जननायक चन्द्रशेखर विश्वविद्यालय, बलिया-277001 (उ.प्र.)

Jananayak Chandrashekhar University, Ballia-277001 (U. P.)

FACULTY OF AGRICULTURE

(As per ICAR Dean Committee 2021)

Academic Regulations and Restructured Syllabi 2021

SOIL SCIENCE AND AGRICULTURAL CHEMISTRY

M.Sc. (Agriculture)

ACADEMIC SESSION -2022-23

M.Sc. (Agriculture)

Soil Science and Agricultural Chemistry
Faculty of Agriculture

Jananayak Chandrashekhar University, Ballia, India

Academic Regulations and Restructured Syllabi
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Study of soils' is the key to understand how an ecosystem works. Soil is a store house of water and nutrients to plants, filter for effluents-wastes, home to organisms, and is critical for recycling elements vital for plant growth, as well as organic and inorganic wastes. Moreover, soil is act as physical support to life. Soil management is essential in our continued quest to increase the production of food, fodder, fiber, fuel and fertilizers while maintaining and improving the environment, and mitigating the effects of climate change. Being the essence of all terrestrial life and ecosystem services, we cannot take the soils for granted. Soil is the foundation of survival for present and future generations. Due to over exploitation of soil resource for different purposes by the society, soil is undergoing several degradation processes, putting the soil quality at a stake, and threatening the sustainability of food productivity globally. It is nearly impossible to feed burgeoning population without maintaining soil health. Soil professionals have an important role to play in optimally managing soil resources. The Soil Scientists and soil professionals continue to enrich the lives of all human beings by improving stewardship of the soil, combating soil degradation, and ensuring the future protection and sustainable use of our air, soil, and water resources. We never think good agriculture without good soils? The future of all life is directly linked to our understanding and appreciation of soil and land management.

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 M.Sc. 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 as elective. So, **there is no soil without life and no life without soil.**

However, new topics and also new courses have been added to new blood in the area

- All the courses have been designed and updated as per present and future needs.
- New courses have been introduced to keep pace with the latest developments.
- List of books and Journals have been provided to keep pace with latest developments in the area.
- Suggested Areas of research have also been added for providing directions to the area

Common Academic Regulation

1-Academic Year and Registration

2. Credit requirements

2.1 Framework of the courses

2.2 Supporting courses

2.3 Syllabus of Common Courses for PG programmes

2.4 Mandatory requirement of seminars

3. Residential requirements

4. Evaluation of course work and comprehensive examination

5. Advisory System

1. Academic Year and Registration

• An academic year shall be normally from July to June of the following calendar year otherwise required under special situations. It shall be divided into two academic terms known as semesters. Dates of registration, commencement of instructions, semester end examination, end of semester and academic year, etc. The Academic Calendar shall be developed by the concerned University from time to time and notified accordingly by the Registrar in advance.

• An orientation programme shall be organized by the Director (Education)/ Dean PGS for the benefit of the newly admitted students immediately after commencement of the semester.

• On successful completion of a semester, the continuing students shall register for subsequent semester on the date specified in the Academic/ Semester Calendar or specifically notified separately. Every enrolled student shall be required to register at the beginning of each semester till the completion of his/ her degree programmes.

System of Education- The semester system of education should be followed across the country at M.Sc.(Ag.) levels. Each semester will be of 110 day duration. Every enrolled student will be required to take a specified load of course work in the chosen subject of specialization (major, minor and supporting and common courses) and also complete a research work and present this in the form of a thesis.

Eligibility for Admissions- A bachelor's degree in the respective/related subjects and as per University and competent authority regulation. Those who are coming from the 3-year Bachelor Degree stream should undergo one year remedial programme before registering for regular courses.

Mode of Admission and Reservation of Seats- On the basis of entrance examination and as per University and competent authority regulation.

2. Credit requirements

2.1 Framework of the courses

The following nomenclature and Credit Hrs need to be followed while providing the syllabus for all the disciplines:

(i)	**Course work**	**Credit Hours**
	Major courses	20
	Minor courses	08
	Supporting courses	06
	Common courses	05
	Seminar	01
(ii)	**Thesis Research**	30
	Total	**70**

Major courses: From the Discipline in which a student takes admission. Among the listed courses, the core courses compulsorily to be taken may be given *mark

Minor courses: From the subjects closely related to a student's major subject

Supporting courses: The subject not related to the major subject. It could be any subject considered relevant for student's research work (such as Statistical Methods, Design of Experiments, etc.) or necessary for building his/ her over all competence.

Common Courses: The following courses (one credit each) will be offered to all students undergoing Master's degree programme:

1.**Comm.501** Library and Information Services	0+1
2. Comm.502 Technical Writing and Communications Skills	0+1
3. Comm.503 Intellectual Property and its management in Agriculture	1+0
4. Comm.504 Basic Concepts in Laboratory Techniques	0+1
5. Comm.505 Agricultural Research, Research Ethics and Rural Development Programmes	1+0

Some of these courses are already in the form of e-courses/ MOOCs. The students may be allowed to register these courses/ similar courses on these aspects, if available online on SWAYAM or any other platform. If a student has already completed any of these courses during UG, he/ she may be permitted to register for other related courses with the prior approval of the Head of Department (HOD)/ Board of Studies (BOS).

2.2 **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:

Supporting Courses for PG programmes

Code	Course Title	Credit Hours
STAT 501	Mathematics for Applied Sciences	2+0
***STAT 502**	**Statistical Methods for Applied Sciences**	**3+1**

***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
MCA 501	Computers Fundamentals and Programming	2+1
MCA 502	Computer Organization and Architecture	2+0
MCA 511	Introduction to Communication Technologies, Computer Networking and Internet	1+1
MCA 512	Information Technology in Agriculture	1+1
BIOCHEM 501	Basic Biochemistry	3+1
BIOCHEM 505	Techniques in Biochemistry	2+2

***Indicates supporting Courses which are Suitable for Master Programme**

Syllabus of Supporting Courses for PG programmes

I. Course Title: Statistical Methods for Applied Sciences
II. Course Code: STAT 502 **III. Credit Hours: 3+1**
(M.M.:100- Mid term-25, End term- 50, Practical-25)

IV. Aim and objective

This course is meant for students who do not have sufficient background of Statistical. Statistical Sciences: Agricultural Statistics. 1-The students would be exposed to concepts of statistical methods and statistical inference that would help them in understanding the importance of statistics. 2- It would also help them in understanding the concepts involved in data presentation, analysis and interpretation. 3- The students would get an exposure to presentation of data, probability distributions, parameter estimation, tests of significance, regression and multivariate analytical techniques.

V. Theory

Unit I

Box-plot, Descriptive statistics, Exploratory data analysis, Theory of probability, Random variable and mathematical expectation.

Unit II

Discrete and continuous probability distributions, Binomial, Poisson, Negative Binomial, Normal distribution and their applications. Concept of sampling distribution: chi-square, *T* and *F* distributions. Tests of significance based on Normal, chi-square, *t* and *F* distributions.

Unit III

Introduction to theory of estimation and confidence-intervals, Simple and multiple correlation coefficient, partial correlation, rank correlation, Simple and multiple linear regression model, test of significance of correlation coefficient and regression coefficients, Coefficient of determination.

