POST GRADUATE DEPARTMENT OF AGRICULTURE

SYLLABUS FOR THE BATCH FROM THE YEAR 2024 TO YEAR 2026

Programme Code: MSSC

Programme Name: M.Sc. Ag. (Soil Science & Agricultural Chemistry)

(Semester I-IV)

Examinations: 2024-25

Khalsa College Amritsar

Programme Objectives:-

1. To familiarize students with latest techniques and instruments used in soil laboratories for analytical purposes and knowing about their application in soil laboratories.
2. To acquaint students with problematic soils, their amelioration for proper maintaining nutrients and their use.
3. To provide knowledge to learners about soil formation, mineralogy and factors affecting soil forming processes so as to improve their information regarding pedology of soil.
4. To familiarize students with soil's various physical, chemical and biological properties for maintaining proper plant growth and development.

PROGRAMME SPECIFIC OUTCOMES:

PSO-1	To acquaint the students with behavior of physical properties in relation to crop production, plant growth, morphology and growth parameters of different crops
PSO-2	Students will learn about methods of soil fertility evaluation and fertilizer recommendation.
PSO-3	To acquaint the students with 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.
PSO-4	Students will learn about structure of aluminosilicate 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
PSO-5	This programme also provides detailed knowledge regarding landform- soil relationship, major soil groups of India with special reference to respective states. Land capability and land irrigability classification.
PSO-6.	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.
PSO-7	The course provides information about biotic factors in soil development, microbial toxins in the soil, preparation and preservation of organic manures, rural and urban composts and vermicomposting.
PSO-8	The programme provides knowledge on the history, distribution, identification and description of soil erosion problems in India, soil conservation planning in hilly, arid and semiarid regions, waterlogged and wet land.
PSO-9	Students will learn about farming systems; Concept and its role in sustainability of agriculture
PSO-10	To make the students aware of the problems of soil, water and air pollution associated with use of soils for crop production.
PSO-11	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.
PSO-12	To provide information about area, distribution, origin and basic concepts of problematic soils, monitoring and management of salt- affected soils, salt tolerance of crops - mechanism and ratings.
PSO-13	To provide information about model, mathematical model, modeling processes and abstraction technique. Simulation models their verification, validation and calibration.
PSO-14	The students would be exposed to concepts of statistical methods and statistical inference that would help them in understanding the importance of statistics. It would also help them study various experimental designs and transform the various inferences for agricultural experiments.

PSO-15	To provide knowledge about organic farming, sustainable farming and integrated farming system; recent updates in resource conservation. i.e. crop residue, water and soil, cropping systems and interaction between farm enterprises.
PSO-16	This programme provides information about how to collect material related to their research, how to write thesis, use scientific language in thesis, and how to publish their research paper in different journals

SEMESTER-I

Sr. No.	Course Code	Course Title	Credit Hours	Marks	Total Marks	Page No.
				Theory + Practical +I. Assessment		
1.	SSC-511	Soil Physics	3 (2+1)	50+25+25	100	8-9
2.	SSC-512	Soil Fertility and Fertilizer use	3 (2+1)	50+25+25	100	10-11
3.	SSC- 513	Soil Erosion and Conservation	3 (2+1)	50+25+25	100	12-13
4.	STAT-511	Statistical Methods for Applied Sciences/ Social Sciences	4(3+1)	57+18+25	100	14-15
5.	*PGS-511	Technical Writing & Communications Skills	1 (0+1)	100 (Pr)	100	16-17
6.	*PGS-512	Library and Information Services	1(0+1)	100 (Pr)	100	18
7.	*SSC-599	Masters' Research	5(0+5)	--	S/US	19
Total			**20 (13+7*)**			

*Non-credit course.

Total Internal Assessment= 25 Marks (Mid semester test- 10 marks; Attendance – 10 marks; Conduct & Academic, Extra Curricular Activities – 5 marks).

SEMESTER-II

Sr. No.	Course Code	Course Title	Credit Hours	Marks	Total Marks	Page No.
				Theory + Practical +I. Assessment		
1.	SSC-521	Soil Mineralogy, Genesis and Classification	3 (2+1)	50+25+25	100	20-21
2.	SSC-522	Analytical Techniques and Instrumental Methods in Soil and Plant Analysis	2 (0+2)	0+75+25	100	22-23
3.	SSC-523	Land Degradation and Restoration	1 (1+0)	75+0+25	100	24-25
3.	AGR-522	Principles and Practices of Water Management	3 (2+1)	50+25+25	100	26-27
4.	STAT-521	Experimental Designs	3(2+1)	50+25+25	100	28-29
5.	*PGS-521	Agricultural Research, Research Ethics and Rural Development Programmes	1(1+0)	100 (Th)	100	30-31
6.	*SSC-599	Masters' Research	5(0+5)	--	U/US	32
Total			**18 (12+6*)**			

*Non-credit course.

Total Internal Assessment= 25 Marks (Mid semester test- 10 marks; Attendance – 10 marks; Conduct & Academic, Extra Curricular Activities – 5 marks).

SEMESTER-III

Sr. No.	Course Code	Course Title	Credit Hours	Marks	Total Marks	Page No.
				Theory + Practical + I. Assessment		
1.	SSC-531	Soil, Water and Air Pollution	3 (2+1)	50+25+25	100	33-34
2.	SSC-532	Soil Biology and Biochemistry	3 (2+1)	50+25+25	100	35-36
3.	AGR-532	Principles and Practices of Organic Farming	3 (2+1)	50+25+25	100	37-38
4.	SSC-591	Credit seminar	1 (1+0)	100	100	39
5.	*PGS-531	Intellectual Property & its Management in Agriculture	1 (1+0)	100 (Th)	100	40-41
6.	*SSC-599	Masters' Research	10 (0+10)	--	U/US	42
Total			**21 (10 +11*)**			

*Non-credit course.

Total Internal Assessment= 25 Marks (Mid semester test- 10 marks; Attendance – 10 marks; Conduct & Academic, Extra Curricular Activities – 5 marks).

SEMESTER-IV

Sr. No.	Course Code	Course Title	Credit Hours	Marks	Total Marks	Page No.
				Theory + Practical + I. Assessment		
1.	SSC-541	Soil Chemistry	3 (2+1)	50+25+25	100	43-44
2.	*PGS-541	Basic Concepts in Laboratory Techniques	1 (0+1)	100	100	45
3.	*SSC-599	Masters' Research	10 (0+10)	--	U/US	46
Total			**14 (3 + 11*)**			

*Non-credit course.

