POST GRADUATE DEPARTMENT OF AGRICULTURE

SYLLABUS FOR THE BATCH FROM THE YEAR

2022 TO YEAR 2024

Programme Code: MSSC

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

(Semester III-IV)

Examinations: 2023-24

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 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
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 Theory + Practical + I. Assessment	Total Marks	Page No.
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.	AGR- 513 (Minor)	Crop Ecology	3 (2+1)	50+25+25	100	12-13
4.	STA-414	Statistical Methods for Research Workers	3 (2+1)	50+25+25	100	14-15
5.	*PGS-501	Technical Writing & Communication Skills	1 (1+0)	100 (Th)	100	16-17
6.	*PGS-502	Library & Information Services	1 (0+1)	100 (Pr)	100	18
7.	*SSC-600	Masters' Research	4 (0+4)		S/US	19
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-II

Sr. No.	Course Code	Course Title	Credit Hours	Marks	Total Marks	Page No.
				Theory + Practical + I. Assessment		
1.	SSC-521	Soil Mineralogy, Genesis, Classification and Survey	3 (2+1)	50+25+25	100	20-21
2.	SSC-522	Soil Biology and Biochemistry	3 (2+1)	50+25+25	100	22-23
3.	AGR-523 (Minor)	Farm Cropping System	3 (2+1)	50+25+25	100	24-25
4.	STA-524	Experimental Designs for Research Workers	3 (2+1)	50+25+25	100	26-27
5.	*PGS-503	Agricultural Research and Publication Ethics	1 (1+0)	100 (Th)	100	28-29
6.	*SSC-600	Masters' Research	4 (0+4)	-	U/US	30
Total			**17 (12+ 5*)**			

*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	31-32
2.	SSC-532	Analytical Techniques and Instrumental Methods	3 (2+1)	50+25+25	100	33-34
3.	SSC-533 / AGM-533/ BOT-533 (Minor)	Fertilizer Technology / Fundamentals of Agro-climatology/ Physiology of Growth & Development	3 (2+1)	50+25+25	100	35-39
4.	SSC-591	Credit seminar	1 (1+0)	100	100	40
5.	*PGS-504	Intellectual Property & its Management in Agriculture	1 (1+0)	100 (Th)	100	41-42
6.	*SSC-600	Masters' Research	6 (0+6)	-	U/US	43
Total			**17(10 + 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-IV

Sr. No.	Course Code	Course Title	Credit Hours	Marks	Total Marks	Page No.
				Theory + Practical +I. Assessment		
1.	SSC-541	Management of Problem Soils and Water	3 (2+1)	50+25+25	100	44-45
2.	SSC-542	Soil Chemistry	3 (2+1)	50+25+25	100	46-47
3.	*PGS-505	Disaster Management	1(1+0)	100 (Th)	100 (NC)	48-49
4.	*SSC-600	Masters' Research	6 (0+6)	-	U/US	50
Total			**13 (6+ 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-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: Soil physical behavior. Soil consistence. Dispersion and workability of soils. Soil compaction and consolidation. Soil strength-bulk density relations. Swelling and shrinkage- basic concepts.

Section-B: Soil structure genesis, characterization and management. Soil tilth. Soil crusting - mechanism, factors affecting and evaluation. Soil conditioners. Puddling, its effect on soil physical properties.

Section-C: Soil water - retention, constants. Energy state of soil water, soil-moisture characteristics. Hysteresis. Water flow in saturated and unsaturated soils, Darcy's law, hydraulic conductivity, permeability. Infiltration, internal drainage and redistribution.

Section-D: Evaporation. Hydrologic cycle, field water balance. Soil-plant-atmosphere continuum. Composition, renewal and measurement of soil air. Aeration requirement for plant growth. Modes of energy transfer in soils, energy balance, thermal properties of soil. Soil temperature in relation to plant growth.

Practical:

Mechanical analysis of soil. Measurement of Atterberg limits. Aggregate analysis. Measurement of soil-water content. Measurement of soil-water potential. 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.

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. Academic Press.
5. Hillel D. 1980. Applications of Soil Physics. Academic Press.
6. Hillel D. 1980. Fundamentals of Soil Physics. Academic Press.
7. Hillel D. 1998. Environmental Soil Physics. Academic Press.
8. Hillel D. 2003. Introduction to Environmental Soil Physics. Academic Press.
9. Indian Society of Soil Science. 2002. Fundamentals of Soil Science. ISSS, New Delhi.
10. Kirkham D and Powers WL. 1972. Advanced Soil Physics. Wiley-Interscience.
11. Kohnke H. 1968. Soil Physics. McGraw Hill.
12. Lal R and Shukla MK. 2004. Principles of Soil Physics. Marcel Dekker.
13. 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. Nutrient sources - fertilizers and manures. Soil N - sources and N transformations. Biological nitrogen fixation. Nitrogenous fertilizers - their fate in soils and enhancing N use efficiency.

Section-B: Soil P - forms, reactions in soils and factors affecting availability. Management of P fertilizers. Potassium- forms, mechanism of fixation, Q/I relationships. Management of K fertilizers.