Unit IV

Non-parametric tests – sign, Wilcox on, Mann-Whitney U-test. Median test. Introduction to ANOVA: One way and Two Way, Introduction to Sampling Techniques, Introduction to Multivariate Analysis, Transformation of Data.

VI. Practical

• Exploratory data analysis, fitting of distributions ~ Binomial, Poisson, Negative Binomial, Normal.

• Large sample tests, testing of hypothesis based on exact sampling distributions ~chi square, t and F.

• Confidence interval estimation and Correlation and regression analysis, fitting ofLinear and Quadratic Model.

• Non-parametric tests. ANOVA: One way, Two Way, SRS.

VII. Suggested Reading

• Goon, A.M., Gupta, M.K and Dasgupta, B. (1977). *An Outline of Statistical Theory*. Vol. I. The World Press.

• Goon, A.M., Gupta, M.K. and Dasgupta, B. (1983). *Fundamentals of Statistics*. Vol. I. The World Press.

• Hoel, P.G. (1971). *Introduction to Mathematical Statistics*. John Wiley.

• Hogg, R.V. and Craig, T.T. (1978). *Introduction to Mathematical Statistics*. Macmillan.

• Morrison, D.F. (1976). *Multivariate Statistical Methods*. McGraw Hill.

• Hogg, R.V., McKean, J.W., Craig, A.T. (2012). *Introduction to Mathematical Statistics* 7th Edition.

• Siegel, S., Johan, N.andCasellan, Jr. (1956). *Non-parametric Tests for Behavior Sciences*. John Wiley.

• Anderson, T.W. (2009). *An Introduction to Multivariate Statistical Analysis,* 3rd Ed . John Wiley

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• http://freestatistics.altervista.org/en/learning.php.

• http://www.statsoft.com/textbook/stathome.html.

I. Course Title: Experimental Designs

II. Course Code: STAT 511 **III. Credit Hours: 2+1**

(M.M.:100- Mid term-25, End term- 50, Practical-25)

IV. Aims and objective

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. 1- The students would be exposed to concepts of Design of Experiments. 2- Students will be able to understand the concepts involved in planning, designing their experiments and analysis of experimental data.

V. 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, W.G. and Cox, G.M. (1957). Experimental Designs. 2nd Ed. John Wiley.
• Dean, A.M. and Voss, D. (1999). Design and Analysis of Experiments. Springer.
• Montgomery, D.C. (2012). Design and Analysis of Experiments, 8th Ed. John Wiley.
• Federer, W.T. (1985). Experimental Designs. MacMillan.
• Fisher, R.A. (1953). Design and Analysis of Experiments. Oliver & Boyd.
• Nigam, A.K. and Gupta, V.K. (1979). Handbook on Analysis of Agricultural Experiments. IASRI Publ.
• Pearce, S.C. (1983). The Agricultural Field Experiment: A Statistical Examination of Theory and Practice. John Wiley.
• www.drs.icar.gov.in.

2.3 Syllabus of Common Courses for PG programmes

Course Title: Library and Information Services

Course Code: Comm.501 **Credit Hours: (0+1)**

(M.M.:100- Mid term-25, End term- 00, Practical-75)

Aims and Objectives

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; resources access methods.

Course Title: Technical Writing and Communications Skills

Course Code: Comm.502 **Credit Hours: (0+1)**

(M.M.:100- Mid term-25, End term- 00, Practical-75)

Aims and 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.; Course Code Course Title Credit Hours xiii Common Academic Regulations for PG and Ph.D. Programmes

• 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 J.A. (1970). Technical Writing. 3rd Ed.
5. Holt, Rinehart and Winston. Hornby, A.S. (2000). Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press.
6. James, H.S. (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 W.S. (1969). Technical Writing.
10. Sethi, J. and Dhamija, P.V. (2004). Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India.
11. Wren, P.C. and Martin, H. (2006). High School English Grammar and Composition. S. Chand & Co.

Course Title: Intellectual Property and Its Management in Agriculture

Course Code: Comm.503 **Credit Hours: (1+0)**

(M.M.:100- Mid term-25, End term- 75, Practical-00)

Aims and Objectives

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

Unit I

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;

Unit-II

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.

Unit III

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.

Unit IV

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, F.H. 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.

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.

Course Title: Basic Concepts in Laboratory Techniques

Course Code: Comm.504 **Credit Hours: (0+1)**

(M.M.:100- Mid term-25, End term-00, Practical-75)

Aims and Objectives

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, sand bath, water bath, oil bath;
• 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, A.K. (2000). CRC Hand Book of Laboratory Safety. CRC Press.

2. Gabb, M.H. and Latchem, W.E. (1968). A Handbook of Laboratory Solutions. Chemical Publ. Co.

Course Title: Agricultural Research, Research Ethics and Rural Development Programmes

Course Code: Comm.505 **Credit Hours: (1+0)**

(M.M.:100- Mid term-25, End term- 75, Practical-0)

Aims and Objectives

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.

Unit IV

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

Suggested Readings

1. Bhalla, G.S. and Singh, G. (200). Indian Agriculture - Four Decades of Development. Sage Publ.

2. Punia, M.S. Manual on International Research and Research Ethics. CCS Haryana Agricultural University, Hisar.

3. Rao, B.S.V. (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.

2.4 Mandatory requirement of seminars

- It has been agreed to have mandatory seminars one in Masters (One Credit)
- The students should be encouraged to make presentations on the latest developments and literature in the area of research topic. This will provide training to the students on preparation for seminar, organizing the work, critical analysis of data and presentation skills.
- The evaluation of seminar presentation shall be done by the departmental committee which shall be constituted by the Head of Department /Principal of College
- **Result should be satisfactory**

3. Residential requirements

The minimum and maximum duration of residential requirement for Masters' Degree Programmes shall be as follows:

	Duration of Residential Requirement	
	Minimum	Maximum
Masters' Degree	2 Academic Years (4 Semesters)	5 Academic Years (10 Semesters)

*Student may be allowed to discontinue temporarily only after completion of course work

In case a student fails to complete the degree programme within the maximum duration of residential requirement, his/ her admission shall stand cancelled. The requirement shall be treated as satisfactory

in the cases in which a student submits his/ her thesis any time during the 4th and 6th semester of his/ her residentship at the University for Masters' programme, respectively.

4. Evaluation of course work and comprehensive examination

Grading System -Master's Programme
Scale: 10 point, Minimum passing grade in a course: 5.00, Minimum OGPA to continue and to obtain degree: 5.50.
For M.Sc. (Ag.) multiple levels of evaluation (Midterm and Final semester) is desirable. However, it has been felt that the comprehensive examination is redundant for M.Sc. students.

Mid term 25 marks, Final (End term) semester- 50 marks, Practical - 25 marks

Each paper has maximum marks-100.

- **Theory –** Internal/External
- **Practical** – Internal, to be conducted by the course teacher + one external examiner for all paper in each semester to be nominated by the University.
- The Advisor should convene a meeting of the Advisory Committee at least once in a Semester. The summary record should be communicated to the Head of Department, Dean of the College of concerned, Dean PGS and Registrar for information.

5. Advisory System

5.1 Advisory Committee

• There shall be an Advisory Committee for every student consisting of not fewer than three members in the case of a candidate for Masters' degree with the Advisor as Chairperson. The Advisory Committee should have representatives from the major and minor fields amongst the members of the Post-graduate faculty accredited for appropriate P.G. level research. However, in those departments where qualified staff exists but due to unavoidable reasons Post-graduate degree programmes are not existing, the staff having Post-graduate teaching experience of two years or more may be included in the Advisory Committee as member representing the minor.