Total Internal Assessment= 25 Marks (Mid semester test- 10 marks; Attendance – 10 marks; Conduct & Academic, Extra Curricular Activities – 5 marks).

SEMESTER-I

SSC-511 **Soil Physics**

Time: 3 Hours **Maximum Marks: 100**

Theory: 50

Practical: 25

Internal assessment: 25

Credit hours: 3 (2+1)

Instructions for the Paper Setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. In all nine questions should be asked, of which first question of 10 marks (Comprising of 10 short answer type questions covering the whole syllabus) will be compulsory.
4. Out of remaining eight questions, two questions should be asked from each section, out of which the candidates are required to attempt one question from each section. All question will carry equal marks (10).

Course objectives:

- To provide information about various physical properties of soil in relation to plant growth.
- To provide the knowledge about soil water constants and water retention.
- To impart knowledge about soil and plant environment.
- To give information about the thermal properties of soil and its effect on plant growth.

Theory:

Section-A: 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.

Section-B: 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.

Section-C: Soil water: content and potential, soil water retention, soil-water constants, measurement of soil water content, energy state of soil water, soil water potential, soil-moisture characteristic curve; hysteresis, measurement of soil-moisture potential. 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.

Section-D: 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.

Practical:

Determination of B.D, P.D and mass volume relationship of soil, Mechanical analysis by hydrometer and international pipette method, Measurement of Atterberg limits, Aggregate analysis - dry and wet, Measurement of soil-water content by different methods, Measurement of soil-water potential by using tensiometer and gypsum Blocks, Determination of soil-moisture characteristics curve and computation

of pore-size, distribution, Determination of hydraulic conductivity under saturated and unsaturated conditions, Determination of infiltration rate of soil, Determination of aeration porosity and oxygen diffusion rate, Soil temperature measurements by different methods, Estimation of water balance components in bare and cropped fields.

Suggested Reading

1. Baver LD, Gardner WH and Gardner WR. 1972. Soil Physics. John Wiley & Sons.
2. Ghildyal BP and Tripathi RP. 2001. Soil Physics. New Age International.
3. Hanks JR and Ashcroft GL. 1980. Applied Soil Physics. Springer Verlag.
4. Hillel D. 1972. Optimizing the Soil Physical Environment toward Greater Crop Yields.
5. Academic Press.
6. Hillel D. 1980. Applications of Soil Physics. Academic Press.
7. Hillel D. 1980. Fundamentals of Soil Physics. Academic Press.
8. Hillel D. 1998. Environmental Soil Physics. Academic Press.
9. Hillel D. 2003. Introduction to Environmental Soil Physics. Academic Press.
10. Indian Society of Soil Science. 2002. Fundamentals of Soil Science. ISSS, New Delhi.
11. Kirkham D and Powers WL. 1972. Advanced Soil Physics. Wiley-Interscience.
12. Kohnke H. 1968. Soil Physics. McGraw Hill.
13. Lal R and Shukla MK. 2004. Principles of Soil Physics. Marcel Dekker.
14. Oswal MC. 1994. Soil Physics. Oxford & IBH.

Course outcomes:

Course Title: Soil Physics **Course Code: SSC-511**

Sr. No.	On completing the course, the students will be able to:
CO1	This course will help the students to get knowledge about soil physical behavior based on different soil properties.
CO2	It will provide information to the students regarding plant growth based on different soil properties like soil structure, soil retention, and density of soil etc.,
CO3	Students will get knowledge about the physical condition of soil based on various properties.
CO4	It will help them to understand the physical behavior of soil.

SEMESTER-I

SSC-512 Soil Fertility and Fertilizer Use

Time: 3 Hours **Maximum Marks: 100**

Theory: 50

Practical: 25

Internal assessment: 25

Credit hours: 3(2+1)

Instructions for the Paper Setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. In all nine questions should be asked, of which first question of 10 marks (Comprising of 10 short answer type questions covering the whole syllabus) will be compulsory.
4. Out of remaining eight questions, two questions should be asked from each section, out of which the candidates are required to attempt one question from each section. All question will carry equal marks (10).

Course objectives:

1. To know about the nutrients and their various organic and synthetic sources.
2. Gain knowledge about the composition of different manures and fertilizers, their fates, NUE.
3. Help to get information about behaviour of different nutrients and their sources in soil, their critical limits in soil and plants.
4. To provide knowledge on nutrient management concepts and nutrient use efficiencies of major and micronutrients and enhancement techniques.

Theory:

Section-A: 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.

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

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

Section-D: Fertilizer use efficiency; site-specific nutrient management; plant need based nutrient management; integrated nutrient management; speciality fertilizers concept, need and category. Current status of speciality 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; Long term effects of fertilizers and soil quality.

Practical:

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

Suggested Reading

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

Course outcomes:

Course Title: Soil Fertility and Fertilizer Use **Course Code: SSC-512**

Sr. No.	On completing the course, the students will be able to:
CO1	To know about the manures, fertilizers and soil fertility management.
CO2	Gain knowledge about the composition of different manures and fertilizers.
CO3	Help to learn about transformations of different nutrient transformations.
CO4	It provides knowledge about the critical limits of nutrients in soil and plants.

SEMESTER-I

SSC-513 Soil Erosion and Conservation

Time: 3 Hours **Maximum Marks: 100**

Theory: 50

Practical: 25

Internal assessment: 25

Credit hours: 3(2+1)

Instructions for the Paper Setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. In all nine questions should be asked, of which first question of 10 marks (Comprising of 10 short answer type questions covering the whole syllabus) will be compulsory.
4. Out of remaining eight questions, two questions should be asked from each section, out of which the candidates are required to attempt one question from each section. All question will carry equal marks (10).

Course objectives:

1. To know about the distribution and description of soil erosion problems in India
2. Gain knowledge about the types and impact of erosion.
3. Help to get information about LCC and their basis management of problematic soils.
4. To provide knowledge on evaluation of watersheds; use of remote sensing in assessment and planning of watersheds, sediment measurement.

Theory:

Section-A: 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 -estimation as EI30 index and kinetic energy; factors affecting water erosion; empirical and quantitative estimation of water erosion; methods of measurement and prediction of runoff; soil losses in relation to soil properties and precipitation.

Section-B: 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.

