X-ray, and electron beam lithography, self-assembled organic layers, process of synthesis of nano powders, electrode position, important nanomaterials.

Unit III

Mechanical properties, magnetic properties, electrical properties, electronic conduction with nanoparticles, investigating and manipulating materials in the nanoscale: Electron microscopy.

Unit IV

Nano-biology: Interaction between biomolecules and nano-particle surface, different types of inorganic materials used for the synthesis of hybrid nano-bioassemblies, application of nano-inagriculture, current status of nano-biotechnology, future perspectives of nano-biology, nano-sensors.

Practical

- Sources of nanoparticles and its preparation by different approaches Electrospinning and its use in agriculture and allied sector.
- Equipment's used in Nanotechnology: its principle and uses.
- Acquaintances with different equipment used in nanotechnology.
- Synthesis and characterization of Ag and ZnO nanoparticles.
- Mode of action of ZnO nanoparticles against soil borne diseases
- Study on efficacy of ZnO nanoparticles as seed treating agent on plant growth parameters.

Teaching methods/activities

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

Learning outcome

Experience on the knowledge of nano science and their utility in research for solving field problem.

Suggested Reading

- Balandin AA and Wang KL. 2006. Handbook of semiconductor nano structures and nano devices. California: American Scientific Publishers.
- Timp G. 1999. Nanotechnology. New York: Springer Verlag.
- Challa Kumar SSR. 2006. Nanotechnologies for the life sciences. Weinheim: Wiley-VCH GmbH.
- Kohler M and Frintzsche W. 2007. Nanotechnology: Introduction to nano-structuring techniques W Weinheim: Wiley-VCH Verlag GmbH.
- Kosal ME. 2009. Nanotechnology for chemical and biological defense. Dordrecht: Springer.