• At any given time, a P.G. teacher shall not be a Chairperson, Advisory Committee (including Master's programme) for more than five students. The Advisor should convene a meeting of the Advisory Committee at least once in a Semester. The summary record should be communicated to the Head of Department, Dean of the College of concerned, Director (Education)/ Dean PGS and Registrar for information.

Advisor/ Co-guide/ Member, Advisory Committee from other collaborating University/ Institute/ Organization

• In order to promote quality Post-graduate research and training in cutting edge areas, the University may enter into Memorandum of Understanding (MOU) with other Universities/ Institutions for conducting research. While constituting an Advisory Committee of a student, if the Chairperson, Advisory Committee feels the requirement of involving of a faculty member/ scientist of such partnering university/ Institute/ Organization, he/ she may send a proposal to this effect to Director (Education)/ Dean PGS along with the proposal for consideration of Student's Advisory Committee (SAC).

• The proposed faculty member from the partnering institution can be allowed to act as Chairperson/ Co-guide/ Member, SAC, by mutual consent, primarily on the basis of intellectual input and time

devoted for carrying out the research work at the particular institution. The faculty member/ scientist of partnering institutions in the SAC shall become a temporary faculty member of the University by following the procedure approved by the Academic Council.

Allotment of students to the retiring persons

Normally, retiring person may not be allotted M.Sc.(Ag.) Student if he/ she is left with less than 2 years of service. However, in special circumstances, permission may be obtained from the Director (Education)/ Dean PGS, after due recommendation by the concerned Head of the Department.

Changes in the Advisory Committee:

(i) Change of the Chairperson or any member of the Advisory Committee is not ordinarily permissible. However, in exceptional cases, the change may be effected with due approval of the Director of Education/ Dean PGS.

(ii) Normally, staff members of the university on extra ordinary leave or on study leave or who leave the University service will cease to continue to serve as advisors of the Post-graduate students of the University. However, the Director (Education)/ Dean PGS may permit them to continue to serve as advisor subject to the following conditions:

(a) The concerned staff member must be resident in India and if he/ she agrees to guide research and must be available for occasional consultations;

(b) An application is made by the student concerned duly supported by the Advisory Committee;

(c) The Head of the Department and the Dean of the College concerned agree to the proposal;

(d) The staff member, after leaving the University service is granted the status of honorary faculty's membership by the Vice-Chancellor on the recommendation of the Director (Education)/ Dean PGS for guiding as Chairperson or Member, Advisory Committee the thesis/ theses of the student(s) concerned only.

(iii) In case the Chairperson/ member of a Student's Advisory Committee retires, he/ she shall be allowed to continue provided that the student has completed his course work and minimum of 10 research credits and the retiring Chairperson/ member stays at the Headquarters of the College, till the thesis is submitted.

(iv) If the Chairperson/ member proceeds on deputation to another organization, he/ she may be permitted to guide the student provided his/ her new organization is at the Headquarters of the College and his/ her organization is willing for the same.

(v) The change shall be communicated to all concerned by the Head of Department.

6. Thesis:- Synopsis/Evaluation of research work

Approval of synopsis - Should be accomplished in the first/second semester and approved by the Departmental committee. The approval time between synopsis and thesis submission should be one semester before.

- It is highly desirable for M.Sc.(Ag.) programme and this should be done by one external examiner
- The research work may be initiated in any of I to IV^{rth} semester but the thesis shall be submitted at the end of IV semester.
- The viva voce will be conducted on thesis by external examiner and advisory committee
- The result/ Assessment should be satisfactory/Unsatisfactory

6.1 Prevention of plagiarism

• An institutional mechanism should be in place to check the plagiarism. The students must be made aware that manipulation of the data/ plagiarism is punishable with serious consequences.

7. Learning through online courses

• In line with the suggestion in new education policy and the initiatives taken by ICAR and MHRD in the form of e-courses, MOOCs, SWAYAM, etc. and also changes taking place globally in respect of learning through online resources it has been agreed to permit the students to enroll. for online courses. It is expected that the provision of integrating available online courses with the traditional system of education would provide the students opportunities to improve their employability by imbibing the additional skills and competitive edge.

The Committee recommends the following points while integrating the online courses:

1. Board of Studies (BoS) of each Faculty shall identify available online courses and a student may select from the listed courses. The interested students may provide the details of the on-line courses to the BoS for its consideration.

2. A Postgraduate student may take up to a maximum of 20% credits in a semester through online learning resources.

3. The host institute offering the course does the evaluation and provide marks/ grades. The BoS shall develop the conversion formula for calculation of GPA and it may do appropriate checks on delivery methods and do additional evaluations, if needed.

8. <u>Internship during Masters programme</u>

Internship for Development of Entrepreneurship in Agriculture (IDEA) Currently, a provision of 30 credits for dissertation work in M.Sc./ M.Tech/ M.F.Sc./ M.V.Sc. programmes helps practically only those students who aspire to pursue their career in academic/ research. There is hardly any opportunity/ provision under this system to enhance the entrepreneurship skills of those students who could start their own enterprise or have adequate skills to join the industry. Therefore, in order to overcome this gap, an optional internship/ in-plant training (called as IDEA) in lieu of thesis/ research work is recommended which will give the students an opportunity to have a real-time hands-on experience in the industry.

It is envisaged that the internship/ in-plant training would enhance the interactions between academic organizations and the relevant industry. It would not only enable the development of highly learned and skilled manpower to start their-own enterprises but also the industry would also be benefitted through this process. This pragmatic approach would definitely result in enhancedpartnerships between academia and industry.

<u>The main objectives of the programme</u>

1. To promote the linkages between academia and industry

2. To establish newer University – Cooperative R and D together with industry for knowledge creation, research and commercialization

3. Collaboration between Universities and industries through pilot projects

4. To develop methods for knowledge transfer, innovation and networking potential

5. To enhance skill, career development and employability

Following criteria for IDEA will be taken into consideration:

• At any point of time there will not be more than 50% of students who can opt under IDEA

• Major Advisor will be from Academia and Co-advisor (or Advisory Committee member) from industry

• Total credits (30) will be divided into 20 for internship/ in-plant training and10 for writing the report followed by viva-voce similar to dissertation

• Work place will be industry; however, academic/ research support would be provided by the University or both. MoU may be developed accordingly

• The IPR, if any, would be as per the University policy

9. Teaching assistantship

•Teaching assistantship shall be encouraged. This will give the required experience to the students on how to conduct courses, practical classes, evaluation and other related academic matters. This is an important part of Ph.D. training all over the world and it is expected to address the shortage of faculty in many institutions/ universities.

•The fulltime doctoral students of the University with or without fellowship may be considered for award of Teaching Assistantships in their respective Departments. The Teaching Assistantship shall be offered only to those doctoral students who have successfully finished their course work. Any consideration for award of Teaching Assistantships must have the consent ofthe supervisor concerned.

•Teaching Assistantships shall be awarded on semester to semester basis on the recommendation of a screening/ selection committee to be constituted by the Vice Chancellor. All classes and assignments given to the Teaching Assistants, including tutorials, practical and evaluation work shall be under the supervision of a faculty member who would have otherwise handled the course/ assignment.