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

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

Practical:

Determination of different soil erodibility indices - suspension percentage, dispersion ratio, erosion ratio, clay ratio, clay/moisture equivalent ratio, percolation ratio, raindrop erodibility index,

Computation of kinetic energy of falling rain drops, Computation of rainfall erosivity index (EI30) using rain gauge data, Land capability classification of a watershed, Visits to a watersheds

Suggested Reading

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

Course outcomes:

Course Title: Soil Erosion and Conservation **Course Code: SSC-513**

Sr. No.	On completing the course, the students will be able to:
CO1	The course provide knowledge about history, distribution, identification and description of soil erosion problems in India.
CO2	Student will know about wind erosion and principles and practices of erosion control.
CO3	Students will also learn about soil conservation planning in hilly, arid and semiarid region, waterlogged and wet land. They will learn about land degradation and its impact on soil productivity.
CO4	Course will provide knowledge about watershed management, water harvesting, and recycling and flood control. Socio-economic aspects of watershed management. Case study in respect to monitoring and evaluation of watershed. Remote Sensing.

SEMESTER-I

STAT-511 Statistical Methods for Applied Sciences/ Social Sciences

Time: 3 Hours **Maximum marks: 100**
Theory: 57
Practical: 18
Internal assessment: 25
Credit hours: 4(3+1)

Instructions for the Paper Setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. In all nine questions should be asked, of which first question of 9 marks (Comprising of 9 short answer type questions covering the whole syllabus) will be compulsory.
4. Out of remaining eight questions, two questions should be asked from each section, out of which the candidates are required to attempt one question from each section. All question will carry equal marks (12).

Course Objectives: The aim of this course is to understand the basics of statistical methods and their applications in agriculture. It helps the students in understanding, analyzing and interpreting the agricultural data. It also helps in making appropriate decisions in agricultural research findings.

Theory

Section-A: Box-plot, Descriptive statistics:- measures of central tendency, dispersion, Theory of probability:- types and introduction, Introduction to Random variable and Mathematical expectation and their properties.

Section-B: Discrete and continuous probability distributions:- Binomial, Poisson, 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.

Section-C: 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.

Section-D: Non-parametric tests:- sign, Mann-Whitney U-test, Run test for the randomness of a sequence, Median test:- introduction and their applications. Introduction to ANOVA: One way and Two Way, Introduction to Sampling Techniques:- SRS, cluster, stratified, systematic sampling:- introduction and their applications, Transformation of Data.

Practical:

Fitting of distributions ~ Binomial, Poisson, Normal. Large sample tests, testing of hypothesis based on exact sampling distributions ~ chi-square, t and F. Correlation and regression analysis. Non-parametric tests. ANOVA: One way, Two Way.

Suggested Reading:

1. Goon A.M, Gupta M.K and Dasgupta B. 1977. An Outline of Statistical Theory. Vol. I. TheWorld Press.
2. Goon A.M, Gupta M.K. and Dasgupta B. 1983. Fundamentals of Statistics. Vol. I. The WorldPress.
3. Hoel P.G. 1971. Introduction to Mathematical Statistics. John Wiley.
4. Hogg R.V and Craig T.T. 1978. Introduction to Mathematical Statistics. Macmillan.
5. Morrison D.F. 1976. Multivariate Statistical Methods. McGraw Hill.
6. Hogg RV, McKean JW, Craig AT. 2012. Introduction to Mathematical Statistics 7th Edition.
7. Siegel S, Johan N & Casellan Jr. 1956. Non-parametric Tests for Behavior Sciences. JohnWiley.
8. Anderson TW. 2009. An Introduction to Multivariate Statistical Analysis, 3rd Ed. John Wiley
9. http://freestatistics.altervista.org/en/learning.php.
10. http://www.statsoft.com/textbook/stathome.html.

Course outcomes:

Statistical Methods for Applied Sciences/ Social science Course Code: STAT-511

Sr. No.	**On completing the course, the students will be able to:**
CO1	Understand the concept of probability, sampling techniques, standard error etc.
CO2	Apply correction and regression techniques.
CO3	Know the use of T-Test, chi-square and large sample tests

SEMESTER-I

***PGS-511 Technical Writing & Communications Skills**

Time: 3 Hours **Maximum marks: 100**
Practical: 100
Credit hours: 1(0+1)

Instructions for the Paper Setters:

1. The question paper will consist of nine skill-oriented questions.
2. The first 5 questions carry 8 marks each. There will be internal choice wherever possible. The answer should be in 50-80 words. (5×8=40 Marks)
3. There will be four essay type questions from the entire syllabus. There will be internal choice wherever possible. The answer should be in 250 words. (4×15= 60 Marks)

Course Objective: To equip the students with skills and techniques to write dissertations, research papers, review paper, book chapter and articles etc. To equip the students with skills to communicate and articulate in English and scientific language (verbal as well as writing).

Practical:

Various forms of scientific writings- theses, technical papers, reviews, manuals etc.; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations, etc.; Commonly used abbreviations in the theses and research communications; Illustrations, photographs and drawings with suitable captions; pagination numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups. Editing and proof-reading. Writing of a review article; Communication Skills - Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors), Concord, Collocation, Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech; Participation in group discussion; Facing an interview; Presentation of scientific papers.

Suggested Reading:

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

Course outcomes:

Course Title: Technical writing & communication skills **Course Code: *PGS-511**

Sr. No.	On completing the course, the students will be able to:
CO1	Understand the basic components like definitions, descriptions, process explanations and other common forms of technical writing
CO2	Understand how to follow the stages of the writing process and apply them to technical and workplace writing tasks
CO3	Synthesize material collected from primary and secondary sources with their own ideas while writing research papers

SEMESTER-I

***PGS-512 Library and Information Services**

Time: 3 Hours **Maximum marks: 100**
Practical: 100
Credit hours: 1(0+1)

Instructions for the Paper Setters:

1. The question paper will consist of nine skill-oriented questions.
2. The first 5 questions carry 8 marks each. There will be internal choice wherever possible. The answer should be in 50-80 words. (5×8=40 Marks)
3. There will be four essay type questions from the entire syllabus. There will be internal choice wherever possible. The answer should be in 250 words. (4×15= 60 Marks)

Course 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, Stat software, OPAC, search engines, etc.) of information search.

Practical:

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/ Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; e-resources access methods.