• No additional remuneration shall be paid to the students who are awarded ICAR JRF/ SRF. The amount of fellowship to be paid as remuneration to other students (who are receiving any other fellowship or without any fellowships) may be decided by the concerned universities as per the rules in force. However, the total amount of remuneration/ and fellowship shall not exceed the amount being paid as JRF/ SRF of ICAR.

• At the end of each term, Teaching Assistants shall be given a certificate by the concerned Head of the Department, countersigned by the School Dean, specifying the nature and load of assignments completed.

10. Registration of project personnel (SRF/ RA) for Ph.D.

• A provision may be made to enable the project personnel (SRF/ RA) to register for Ph.D. However, this can be done only if they are selected based on some selection process such as walk-in-interview. The prior approval of PI of the project is mandatory to consider the application of project personnel (SRF/RA) for Ph.D. admission. The candidates need to submit the declaration stating that the project work shall not be compromised because of Ph.D. programme. Further, in order to justify the project work and Ph.D. programme, the number of course credits should not be more than 8 in a semester for the project personnel (SRF/ RA) who intend to register for Ph.D.

11. Compliance with the National Education Policy-2020

•While implementing the course structure and contents recommended by the BSMA Committees, the Higher Education Institutions (HEIs) are required to comply with the provisions of National Education Policy-2020, especially the following aspects:

•Given the 21st century requirements, quality higher education must aim to develop good, thoughtful, well-rounded, and creative individuals. It must enable an individual to study one or more specialized areas of interest at a deep level, and also develop character, ethical and Constitutional values, intellectual curiosity, scientific temper, creativity, spirit of service, and 21st century capabilities across a range of disciplines including sciences, social sciences, arts, humanities, languages, as well as professional, technical, and vocational subjects. A quality higher education must enable personal accomplishment and enlightenment, constructive public engagement, and productive contribution to the society. It must prepare students for more meaningful and satisfying lives and work roles and enable economic independence (9.1.1. of NEP-2020).

• At the societal level, higher education must enable the development of an enlightened, socially conscious, knowledgeable, and skilled nation that can find and implement robust solutions to its own problems. Higher education must form the basis for knowledge creation and innovation thereby contributing to a growing national economy. The purpose of quality higher education is, therefore, more than the creation of greater opportunities for individual employment. It represents the key to more vibrant, socially engaged, cooperative communities and a happier, cohesive, cultured, productive, innovative, progressive, and prosperous nation (9.1.3. of NEP-2020).

• Flexibility in curriculum and novel and engaging course options will be on offer to students, in addition to rigorous specialization in a subject or subjects. This will be encouraged by increased faculty and institutional autonomy in setting curricula. Pedagogy will have an increased emphasis on communication, discussion, debate, research, and opportunities for cross-disciplinary and interdisciplinary thinking (11.6 of NEP-2020).

• As part of a holistic education, students at all HEIs will be provided with opportunities for internships with local industry, businesses, artists, crafts persons, etc., as well as research internships with faculty and researchers at their own or other HEIs/ research institutions, so that students may actively engage with the practical side of their learning and, as a by-product, further improve their employability (11.8 of NEP-2020).

• HEIs will focus on research and innovation by setting up start-up incubation centre's; technology development centers; centers in frontier areas of research; greater industry-academic linkages; and interdisciplinary research including humanities and social sciences research (11.12. of NEP-2020).

• Effective learning requires a comprehensive approach that involves appropriate curriculum, engaging pedagogy, continuous formative assessment, and adequate student support. The curriculum must be interesting and relevant, and updated regularly to align with the latest knowledge requirements and to meet specified learning outcomes. High-quality pedagogy is then necessary to successfully impart the curricular material to students; pedagogical practices determine the learning experiences that are provided to students, thus directly influencing learning outcomes. The assessment methods must be scientific, designed to continuously improve learning and test the application of knowledge. Last but not least, the development of capacities that promote student wellness such as fitness, good health, psycho-social well-being, and sound ethical grounding are also critical for high-quality learning (12.1. of NEP-2020).

Definitions of Academic Terms

Chairperson means a teacher of the major discipline proposed by the Head of Department through the Dean of the College and duly approved by the Director of Education/ Dean Post Graduate Studies (or as per the procedure laid down in the concerned University regulations) to act as the Chairperson of the Advisory Committee and also to guide the student on academic issues.

Course means a unit of instruction in a discipline carrying a specific number and credits to be covered in a semester as laid down in detail in the syllabus of a degree programme.

Credit means the unit of work load per week for a particular course in theory and/ or practical. One credit of theory means one class of one clock hour duration and one credit practical means one class of minimum two clock hours of laboratory work per week.

Credit load of a student refers to the total number of credits of all the courses he/ she registers during a particular semester. Grade Point (GP) of a course is a measure of performance. It is obtained by dividing the per cent mark secured by a student in a particular course by 10, expressed and rounded off to second decimal place.

Credit Point (CP) refers to the Grade point multiplied by the number of credits of the course, expressed and rounded off to second decimal place.

Grade Point Average (GPA) means the total credit point earned by a student divided by total number of credits of all the courses registered in a semester, expressed and rounded off to second decimal place. **Cumulative Grade Point Average (CGPA)** means the total credit points earned by a student divided by the total number of credits registered by the student until the end of a semester (all completed semesters), expressed and rounded off to second decimal place.

Overall Grade Point Average (OGPA) means the total credit points earned by a student in the entire degree programme divided by the total number of credits required for the P.G. degree, expressed and rounded off to second decimal place.

Course Title with Credit Load
M.Sc. (Ag.) Soil Science and Agricultural Chemistry

Course Code	Course Title	Credit Hours
*Soil 501	Soil Physics	(2+1)
*Soil 502	Soil Fertility and Fertilizer use	(2+1)
*Soil 503	Soil Chemistry	(2+1)
*Soil 504	Soil Mineralogy, Genesis and Classification	(2+1)
Soil 505	Soil Erosion and Conservation	(2+1)
Soil 506	Soil Biology and Biochemistry	(2+1)
Soil 507	Radioisotopes in Soil and Plant Studies	(1+1)
Soil 508	Soil, Water and Air Pollution	(2+1)

Soil 509	Remote Sensing and GIS technique for Soil and Crop Studies	(2+1)
Soil 510	Analytical technique and instrumental methods in soil and Plant analysis	(1+1)
Soil 511	Management of Problematic Soils and Water	(1+1)
Soil 512	Land Degradation and Restoration	(1+0)
Soil 513	Soil Survey and Land Use Planning	(2+0)
Soil 514	Introduction to Nanotechnology	(2+1)
	Major courses (Minimum 20 credits from above courses including *marked Courses)	**20**
	Minor courses	08
	Supporting courses	06
	Common compulsory courses	05
Soil 591	Master's Seminar	(1+0)
Soil 599	Master's Research -	30
	Total Credits	70

*Indicates Core Courses which are Compulsory for Master Programme

Semester wise allocation of Major courses

Course Title with Credit Load

M.Sc. (Ag.) Soil Science and Agricultural Chemistry

Course Code	Course Title	Credit Hours
First Semester		
Major Course		
Soil 501	Soil Physics	(2+1)
Soil 504	Soil Mineralogy, genesis and classification	(2+1)
Soil 510	Analytical technique and instrumental methods in soil and Plant analysis	(1+1)
Miner Course		
Common Course		
Comm.501	Library and Information Services	(0+1)
Comm.502	Technical Writing and Communications Skills	(0+1)
Supporting Course		

STAT 502	Statistical Methods for Applied Sciences	(3+1)

Second Semester

Major Course

Soil 503	Soil Chemistry	(2+1)
Soil 508	Soil, Water and Air Pollution	(2+1)

Miner Course

Common Course

Comm.503	Intellectual Property and its management in Agriculture	(1+0)

Supporting Course

STAT 511	Experimental Designs	(2+1)

Third Semester

Major Course

Soil 502	Soil Fertility and Fertilizer use	(2+1)
Soil 506	Soil Biology and Biochemistry	(2+1)

Miner Course (As per need)

Common Course

Comm.504	Basic Concepts in Laboratory Techniques	(0+1)
Comm.505	Agricultural Research, Research Ethics and Rural Development Programmes	(1+0)

Supporting Course (As per need)

Fourth Semester

Major Course

Soil 505	Soil Erosion and Conservation	(2+1
Soil 511	Management of Problematic Soils and Water	(1+1)
*Soil 591	Master's Seminar	(1+0)
*Soil 599	Master's Research -	30
	Total Credits	70

*Indicates Core Courses which are Compulsory for Master Programme

Permissible course workload– Maximum course workload should be 18 credits and minimum 9 credits per semester**.**

Course contents

M.Sc.(Ag.) Soil Science and Agricultural Chemistry

I. Course Title : Soil Physics

II. Course Code : Soil 501 Credit Hours: 2+1 (M.M.:100- Mid term-25, End term- 50, Practical-25)

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

IV. Theory

Unit I

Basic principles of physics applied to soils, soil as a three phase system. Soil texture, textural classes, mechanical analysis, specific surface. 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 II

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 III

Soil water: content and potential, soil water retention, soil-water constants, measurement of soil water content, soil water potential, soil-moisture characteristic curve; hysteresis, measurement of soil-moisture potential. Water flow in saturated and unsaturated soils, Poiseuille's law, Darcy's law; hydraulic conductivity, permeability and fluidity, hydraulic diffusivity; measurement of hydraulic conductivity in saturated and unsaturated soils.

Unit IV

Infiltration; internal drainage and redistribution; evaporation; hydrologic cycle, field water balance; soil-plant-atmosphere continuum. Composition of soil air; renewal of soil air - convective flow and diffusion; measurement of soil aeration; aeration requirement for plant growth; soil air management. Modes of energy transfer in soils; energy balance; thermal properties of soil; measurement of soil temperature; soil temperature in relation to plant growth; soil temperature management.

V. 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 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.

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

VII. **Learning outcome -**Experience on the knowledge of soil physical properties and processes in relation to plant growth.

VIII. Suggested Reading

• Baver, L.D., Gardner, W.H. and Gardner, W.R. (1972). Soil Physics. John Wiley & Sons.
• Ghildyal, B.P. and Tripathi RP. (2001). Soil Physics. New Age International.
• Hanks, J.R. and Ashcroft, G.L. (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 W.L. 1972. Advanced Soil Physics. Wiley-Interscience.
• Kohnke, H. (1968). Soil Physics. McGraw Hill.
• Lal, R. and Shukla, M.K. (2004). Principles of Soil Physics. Marcel Dekker.
• Oswal, M.C. (1994). Soil Physics. Oxford & IBH.

I. Course Title : Soil Fertility and Fertilizer Use

IX. Course Code : Soil 502 Credit Hours : 2+1 (M.M.:100- Mid term-25, End term- 50, Practical-25)

II.

III. Aims and objectives

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

IV. 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; nitrogenous fertilizers and their fate in soils; management of fertilizer nitrogen in lowland and upland conditions for high fertilizer use efficiency. 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 III

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. 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 IV

Common soil test methods for fertilizer recommendations; quantity– intensity relationships; soil test crop response correlations and response functions. 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 use in soils and crops of India; Soil fertility evaluation - biological methods, soil, plant and tissue tests; soil quality in relation to sustainable agriculture, Determination of critical limit, DRIS. Definition and concepts of soil health and soil quality.

V. 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)

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

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

VIII. Suggested Reading

- Brady, N.C. and Weil, R.R. (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, E.A. (1982). Principles of Plant Nutrition. International Potash Institute, Switzerland.
- Mortvedt, J.J., Shuman, L.M., Cox .FR. and Welch R.M.(1991). Micronutrients in Agriculture. 2nd Ed. SSSA, Madison.
- Pierzinsky, G.M., Sims, T.J. and Vance, J.F.(2002).Soils and Environmental Quality. 2nd Ed. CRC Press.
- Stevenson, F.J. and Cole, M.A. (1999).Cycles of Soil: Carbon, Nitrogen, Phosphorus, Sulphur, Micronutrients. John Wiley & Sons.
- Tisdale, S.L., Nelson, S.L., Beaton., J.D. and Havlin, J.L. (1999). Soil Fertility and Fertilizers. 5th Ed. Prentice Hall of India.
- Troeh, F.R. and Thompson, L.M. (2005). Soils and Soil Fertility. Blackwell.

I. Course Title: Soil Chemistry

II. Course Code: Soil 503 **III. Credit Hours : 2+1**

(M.M.:100- Mid term-25, End term- 50, Practical-25)

III. Aims and objectives

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.

IV. Theory

Unit I

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

Elements of equilibrium thermodynamics, chemical equilibria, electro-chemistry and chemical kinetics.

Unit II

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 III

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

Unit IV

Potassium, phosphate and ammonium fixation in soils covering specific and nonspecific sorption; precipitation-dissolution equilibria; Concept of 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 and electrochemistry of submerged and tal land soils, geochemistry of micronutrients, environmental soil chemistry.

V. 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.

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

VII. **Learning outcome**-Experience on the knowledge of chemical behaviour of soil and their utility in research for solving field problem.

VIII. Suggested Reading

• Bear, R.E. (1964). Chemistry of the Soil. Oxford and IBH.
• Bolt, G.H. and Bruggenwert, M.G.M. (1978). Soil Chemistry. Elsevier.
• Greenland, D.J. and Hayes, M.H.B. (1981). Chemistry of Soil Processes. John Wiley & Sons.
• Greenland, D.J. and Hayes, M.H.B. (1985).Chemistry of Soil Constituents. John Wiley & Sons.
• McBride, M.B. (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. Physical Sciences: Soil Science 87
• Sposito, G. (1989). The Chemistry of Soils. Oxford University Press.
• Stevenson, F.J. (1994). Humus Chemistry. 2nd Ed. John Wiley & Sons.
• Van Olphan H. (1977). Introduction to Clay Colloid Chemistry. John Wiley & Sons.

I. Course Title: Soil Mineralogy, Genesis and Classification

II. Course Code : Soil 504 Credit Hours : 2+1

(M.M.:100- Mid term-25, End term- 50, Practical-25)

III. Aims and objectives

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.

IV. 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.

V. 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 soils using available database in terms of soil quality

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

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

VIII. 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. Hand Book No. 436. 2nd Ed. USDA NRCS, Washington.
• Wade, FA and Mattox, RB. (1960). Elements of Crystallography and Mineralogy. Oxford & IBH.
• Wilding, LP and Smeck, NE. (1983). Pedogenesis and Soil Taxonomy: II. The Soil Orders. Elsevier.
• Wilding, N.E. and Hol,l G.F. (Eds.). (1983). Pedogenesis and Soil Taxonomy.