Course outcomes:

Course Title: Library and Information Services **Course Code: *PGS-512**

Sr.No.	On completing the course, the students will be able to:
CO1	Understand the library services and its benefit in research work
CO2	Understand how to follow the stages of the writing process along with material available at library resources
CO3	To understand the library services available at desired institute

SEMESTER-I

***SSC-599** **Masters' Research**

Credits hours: 5 (0+5)
S/US

SEMESTER-II

SSC-521 Soil Mineralogy, Genesis and Classification

Time: 3 Hours **Maximum Marks: 100**
Theory: 50
Practical: 25
Internal assessment: 25
Credit hours: 3 (2+1)

Instructions for the Paper Setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. In all nine questions should be asked, of which first question of 10 marks (Comprising of 10 short answer type questions covering the whole syllabus) will be compulsory.
4. Out of remaining eight questions, two questions should be asked from each section, out of which the candidates are required to attempt one question from each section. All question will carry equal marks (10).

Course objectives:

1. To impart knowledge about basic concepts of earth's composition, soil classification, physical properties of soils and processes in relation to plant growth.
2. This course also familiarizes students with soil colloids, organic and inorganic colloids.
3. To provide knowledge on soil formation, various factors, soil classification systems
4. Learn land capability and land irrigability classification and different approaches for managing soil

Theory:

Section-A: Fundamentals of crystallography, space lattice, coordination theory, isomorphism and polymorphism.

Section-B: 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..

Section-C: 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..

Section-D: Concept of soil individual; soil classification systems–historical developments and modern systems of soil classification with special emphasis on soil taxonomy; soil classification, soil mineralogy and soil maps–usefulness.

Practical:

Separation of sand, silt and clay fraction from soil, Determination of specific surface area and CEC of clay, Identification and quantification of minerals in soil fractions, Morphological properties of soil profile in different land forms, Classification of soils using soil taxonomy, Calculation of weathering

indices and its application in soil formation, Grouping soils using available database in terms of soil quality.

Suggested Reading

1. Brady NC and Weil RR. 2002. The Nature and Properties of Soils. 13th Ed. Pearson Edu.
2. Buol EW, Hole ED, MacCracken RJ and Southard RJ. 1997. Soil Genesis and Classification. 4th Ed. Panima Publ.
3. Dixon JB and Weed SB. 1989. Minerals in Soil Environments. 2nd Ed. Soil Science Society of America, Madison.
4. Grim RE. 1968. Clay Mineralogy. McGraw Hill.
5. Indian Society of Soil Science 2002. Fundamentals of Soil Science. ISSS, New Delhi.
6. Sehgal J. 2002. Introductory Pedology: Concepts and Applications. New Delhi
7. Sehgal J. 2002. Pedology - Concepts and Applications. Kalyani.
8. USDA. 1999. Soil Taxonomy. Hand Book No. 436. 2nd Ed. USDA NRCS, Washington.
9. Wade FA and Mattox RB. 1960. Elements of Crystallography and Mineralogy. Oxford & IBH.
10. Wilding LP and Smeck NE. 1983. Pedogenesis and Soil Taxonomy: II. The Soil Orders. Elsevier.
11. Wilding NE and Holl GF. (Eds.). 1983. Pedogenesis and Soil Taxonomy. I.

Course outcomes

Course Title: Soil Mineralogy, Genesis and Classification **Course Code: SSC-521**

Sr. No.	On completing the course, the students will be able to:
CO1	To know soil formation and various processes.
CO2	Gain knowledge about the colloids and their types.
CO3	Help to learn about land capability and land irrigability classification.
CO4	It will provide information about different major soil groups based on different states of India.

SEMESTER-II

SSC-522 Analytical Technique and Instrumental Methods in Soil and Plant Analysis

Time: 3 Hours **Maximum Marks: 100**
Practical: 75
Internal assessment: 25
Credit hours: 2 (0+2)

Instructions for the Paper Setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. Questions should be covered from each section.

Course objectives:

1. To impart knowledge about atomic structure, radioisotopes, its principles and properties.
2. This course also familiarizes students with isotopic dilution techniques, radio exposure, and handling of radioactive materials.
3. To provide knowledge on spectroscopy and other analytical techniques.

Practical:

Section-A: Preparation of solutions for standard curves, indicators and standard solutions for acid-base, oxidation reduction and complex metric titration; soil, water and plant sampling techniques, their processing and handling. Determination of nutrient potentials and potential buffering capacities of soils for phosphorus and potassium; estimation of phosphorus, ammonium and potassium fixation capacities of soils.

Section-B: Principles of visible, ultra violet and infrared spectrophotometery, atomic absorption, Flame-photometry, inductively coupled plasma spectrometry; chromatographic techniques, mass spectrometry and X-ray defractometery; identification of minerals by X-ray by different methods, CHNS analyzer.

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

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

Suggested Reading

1. Hesse P. 971. *Textbook of Soil Chemical Analysis*. William Clowes& Sons.
2. Jackson ML. 1967. *Soil Chemical Analysis*. Prentice Hall of India.
3. Keith A Smith 1991. *Soil Analysis; Modern Instrumental Techniques*. Marcel Dekker.
4. Kenneth Helrich 1990. *Official Methods of Analysis*. Association of Official Analytical Chemists.
5. Page AL, Miller RH and Keeney DR. 1982. *Methods of Soil Analysis*. Part II. SSSA, Madison.
6. Piper CE. *Soil and Plant Analysis*. Hans Publ.
7. Singh D, Chhonkar PK and Pandey RN. 1999. *Soil Plant Water Analysis - A Methods Manual*.IARI, New Delhi.
8. Tan KH. 2003. *Soil Sampling, Preparation and Analysis*. CRC Press/Taylor & Francis.

9. Tandon HLS. 1993. *Methods of Analysis of Soils, Fertilizers and Wat*ers. FDCO, New Delhi.
10. Vogel AL. 1979. *A Textbook of Quantitative Inorganic Analysis*. ELBS Longman.

Course outcomes

Course Title: Analytical Techniques and Instrumental Methods in Soil and Plant Analysis **Course Code: SSC-522**

Sr. No.	On completing the course, the students will be able to:
CO1	To know about the radioactivity concept.
CO2	Gain knowledge about the different analytical techniques, instruments and their principles.
CO3	To know about installation and working of various analytical instruments
CO4	Helps to gain knowledge about soil, plant and water testing.

SEMESTER-II

SSC-523 Land Degradation and Restoration

Time: 3 Hours **Maximum Marks: 100**
Theory: 75
Internal assessment: 25
Credit hours: 1 (1+0)

Instructions for the Paper Setters:

4. Question paper should be set strictly according to the syllabus.
5. The language of questions should be straight & simple.
6. In all nine questions should be asked, of which first question of 15 marks (Comprising of 10 short answer type questions covering the whole syllabus) will be compulsory.
7. Out of remaining eight questions, two questions should be asked from each section, out of which the candidates are required to attempt one question from each section. All question will carry equal marks (15).

Course objectives:

1. To impart knowledge about natural resources and process of soil land degradation.
2. This course also familiarizes students with conservation techniques-erosion control and reclamation of salt affected soil.
3. To provide knowledge on diagnosis and mapping of land degradation.

Theory:

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

Section-B: Land restoration and conservation techniques-erosion control.

Section-C: Reclamation of salt affected soils; mine land reclamation, afforestation, organic products.

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

Suggested Reading

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

Course outcomes

Course Title: Land Degradation and Restoration **Course Code: SSC-523**

Sr. No.	**On completing the course, the students will be able to:**
CO1	Get knowledge on the soil/land degradation and its impact on soil productivity.
CO2	Study various reclamation methods of salt affected soils; mine land reclamation.
CO3	To know about diagnosis and mapping of land degradation.

SEMESTER-II

AGR-522 Principles and Practices of Water Management

Time: 3 Hours **Maximum Marks: 100**
Theory: 50
Practical: 25
Internal assessment: 25
Credit hours: 3 (2+1)

Instructions for the Paper Setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. In all nine questions should be asked, of which first question of 10 marks (Comprising of 10 short answer type questions covering the whole syllabus) will be compulsory.
4. Out of remaining eight questions, two questions should be asked from each section, out of which the candidates are required to attempt one question from each section. All question will carry equal marks (10).

Course objectives:

- To study about the water resources of India
- To study about the different irrigation projects, soil water plant relationship
- To know about the water management crop and cropping systems and management of crops
- To know the effect of excess water on plant growth, drainage requirements of crop.

Theory:

Section-A: Water and its role in plants; Irrigation: Definition and objectives, water resources and irrigation development in of India and concerned state, major irrigation projects, extent of area and crops irrigated in India and in different states. Field water cycle, water movement in soil and plants; transpiration; soil-water plant relationships; water absorption by plants; plant response to water stress, crop plant adaptation to moisture stress condition, Water availability and its relationship with nutrient availability and loses..

Section-B: Soil, plant and meteorological factors determining water needs of crops, scheduling, depth and methods of irrigation; micro irrigation systems; deficit irrigation; fertigation; management of water in controlled environments and polyhouses. Irrigation efficiency and water use efficiency.

Section-C: Water management of crop and cropping system, Quality of irrigation water and management of saline water for irrigation, water use efficiency, Crop water requirement- estimation of ET and effective rainfall; Water management of the major crops and cropping systems. Automated irrigation system, Excess of soil water and plant growth; water management in problem soils, drainage requirement of crops and methods of field drainage, their layout and spacing; rainwater management and its utilization for crop production.

Section-D: Quality of irrigation water and management of saline water for irrigation, water management in problem soils. Soil moisture conservation, water harvesting, rain water management and its utilization for crop production. Hydroponics, Water management of crops under climate change scenario.

Practical:

Determination of Field capacity by field method, Determination of Permanent Wilting Point by sunflower pot culture technique, • Determination of Field capacity and Permanent Wilting Point by Pressure Plate Apparatus, Determination of Hygroscopic Coefficient, Determination of maximum water holding capacity of soil, Measurement of matric potential using gauge and mercury type tensiometer, Determination of soil-moisture characteristics curves, Determination of saturated hydraulic conductivity by constant and falling head method, Determination of hydraulic conductivity of saturated soil below the water table by auger hole method, Measurement of soil water diffusivity, Estimation of unsaturated hydraulic conductivity, Estimation of upward flux of water using tensiometer and from depth ground water table, Determination of irrigation requirement of crops (calculations), Determination of effective rainfall (calculations), Determination of ET of crops by soil moisture depletion method16. Determination of water requirements of crops, Measurement of irrigation water by volume and velocity-area method, Measurement of irrigation water by measuring devices and calculation of irrigation efficiency, Determination of infiltration rate by double ring infiltrometer.

Suggested Reading

1. Majumdar DK. 2014. Irrigation Water Management: Principles and Practice. PHL Learning private publishers
2. Mukund Joshi. 2013. A Text Book of Irrigation and Water Management Hardcover, Kalyani Publishers
3. Lenka D. 1999. Irrigation and Drainage. Kalyani.
4. Michael AM. 1978. Irrigation: Theory and Practice. Vikas Publ.
5. Paliwal KV. 1972. Irrigation with Saline Water. IARI Monograph, New Delhi.
6. Panda SC. 2003. Principles and Practices of Water Management. Agrobios.
7. Prihar SS and Sandhu BS. 1987. Irrigation of Food Crops - Principles and Practices. ICAR.
8. Reddy SR. 2000. Principles of Crop Production. Kalyani.
9. Singh Pratap and Maliwal PL. 2005. Technologies for Food Security and Sustainable Agriculture. Agrotech Publ.

Course outcomes

Course Title: Principles and Practices of Water Management Course Code: AGR-522

Sr. No.	**On completing the course, the students will be able to:**
CO1	Understand the principles involved in estimating water requirements of different crops.
CO2	Gain knowledge on various methods of irrigation scheduling .
CO3	Acquire knowledge on pressurized irrigation systems to economize the use of water.
CO4	Construct ideologies pertaining to water management in problematic soils
CO5	Analyse the quality of irrigation water.

SEMESTER-II

STAT-521: Experimental Designs

Time: 3 Hours **Maximum marks: 100**
Theory: 50
Practical: 25
Internal assessment: 25
Credit hours: 3(2+1)

Instructions for the Paper Setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. In all nine questions should be asked, of which first question of 10 marks (Comprising of 10 short answer type questions covering the whole syllabus) will be compulsory.
4. Out of remaining eight questions, two questions should be asked from each section, out of which the candidates are required to attempt one question from each section. All question will carry equal marks (10).

Course Objectives: The aim of this course is to understand the basics of statistical methods and their applications in agriculture. It helps the students in understanding, analyzing and interpreting the agricultural data. It also helps in making appropriate decisions in agricultural research findings.