I. Course Title : Soil Erosion and Conservation

II. Course Code : Soil 505 Credit Hours : 2+1

(M.M.:100- Mid term-25, End term- 50, Practical-25)

III. Aims and objectives

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

IV. Theory

Unit I

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

Forms of soil erosion; effects of soil erosion and factors affecting soil erosion; types and mechanisms of water erosion; raindrops and soil erosion; rainfall erosivity; factors affecting water erosion; empirical and quantitative estimation of water erosion

Unit III

Methods of measurement and prediction of runoff; soil losses in relation to soil properties and precipitation. Wind erosion- types, mechanism and factors affecting wind erosion; extent of problem in the country. Principles of erosion control; erosion control measures – agronomical and engineering; erosion control structures - their design and layout

Unit III

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

Unit IV

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

V. 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

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

VII. **Learning outcome**-Experience on the knowledge of soil conservation and their utility in research for solving field problem.

IX. Suggested Reading

• Biswas, T.D. and Narayanasamy, G. (Eds.) (1996). Soil Management in Relation to Land Degradation and Environment. Bull. Indian Society of Soil Science No. 17.
• Doran, J.W. and Jones, A.J. (1996). Methods of Assessing Soil Quality. Soil Science Society of America, Spl. Publ. No. 49, Madison, USA.
• Gurmal, Singh, Venkataramanan, C., Sastry, G and Joshi, B.P. (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, M.C. (1994). Soil Physics, Oxford & IBH

I. Course Title : Soil Biology and Biochemistry

II. Course Code : Soil 506 Credit Hours : 2+1

(M.M.:100- Mid term-25, End term- 50, Practical-25)

III. Aims and objectives

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.

IV. Theory

Unit I

Soil biota, soil microbialecology, types of organisms indifferent soils; soil microbial biomass; microbial interactions; un-culturable soil biota. Microbiology and biochemistry of root-soil interface; rhizosphere; phyllosphere. Soil enzymes, origin, activities and importance. Soil characteristics influencing growth and activity of microflora; PGPR.

Unit II

Microbial transformations of nitrogen, phosphorus, sulphur, iron and manganese in soil. Biochemical composition and biodegradation of soil organic matter and residues, microbiology and biochemistry of decomposition of carbonaceous and protenaceous materials, cycles of important nutrients.

Unit III

Organic wastes and their use for production of biogas and manures; microbial toxins in the soil. Preparation and preservation of farmyard manure, animal manures, rural and urban composts and vermicompost. Biofertilizers–definition, classification, specifications, method of production and role in crop production; FCO specifications and quality control of biofertilizers.

Unit IV

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.

V. 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

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

VIII. **Learning outcome**- Experience on the knowledge of soil microbes and their utility in research for solving field problem.

IX. **Suggested Reading**

- Paul, E.A. and Clark, F.E. Soil Microbiology and Biochemistry.
- Lynch, J.M. Soil Biotechnology
- Willey, J.M, Linda M. Sherwood and Woolverton CJ. Prescott's Microbiology.
- Subba, Rao N.S. Advances In Agricultural Microbiology.

I. Course Title : Radioisotopes in Soil and Plant Studies

II. Course Code : Soil 507 Credit Hours : 1+1

(M.M.:100- Mid term-25, End term- 50, Practical-25)

III. Aims and objectives

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

IV. 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 cintillation 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

V. Practical

- Storage and handling of radioactive materials

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

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

VIII. **Learning outcome**- Experience on the knowledge of radio activity and their utility in research for solving field problems.

VII. 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, F.L. and Annunziata. 2003. Handbook of Radioactivity Analysis. Academic Press.

I. Course Title : Soil, Water and Air Pollution

II. Course Code : Soil 508 **Credit Hours : 2+1**

(M.M.:100- Mid term-25, End term- 50, Practical-25)

III. Aims and objectives

To teach students the basics of the problems of soil, water and air pollution associated with use of soils for crop production, including biogeochemical cycles and interactions in soil and crops and animals as well as soil activities.

IV. Theory

Unit I

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

Nature and sources of pollutants – agricultural, industrial, urban wastes, fertilizers and pesticides, acid rains, oil spills etc.

Unit II

Air, water and soil pollutants- their CPC standards and effect on plants, animals and human beings. Sewage and industrial effluents–their composition and effect on soil properties/ health, and plant growth and human beings; soil as sink for waste disposal

Unit III

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

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

Unit IV

Pollution of water resources due to leaching of nutrients and pesticides from soil; emission of green house gases–carbondioxide, 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.

V. 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 coli form (MPN), nitrate and ammoniacal nitrogen and phosphorus, heavy metal content in effluents, Heavy metals in contaminated soils and plants, Management of contaminants in soil and plants to safe guard food safety, Air sampling and determination of particulate matter and oxides of sulphur, NO_2 and O_2 conc. Visit to various industrial sites to study the impact of pollutants on soil and plants.

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

VII. **Learning outcome-**Management of soil and water pollution

VIII. Suggested Reading

• Lal, R., Kimble, J., Levine, E. and Stewart, B.A. (1995). Soil Management and Greenhouse Effect. CRC Press.

• Middlebrooks, E.J. (1979). Industrial Pollution Control. Vol. I. Agro-Industries. John Wiley Interscience.

• Ross, S.M. Toxic Metals in Soil Plant Systems. John Wiley & Sons.

• Vesilund, P.A. and Pierce,(1983). Environmental Pollution and Control. Ann Arbor Science Publ.

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

II. **Course Code : Soil 509** Credit Hours : 2+1

(M.M.:100- Mid term-25, End term- 50, Practical-25)

III. Aims and objectives

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.

IV. 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.

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

V. **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 data files in a database programme, Use of GIS for soil spatial simulation and analysis, To enable the students to conduct soil survey and interpret soil survey reports in terms of land use planning.

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

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

IX. Suggested Reading

• Brady, N.C. and Weil, R.R. (2002). The Nature and Properties of Soils. 13th Ed. Pearson Edu.
• Elangovan, K. (2006). GIS Fundamentals, Applications and Implementations. New India Publ. Agency.
• Lillesand, T.M. and Kiefer, R.W. (1994). Remote Sensing and Image Interpretation. 3rd Ed. Wiley. • Nielsen, D.R. and Wendroth, O. (2003). Spatial and Temporal Statistics. Catena Verloggmbh.
• Star, J. and Esles, J. (1990). Geographic Information System: An Introduction. Prentice Hall.

I. Course Title : Analytical Technique and Instrumental Methods in Soil and Plant Analysis

II. **Course Code : Soil 510** **Credit Hours : 1+1**

(M.M.:100- Mid term-25, End term- 50, Practical-25)

III. Aims and objectives

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.

IV. Theory

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. Principles of visible, ultra violet and infrared spectrophotometry,

Unit III

flame-photometry, Atomic absorption; chromatographic techniques, mass spectrometry and X-ray defractrometery; identification of minerals by X-ray by different methods, CHNS analyzer. Electrochemical titration of clays; estimation of exchangeable cations (Na, Ca, Mg, K); estimation of root cation exchange capacity.

Unit IV

Wet digestion/fusion/extraction of soil with aquaregia with soil for elemental analysis; tri acid/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. Measurement of redox potential.