Theory:

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

Section-B: Uniformity trials, size and shape of plots and blocks, Analysis of variance, completely randomized design, randomized block design and Latin square design.

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

Section-D: 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.

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

Note: Students shall be trained to use computer to analysis the data, using available softwares. However, during university examination students are allowed to use scientific calculators to analysis is the data.

Note: Students are allowed to use scientific calculator in University examinations; statistical tables will be provided to students in examinations. No rigorous mathematical proofs are expected from students; stress will be on application only.

Suggested Reading:

1. Cochran WG and Cox GM. 1957. Experimental Designs. 2nd Ed. John Wiley.
2. Dean AM and Voss D. 1999. Design and Analysis of Experiments. Springer.
3. Montgomery DC. 2012. Design and Analysis of Experiments, 8th Ed. John Wiley.
4. Federer WT. 1985. Experimental Designs. MacMillan.
5. Fisher RA. 1953. Design and Analysis of Experiments. Oliver & Boyd.
6. Nigam AK and Gupta VK. 1979. Handbook on Analysis of Agricultural Experiments. IASRI Publ.
7. Pearce SC. 1983. The Agricultural Field Experiment: A Statistical Examination of Theory and Practice. John Wiley.
8. www.drs.icar.gov.in.

Course Outcomes

Course Title: Experimental Designs **Course Code: STAT-521**

Sr. No.	**On completing the course, the students will be able to:**
CO1	Get knowledge on the designs, their principles, analysis of variance and interpretation of data.
CO2	Study various mechanical errors in field experiments, methods of reducing them and presentation of research results.

SEMESTER-II

***PGS-521 Agricultural Research, Research Ethics and Rural Development Programmes**

Time: 3 Hours **Maximum marks: 100**

Theory: 100

Credit hours: 1 (1+0)

Instructions for the Paper Setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. There will be total of five questions, out of which first question of 20 marks (Comprising of 10 short answer type questions of 2 mark each) covering the whole syllabus will be compulsory.
4. Out of remaining eight questions, two questions should be asked from each section, out of which the candidates are required to attempt one question from each section. All question will carry equal marks (20).

Course Objectives: The aim of this course is to understand the moral judgment and reactions. Identify the publication misconduct, scientific misconduct, complaints and appeals.

Theory:

Section A: 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):

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

Section C: 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,

Section D: Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/ Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings:

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

Course outcomes

Course Title: Agricultural Research, Research Ethics and Rural Development Programmes **Course Code: *PGS-521**

Sr. No.	On completing the course, the students will be able to:
CO1	Understand the moral judgment and reactions
CO2	Identify the publication misconduct, scientific misconduct, complaints and appeals

SEMESTER-II

***SSC-599**

Masters' Research

Credits hours: 5 (0+5)
S/US

SEMESTER-III

SSC-531 Soil, Water and Air Pollution

Time: 3 Hours **Maximum Marks: 100**
Theory: 50
Practical: 25
Internal assessment: 25
Credit hours: 3 (2+1)

Instructions for the Paper Setters:

5. Question paper should be set strictly according to the syllabus.
6. The language of questions should be straight & simple.
7. In all nine questions should be asked, of which first question of 10 marks (Comprising of 10 short answer type questions covering the whole syllabus) will be compulsory.
8. Out of remaining eight questions, two questions should be asked from each section, out of which the candidates are required to attempt one question from each section. All question will carry equal marks (10).

Course objectives:

- To learn about pollution and its various types w.r.t agriculture, pollutants and their sources, nature, and effect on plant, animal and human life.
- To impart knowledge about CPC standards.
- To study about water pollution, effluents, their behaviour and effect on nutrient availability.
- To learn about the concept of remote sensing and their use in monitoring and management of different pollution.

Theory:

Section-A: 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.; air, water and soil pollutants- their CPC standards and effect on plants, animals and human beings.

Section-B: Sewage and industrial effluents–their composition and effecton soil properties/Health, and plant growth and human beings; soil as sink for waste disposal. Pesticides–their classification, behaviour in soil and effecton soil microorganisms.

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

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

Practical:

Sampling of sewage waters, sewage sludge, solid/ liquid industrial wastes, polluted soils and plants and their processing, Estimation of dissolved and suspended solids, chemical oxygen demand (COD), biological demand (BOD), measurement of coliform (MPN), nitrate and ammonical nitrogen and phosphorus, heavy metal content in effluents, Heavy metals in contaminated soils and plants, Management of contaminants in soil and plants to safe guard food safety, Air sampling and determination of particulate matter and oxides of sulphur, NO2 and O2 conc. Visit to various industrial sites to study the impact of pollutants on soil and plants.

Suggested Reading

1. Lal R, Kimble J, Levine E and Stewart BA. 1995. Soil Management and Greenhouse Effect. CRC Press.
2. Middlebrooks EJ. 1979. Industrial Pollution Control. Vol. I. Agro-Industries. John Wiley Interscience.
3. Ross SM. Toxic Metals in Soil Plant Systems. John Wiley & Sons.
4. Vesilund PA and Pierce 1983. Environmental Pollution and Control. Ann Arbor Science Publ.

Course outcomes:

Course Title: Soil, Water and Air Pollution **Course Code: SSC-531**

Sr. No.	On completing the course, the students will be able to:
CO1	To know about the different kind of soil pollution, their sources and effluents
CO2	Gain knowledge about CPC standards
CO3	Help to learn about remote sensing and its use in management of soil pollution.

SEMESTER-III

SSC-532 **Soil Biology and Biochemistry**

Time: 3 Hours **Maximum Marks: 100**
Theory: 50
Practical: 25
Internal assessment: 25
Credit hours: 3 (2+1)

Instructions for the Paper Setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. In all nine questions should be asked, of which first question of 10 marks (Comprising of 10 short answer type questions covering the whole syllabus) will be compulsory.
4. Out of remaining eight questions, two questions should be asked from each section, out of which the candidates are required to attempt one question from each section. All question will carry equal marks (10).

Course objectives:

- Help to learn soil microbiology, Organisms, various soil enzymes and
- To know about soil organic matter, humus formation, and their significance and functions in soil relevant to soil microbes.
- Help to learn about Biofertilizers, their classifications and features.
- Helps to know about the rhizosphere and phylloshpere, their biota and various functions.

Theory:

Section-A: Soil biota, soil microbial ecology, types of organism's in different soils; soil microbial biomass; microbial interactions; un-culturable soil biota. Microbiology and biochemistry of root-soil interface; phyllosphere; soil enzymes, origin, activities and importance; soil characteristics influencing growth and activity of micro flora; Root rhizosphere and PGPR.

Section-B: Microbial transformations of nitrogen, phosphorus, Sulphur, iron and manganese in soil; biochemical composition and biodegradation of soil organic matter and crop residues, microbiology and biochemistry of decomposition of carbonaceous and protenaceous materials, cycles of important organic nutrients.

Section-C: organic wastes and their use for production of biogas and manures; biotic factors in soil development; microbial toxins in the soil. Preparation and preservation of farmyard manure, animal manures, rural and urban composts and vermicompost.

Section-D: Biofertilizers–definition, classification, specifications, method of production and role in crop production; FCO specifications and quality control of biofertilizers. 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 bio-prospecting; soil sickness due to biological agents; xenobiotics; antibiotic production in soil.

Practical:

Determination of soil microbial population, Soil microbial biomass carbon, Elemental composition, fractionation of organic matter and functional groups, Decomposition of organic matter in soil, Soil enzymes, Measurement of important soil microbial processes such as ammonification, nitrification, N2 fixation, S oxidation, P solubilization and mineralization of other micronutrients.

Suggested Reading

1.Paul EA and Clark FE. Soil Microbiology and Biochemistry.
2.Lynch JM. Soil Biotechnology
3.Willey JM, Linda M. Sherwood and Woolverton CJ. Prescott's Microbiology.
4.Subba Rao NS. Advances In Agricultural Microbiology.

Course outcomes

Course Title: Soil Biology and Biochemistry **Course Code: SSC-532**

Sr. No.	On completing the course, the students will be able to:
CO1	Help to know about the soil microbes, various enzymes
CO2	Learn about soil organic matter, its decomposition, role and functions.
CO3	Help to learn about transformations of different nutrient transformations.
CO4	To get information about biofertilizers and their uses and effects in soil and on plant growth.

SEMESTER-III

AGR-532: Principles and Practices of Organic Farming

Time: 3 Hours **Maximum marks: 100**

Theory: 50

Practical: 25

Internal assessment =25

Credit hours per week: 3(2+1)

Instructions for the Paper Setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. In all nine questions should be asked, of which first question of 10 marks (Comprising of 10 short answer type questions covering the whole syllabus) will be compulsory.
4. Of the remaining eight questions, two questions should be asked from each section, of which the candidates are required to attempt one question from each section. All questions carry equal marks (10).

Course objective:

- Knowledge and concept of organic farming
- Basics of soil fertility, nutrient cycle manures and soil biota
- Knowledge of weeds and their control in agricultural crops
- Basic concepts of marketing and export potential, certification and labelling
- Study of cropping and farming systems for sustainable agriculture

Theory:

Section-A: Organic farming - concept and definition, its relevance to India and global agriculture and future prospects;

Section-B: land and water management - land use, minimum tillage; shelter zones, hedges, pasture management**,** agro-forestry**.** Organic farming and water use efficiency; soil fertility, nutrient recycling, organic residues, organic manures, composting, soil biota and decomposition of organic residues, earthworms and vermicompost, green manures and biofertilizers.

Section-C: Farming systems, crop rotations, multiple and relay cropping systems, intercropping in relation to maintenance of soil productivity. Control of weeds, diseases and insect pest management, biological agents and pheromones, Biopesticides.

Section-D: Socio-economic impacts; marketing and export potential: inspection, certification, labeling and accreditation procedures; organic farming and national economy.

Practical:

Aerobic and anaerobic methods of making compost; making of vermicompost; identification and nursery raising of important agro-forestry tress and tress for shelter belts; efficient use of biofertilizers, technique of treating legume seeds with Rhizobium cultures, use of Azotobacter, Azospirillum, and PSB cultures in field; visit to an organic farm; quality standards, inspection, certification and labeling and accreditation procedures for farm produce from organic farms.

Suggested Reading

1. Anantha krishnan TN. (Ed.). 1992. Emerging Trends in Biological Control of Phytophagous Insects. Oxford & IBH.
2. Gaur AC. 1982. A Manual of Rural Composting, FAO/UNDP Regional Project Document, FAO.
3. Joshi M. 2016. New Vistas of Organic Farming. Scientific Publishers
4. Lampin N. 1990. Organic Farming. Press Books, lpswitch, UK.
5. Palaniappan SP and Anandurai K. 1999. Organic Farming – Theory and Practice. Scientific Publ.
6. Rao BV Venkata. 1995. Small Farmer Focused Integrated Rural Development: Socio-economic Environment and Legal Perspective: Publ.3, ParisaraprajnaParishtana, Bangalore.
7. Reddy MV. (Ed.). 1995. Soil Organisms and Litter Decomposition in the Tropics. Oxford & IBH.
8. Sharma A. 2002. Hand Book of Organic Farming. Agrobios.
9. Singh SP. (Ed.). 1994. Technology for Production of Natural Enemies. PDBC, Bangalore.
10. Subba Rao NS. 2002. Soil Microbiology. Oxford & IBH.
11. Trivedi RN. 1993. A Text Book of Environmental Sciences, Anmol Publ.
12. Veeresh GK, Shivashankar K and Suiglachar MA. 1997. Organic Farming and Sustainable Agriculture. Association for Promotion of Organic Farming, Bangalore.
13. WHO. 1990. Public Health Impact of Pesticides Used in Agriculture. WHO.
14. Woolmer PL and Swift MJ. 1994. The Biological Management of Tropical Soil Fertility. TSBF & Wiley.

Course outcomes

Course Title: Principles and Practices of Organic Farming Course Code: AGR-532

Sr. No.	**On completing the course, the students will be able to:**
CO1	Acquire knowledge on the concepts of organic agriculture.
CO2	Get information about the impact of organic farming and indigenous practices on the environment.
CO3	Understand the procedure followed for organic certification

SEMESTER-III

SSC-591 **Credit Seminar**

Maximum Marks: 100
Practical: 100
Credit hours: 1 (1+0)

SEMESTER-III

***PGS-531 Intellectual Property & its Management in Agriculture**

Time: 3 Hours **Maximum Marks: 100**
Theory: 100
Credit hours: 1 (1+0)

Instructions for the Paper Setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. In all nine questions should be asked, of which first question of 20 marks (Comprising of 10 short answer type questions covering the whole syllabus) will be compulsory.
4. Out of remaining eight questions, two questions should be asked from each section, out of which the candidates are required to attempt one question from each section. All question will carry equal marks (20).