V. **Teaching methods/activities**-Classroom teaching and laboratory practicals

VI. **Learning outcome**-Development of confidence for setting soil testing laboratory.

VII. Suggested Reading

• Hesse, P. (1971). Textbook of Soil Chemical Analysis. William Clowes& Sons.
• Jackson, M.L. (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, A.L., Miller, R.H. and Keeney, D.R. (1982). Methods of Soil Analysis. Part II. SSSA, Madison.
• Piper, C.S.(1966). Soil and Plant Analysis. Hans Publ.
• Singh, D, Chhonkar, P.K. and Pandey, R.N. (1999). Soil Plant Water Analysis - A Methods Manual. IARI, New Delhi.
• Tan, K.H. (2003). Soil Sampling, Preparation and Analysis. CRC Press/Taylor & Francis.
• Tandon, H.L.S. (1993). Methods of Analysis of Soils, Fertilizers and Waters. FDCO, New Delhi.
• Vogel, A.L. (1979). A Textbook of Quantitative Inorganic Analysis. ELBS Longman.

I. Course Title : Management of Problem Soils and Water

II. Course Code : Soil 511 Credit Hours : 2+1

(M.M.:100- Mid term-25, End term- 50, Practical-25)

III. Aims and objectives

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

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

Unit II

Management of salt-affected soils; salt tolerance of crops- mechanism and ratings; salt stress meaning and its effect on crop growth, monitoring of soils alinity in the field; management principles for sandy, clayey, red lateritic and dryland soils.

Unit III

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 IV

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 ground waters.

V. Practical

Characterization of acid, acid sulfate, salt-affected and calcareous soils, Determination of cations (Na^+, K^+, Ca^{++} and Mg^{++}) in groundwater and soil samples, Determination of an ions (Cl^- , SO_4^- ,

CO_3^- and HCO_3^-) in ground waters and soil samples, Lime and gypsum requirements of acid and sodic soils.

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

VII. **Learning outcome**-Experience on solving field problem of problem soil and waters.

VIII. Suggested Reading

• Bear, F.E. (1964). Chemistry of the Soil. Oxford & IBH.

• Jurinak, J.J. (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.

I. Course Title : Land Degradation and Restoration

II. II. Course Code : Soil 512 Credit Hours : 1+0

(M.M.:100- Mid term -25, End term- 50, Practical-25)

III. Aims and objectives

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

IV. Theory

Unit I

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

Unit II

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

Unit III

Extent, diagnosis and mapping of land degradation by conventional and modern RS-GIS tools; monitoring land degradation by fast assessment, modern tools.

Unit IV

Land use policy, incentives and participatory approach for reversing land degradation; global issues for twenty first century.

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

VI. **Learning outcome**-Experience on restoration of degraded soil for optimization of crop yield.

VII. Suggested Reading

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

• Doran, J.W. and Jones, A.J. (1996). Methods of Assessing Soil Quality. Soil Science Society of America, Madison.

• Greenland, D.J. and Szabolcs, I. (1994). Soil Resilience and Sustainable Land Use. CABI.

• Lal, R., Blum WEH, Vailentine, C. and Stewart, B.A. (1997). Methods for Assessment of Soil Degradation. CRC Press.

• Sehgal, J. and Abrol, I.P. (1994). Soil Degradation in India - Status and Impact. Oxford & IBH.

I. Course Title : Soil Survey and Land Use Planning

II. II. Course Code : Soil 513 Credit Hours : 2+0

(M.M.:100- Mid term-25, End term- 50, Practical-25)

III. Aims and objectives

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.

IV. 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.

Unit II

Application of remote sensing and GIS in soil survey and mapping of major soil group of India. 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;

Unit III

Approaches for managing soils and landscapes in the framework of agro-ecosystem.

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

V. 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

VI. **Teaching methods/activities**-Classroom teaching with AV aids, group discussion, field visit and exposure visit

VII. **Learning outcome**-Planning for land use in proper way for higher crop productivity.

VIII. Suggested Reading

• Boul, S.W., Hole, E.D., MacCraken, R.J. and Southard, R.J. (1997). Soil Genesis and Classification. 4th Ed. Panima Publ.

• Brewer, R. (1976). Fabric and Mineral Analysis of Soils. John Wiley & Sons.

I. Course Title : Introduction to Nanotechnology

II. Course Code : Soil 514 Credit Hours : 2+1

(M.M.:100- Mid term-25, End term- 50, Practical-25)

III. Aims and objectives

To impart basic knowledge about nano science, properties of nano particles and their applications in biology

IV. Theory

Unit I

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

Unit II

Nanostructures: growth of compound semiconductors, super lattices, self-assembled quantum dots, nano-particles, nano tubes and nano wires, fullerenes (buckballs, graphene). Nanofabrication and nano-patterning: 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 in organic 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.

V. Practical

- Sources of nanoparticles and its preparation by different approaches
- Electrospinning and its use in agriculture and allied sector.
- Equipments used in Nanotechnology: its principle and uses
- Acquaintances with different equipments 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.

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

VII. **Learning outcome**-Experience on the knowledge of nano science and their utility in research for solving field problem.

VIII. Suggested Reading

• Balandin, A.A. and Wang, K.L. (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 V C H Gmb H.

• Kohler, M and Frintzsche, W. (2007). Nanotechnology: Introduction to nanostructuring techniques W Weinheim: Wiley-VCH Verlag Gmb H.

• Kosal, M.E. (2009). Nanotechnology for chemical and biological defense. Dordrecht: Stringer.

Suggested Comprehensive Books

1. Agronomy**.** Bull. No 31. Soil Sci. Society of America, Madison.
2. Alexander, M. (1977). Introduction to Soil Microbiology. John Wiley &Sons.America, Madison.