Course objectives:

- To equip students with knowledge of Intellectual Property Rights (IPR) related protection systems, their significance
- Use of IPR as a tool for wealth and value creation in a knowledge based economy.

Theory

Section A: 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;
Section B: Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection;
Section C: Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity;
Section D: International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings

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

Course outcomes

Course Title: Intellectual Property & its Management in Agriculture Course Code: *PGS-531

Sr. No.	On completing the course, the students will be able to:
CO1	The students will have acquaintance of intellectual property rights
CO2	Will have knowledge of National and international laws on biodiversity and sustainable use of plant genetic resources through transfer and sharing.
CO3	Can assist in follow up of various treatises and laws for research collaborations at international levels.

SEMESTER-III

***SSC-599** **Masters' Research**

Credits hours: 10 (0+10)
S/US

SEMESTER-IV

SSC-541 **Soil Chemistry**

Time: 3 Hours **Maximum Marks: 100**

Theory: 50

Practical: 25

Internal assessment: 25

Credit hours: 3 (2+1)

Instructions for the Paper Setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. In all nine questions should be asked, of which first question of 10 marks (Comprising of 10 short answer type questions covering the whole syllabus) will be compulsory.
4. Out of remaining eight questions, two questions should be asked from each section, out of which the candidates are required to attempt one question from each section. All question will carry equal marks (10).

Theory:

Section-A: Chemical (elemental) composition of the earth's crust, soils, rocks and minerals. Elements of equilibrium thermodynamics, chemical equilibria, electrochemistry and chemical kinetics. Soil colloids: inorganic and organic colloids - origin of charge, concept of point of zero-charge (PZC) and its dependence on variable-charge soil components.

Section-B: 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.

Section-C: Ion exchange processes in soil; cation exchange- theories based on law of mass action (Kerr-Vanselow, Gapon equations, hysteresis, Jenny's concept), adsorption isotherms, Donnan-membrane equilibrium concept, clay-membrane electrodes and ionic activity measurement, thermodynamics, statistical mechanics; anion and ligand exchange- inner sphere and outer-sphere surface complex formation, fixation of oxyanions, hysteresis in sorption-desorption of oxy-anions and anions, shift of PZC on ligand exchange, AEC, CEC; experimental methods to study ion exchange phenomena and practical implications in plant nutrition.

Section-D: 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 of salt-affected soils and amendments; soil pH, ECe, ESP, SAR and important relations; soil management and amendments. Chemistry and electrochemistry of submerged soils, geochemistry of micronutrients,
environmental soil chemistry

Practical:

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

substances, Potentiometric and conductometric titration of soil humic and fulvic acids, (E4/E6) ratio of soil humic and fulvic acids by visible spectrophotometric studies and the D (E4/E6) values at two pH values, Adsorption-desorption of phosphate/sulphate by soil using simple adsorption isotherm, Construction of adsorption envelope of soils by using phosphate/fluoride/sulphate and ascertaining the mechanism of the ligand exchange process involved, Determination of titratable acidity of an acid soil by BaCl2-TEA method, Determination of Q/I relationship of potassium, Determination of lime requirement of an acid soil by buffer method, Determination of gypsum requirement of an alkali soil.

Suggested Reading

1. Bear RE. 1964. Chemistry of the Soil. Oxford and IBH.
2. Bolt GH and Bruggenwert MGM. 1978. Soil Chemistry. Elsevier.
3. Greenland DJ and Hayes MHB. 1981. Chemistry of Soil Processes. John Wiley & Sons.
4. Greenland DJ and Hayes MHB. Chemistry of Soil Constituents. John Wiley & Sons.
5. McBride MB. 1994. Environmental Chemistry of Soils. Oxford University Press.
6. Sposito G. 1981. The Thermodynamics of Soil Solutions. Oxford University Press.
7. Sposito G. 1984. The Surface Chemistry of Soils. Oxford University Press.
8. Sposito G. 1989. The Chemistry of Soils. Oxford University Press.
9. Stevenson FJ. 1994. Humus Chemistry. 2nd Ed. John Wiley & Sons.
10. Van Olphan H. 1977. Introduction to Clay Colloid Chemistry. John Wiley & Sons.

Course outcomes

Course Title: Soil Chemistry **Course Code: SSC-541**

Sr. No.	**On completing the course, the students will be able to:**
CO1	Students will learn in detail about chemical composition of earth's crust and soil, all chemical aspects, chemical reaction process occurring in soil, chemistry of problematic soils.
CO2	The course provide the detailed knowledge about Inorganic and organic colloids-surface charge characteristics, diffuse double layer theories, zeta potential stability, and coagulation / flocculation, peptization, and electrometric and sorption properties of soil colloid.
CO3	Students will learn about soil organic matter-fractionation, clay-organic interactions. Cations exchange-theories, adsorption isotherms, hysteresis in sorption-desorption of oxy-anions and anions.

SEMESTER-IV

***PGS-541 Basic Concept in Laboratory Techniques**

Time: 3 Hours **Maximum Marks: 100**
Practical: 100
Credit hours: 1 (0+1)

Instructions for the Paper Setters:

1. The question paper will consist of nine skill-oriented questions.
2. The first 5 questions carry 8 marks each. There will be internal choice wherever possible. The answer should be in 50-80 words. (5×8=40 Marks)
3. There will be four essay type questions from the entire syllabus. There will be internal choice wherever possible. The answer should be in 250 words. (4×15= 60 Marks)

Course objectives:

- To acquaint the students with the basics of commonly used techniques in the laboratory.

Practical

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; Washing, drying and sterilization of glassware; Drying of solvents/ chemicals; Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values; Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; Electric wiring and earthing; Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy.

Suggested Readings

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

Course outcomes

Course Title: Basic Concepts in Laboratory Techniques **Course Code: *PGS 541**

Sr. No.	On completing the course, the students will be able to:
CO1	Know about the use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers and micropipettes.
CO2	Know about different solutes, solvents and agrochemicals
CO3	know about media preparation, handling techniques of solutions and preparation of media and methods of sterilization.

SEMESTER-IV

***SSC-599** **Masters' Research**

Credits hours: 10 (0+10)
S/US