3. Environmental Management. Marcel Dekker.
4. Barber, S.A. (1995). Soil Nutrient Bioavailability. John Wiley & Sons.
5. Barker, V. Allen and Pilbeam, David, J. (2007). Handbook of Plant Nutrition.
6. Baver, L.D., Gardner, W.H. and Gardner, W.R. (1972). Soil Physics. John Wiley &
7. Bear, R.E. (1964). Chemistry of the Soil. Oxford & IBH.
8. Bhalla, G.S. and Singh, G. (2001). Indian Agriculture - Four Decades of Development. Sage Publ.
9. Bolt, G.H. and Bruggenwert, M.G.M. (1978). Soil Chemistry. Elsevier.
10. Boul, S.W., Hole, E.D., MacCraken, R.J. and Southard, R.J. (1997). Soil Genesis and Classification. 4th Ed. Panima Publ.
11. Brady, N.C. and Weil, R.R. (2002). The Nature and Properties of Soils. 13th Ed.
12. Brewer, R. (1976). Fabric and Mineral Analysis of Soils. John Wiley & Sons.
13. Burges, A. Raw, F. (1967). Soil Biology. Academic Press.
14. Cooke GW. 1979. The Control of Soil Fertility. Crossby Lockwood &
15. Design Act, 2000; PPV and FR Act 2001, and Rules 2003;
16. National Biological Diversity Act, 2003.
17. Development and Application. Revised Ed. George Braziller
18. Doran JW & Jones AJ. 1996. Methods of Assessing Soil Quality. Soil
19. Epstein E. 1987. Mineral Nutrition of Plants - Principles and Perspectives.
20. FAO. 1976. A Framework for Land Evaluation, Handbook 32. FAO.
21. Fertilizer (Control) Order, 1985 and the Essential Commodities Act. FAI
22. Fried M &Broeshart H. 1967. Soil Plant System in Relation to Inorganic Nutrition. Academic
23. Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.
24. Gabb MH &Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.
25. Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.
26. Gieseking JE. 1975. Soil Components. Vol. 1. Organic Components. Springer-Verlag.
27. Greenland DJ & Hayes MHB. 1978. Chemistry of Soil Constituents. John Wiley & Sons.
28. Greenland DJ &Szabolcs I. 1994. Soil Resilience and Sustainable Land
29. Gupta HK. 2003. Disaster Management. Indian National Science Academy.
30. Hanks and Ascheroft. 1980. Applied Soil Physics. Springer Verlag.
31. Hanks J & Ritchie JT. (Eds.). 1991. Modelling Plant and Soil System.
32. Hillel D. 1980. Applications of Soil Physics. Academic Press.
33. Hodgkinson PE & Stewart M. 1991. Coping with Catastrophe: A Handbook of Disaster Management. Routledge.
34. Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press.
35. Indian Society of Soil Science 2002. Fundamentals of Soil Science. ISSS,
36. Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC & Aesthetic Technologies.
37. International Potash Institute, Switzerland.
38. James HS. 1994. Handbook for Technical Writing. NTC Business Books.
39. Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.
40. Jurinak JJ. 1978. Chemistry of Aquatic Systems. Dept. of Soil Science & Biometeorology, Utah State Univ.
41. Kabata- PendiasAlina 2001. Trace Elements in Soils and Plants. CRC /
42. Kannaiyan S, Kumar K &Govindarajan K. 2004. Biofertilizers
43. Kanwar JS. (Ed.). 1976. Soil Fertility: Theory and Practice. ICAR.
44. Kirkham D and Powers WL. 1972. Advanced Soil Physics. Wiley
45. Kristiansen P, Taji A and Reganold J. 2006. Organic Agriculture: A Global Perspective. CSIRO Publ.
46. Lal R & Shukla MK. 2004. Principles of Soil Physics. Marcel Dekker.
47. Lillesand TM and Kiefer RW. 1994. Remote Sensing and Image Interpretation
48. Magdoff F and Weil RR 2004. Soil Organic Matter in Sustainable Agriculture. CRC Press.
49. McBride MB. 1994. Environmental Chemistry of Soils. Oxford Univ. Press.
50. McLaren AD & Peterson GH. 1967. Soil Biochemistry. Vol. XI. Marcel

51. Mercky R &Mulongoy K. 1991. Soil Organic Matter Dynamics and Sustainability of Tropical Agriculture. John Wiley & Sons.
52. Metting FB. 1993. Soil Microbial Ecology – Applications in Agricultural
53. Modelling in the Soil - Plant System. Haworth Press.
54. Mohan K. 2005. Speaking English Effectively. MacMillan India.
55. Nielsen DR and Wendroth O. 2003. Spatial and Temporal Statistics. Catena
56. Olson RA, Army TS, Hanway JJ and Kilmer VJ. 1971. Fertilizer Technology
57. Oswal MC.1994. Soil Physics. Oxford & IBH.
58. Paul EA & Ladd JN. 1981. Soil Biochemistry. Marcel Dekker.
59. Paul EA. 1996. Soil Microbiology and Biochemistry. Academic Press.
60. Prasad R & Power JF. 1997. Soil Fertility Management for Sustainable, CRC
61. Punia, MS. Manual on International Research and Research Ethics. H A U, Hisar.
62. Rajaraman V. 2004. Computer Programming in Fortran 90 and 95. PHI.
63. Rao BSV. 2007. Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives. Mittal Publ.
64. Reddy MV. (Ed.). Soil Organisms and Litter in the Tropics. Oxford & IBH.
65. Richard W.S. 1969. Technical Writing. Barnes & Noble.
66. Rothschild M & Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.
67. Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House.
68. Sehgal J and Abrol IP. 1994. Soil Degradation in India - Status and Impact.
69. Sehgal JL, Mandal DK, Mandal C &Vadivelu S. 1990. Agro-Ecological
70. Sharma VK. 2001. Disaster Management. National Centre for Disaster Management, India.
71. Singh K. 1998. Rural Development - Principles, Policies and Management. Sage Publ.
72. Soil Survey Staff 1998. Keys to Soil Taxonomy. 8th Ed. USDA & NRCS,
73. Sparks DL. 1999. Soil Physical Chemistry. 2nd Ed. CRC Press.
74. Sposito G. 1981. The Thermodynamics of Soil Solutions. Oxford Univ. Press.
75. Star J and Esles J. 1990. Geographic Information System: An Introduction.
76. Stevenson FJ. (Ed.). 1982. Nitrogen in Agricultural Soils. Soil Science
77. Stevenson FJ. 1994. Humus Chemistry – Genesis, Composition and Reactions. John Wiley & Sons.
78. Stotzky G &Bollag JM. 1993. Soil Biochemistry. Vol. VIII. Marcel
79. Sylvia DN. 2005. Principles and Applications of Soil Microbiology.
80. The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000;
81. the Soil. ELBS & McGraw Hill.
82. Tisdale SL, Nelson WL, Beaton JD &Havlin JL. 1990. Soil Fertility and
83. Land Degradation and Environment. Bull. Indian Soc. Soil Sci.
84. Trademarks, Act, (1999). The Copyright Act, 1957 and amendments; Layout
85. Tsuji, G.Y., Gerrit, H. and Philip, T. (1998). Understanding Options for
86. USDA (1974). A Manual on Conservation of Soil and Water Handbook of
87. Vogel, A.I. (1979). Textbook of Quantitative Inorganic Analysis. ELBS.
88. Von, Bertalanffy Ludwig (1969). General Systems Theory: FoundationWashington, DC.
89. Wild, A. (Ed.). (1988). Russell's Soil Conditions and Plant Growth. 11th Ed.
90. Wild, A. (1993). Soil and the Environment - An Introduction. Cambridge

SOIL SCIENCE AND AGRICULTURAL CHEMISTRY: LIST OF JOUNALS

- Advanced Soil Science
- Advances in Agronomy
- Agochmemica
- Agriculture Science
- Agropedology
- Annals of Arid Zone
- Australian Journal of Agricultural Research

- Australian Journal of Soil Research
- Biology and Fertility of Soils
- Bioresource Technology Journal
- Canadian Journal of Soil Research
- Catena
- Clays and Clay minerals
- Clays Research
- Communications in Soil Science and Plant Analysis
- Current Microbiology
- Current Science
- Environmental Science and Technology
- European Journal of Soil Science
- Geoderma
- Indian Journal of Agricultural Sciences
- Indian Journals of Indigenous Technology
- Indian Journal of Fertilizers
- International Journal of Remote Sensing
- Journal of Environmental Quality
- Journal of Nuclear Agriculture Biology
- Journal of Plant Nutrition and Soil Science
- Journal of Potassium Research
- Journal of Progressive Science
- Journal of Soil and Water Conservation
- Journal of The Indian Society of Agricultural Chemists
- Journal of The Indian Society of Remote Sensing
- Journal of the Indian Society of Soil Science
- Nutrient Cycling in Agroecosystems
- Plant and Soil
- Soil and Tillage Research
- Soil Biology and Biochemistry
- Soil Science
- Soil Science Society of America Journal
- Soil Use and Management
- Water Pollution
- Water Resources Research
- Water, Air and Soil Pollution

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