Section-C: Sulphur, Ca and Mg - source, forms, fertilizers and their behavior in soils and management. Micronutrients- critical limits in soils and plants, factors affecting their availability, sources and management.

Section-D: Common soil test methods for fertilizer recommendations. Site-specific and plant need based nutrient management. Integrated nutrient management. Blanket fertilizer recommendations-usefulness and limitations. Soil fertility evaluation. Soil quality in relation to sustainable agriculture.

Practical:

Laboratory and greenhouse experiments for evaluation of indices of nutrient availability and their critical values in soils and plants. Chemical analysis of soil for total and available nutrients. Analysis of plants for essential elements.

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

AGR-513 **Crop Ecology (Minor)**

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 impart knowledge about ecology and ecosystem of environment related to plants
- To provide knowledge on different farming, agro ecological zones of the world and India.
- Helpful in learning different cropping patterns, farm size and layout.

Theory

Section-A: Ecology in relation to crop; Eco system- components and energy flow- food chain and energy output relationships; Agro- ecosystem and agro-ecological zones of India; Efficient food producing systems;

Section-B: Farming system of the world-arable, pastoral, lay farming, shifting cultivation, ranching and agro-forestry systems, energy and fuel, wood plantations; Specialized and diversified forming;

Section-C: Family, co-operative and collective farming, their occurrence and adaptation and weakness; Cropping systems, their characteristics and management;

Section-D: Cropping patterns; Farm selection, size of the farm and farm layout, cropping schemes and crop plans; Solar radiation concepts, laws and their absorption in crop system; Bio-geo-chemical cycle and their significance.

Practical:

Analysis of crop ecosystem components; Light measurement in pure and mixed crop stands; Modification in crop environment; Measuring temperature, light and moisture effects: Preparation of farm lay out plans, different intensity crop rotations and cropping schemes; Estimating crop yields; Energy budgeting in different crops and cropping systems; Working out ecological optimum crop zones.

Suggested Reading:

1. Crop Ecology: Productivity and Management in Agricultural Systems by David J. Connor, Kenneth G. Cassman, Robert S. Loomis.
2. Textbook on Crop Ecology by RK Naresh, Sudhir Kumar, Vivek Mekersi Nawal, Mandapelli Sharath Chandra.

Course outcomes:

Course Title: Crop Ecology (Minor) **Course Code: AGR-513**

Sr. No.	**On completing the course, the students will be able to:**
CO1	To know about the ecosystem and various agro ecological zones of India and world.
CO2	Gain knowledge about different farming systems and cropping patterns
CO3	Help to learn solar radiation concepts w.r.t. crops.

SEMESTER-I

STA-414 Statistical Methods for Research Workers

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

Theory

Section-A: Probability and fitting of standard frequency distribution, sampling techniques, sampling distributions, mean and standard error.

Section-B: Simple partial, multiple and intra- class correlation and multiple regression.

Section-C: Tests of significance, students'-t, chi-square and large sample tests, confidence intervals.

Section-D: Analysis of variance for one way and two way classification with equal cell frequencies, transformation of data.

Practical:

Fitting of distributions, samples and sampling distributions, correlation and regression, tests of significance and analysis of variance.

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

Suggested Reading:

1. Goon A.M, Gupta M.K and Dasgupta B. 1977. An Outline of Statistical Theory. Vol. I. The World Press.
2. Goon A.M, Gupta M.K. and Dasgupta B. 1983. Fundamentals of Statistics. Vol. I. The World Press.
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. John Wiley.
8. Anderson TW. 2009. An Introduction to Multivariate Statistical Analysis, 3rd Ed. John Wiley
9. http://freestatistics.altervista.org/en/learning.php.
   http://www.statsoft.com/textbook/stathome.html.

Course outcomes:

Course Title: Statistical Methods for Research Workers **Course Code: STA-414**

Sr. No.	On completing the course, the students will be able to:
CO1	The course Statistical Methods enables the students to know the basics of statistics, probability.
CO2	It enables them to know sampling methods, Sampling distributions and standard error.
CO3	In this course students are taught to find out the simple, partial and multiple relationship (correlation) between variables and the impact of several variables on dependent variables (Regression)..
CO4	This course enables the students to do comparison of means having small no. of observations and large no. of observations, independency of attributes for only two attributes.
CO5	In this course students are taught to do comparison of several means of variables affected by various factors by Analysis of Variance technique. They are also taught to transform the data.

SEMESTER-I

***PGS 501 Technical Writing and Communication Skills**

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. The question paper will consist of Nine skill-oriented questions.
4. The first 5 questions carry 8 marks each. There will be internal choice wherever possible. The answer should be in 50-80 words. (5X8=40 Marks)
5. 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. (4X15= 60 Marks)

Course Objective:

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

Theory:

Technical Writing- Various forms of technical writing-theses, technical papers, reviews, electronics communication etc: qualities of technical writing: parts of research communication- title page, content page, authorship, preface, introduction, review of literature, materials and methods, experimental results, documentation; photographs and drawings with suitable captions; pagination; citation; writing of abstracts; précis; synopsis; editing and proof reading.

Communication Skills-defining communication; types of communication- verbal and non-verbal; assertive communication; assertive communication: using language for effective communication; techniques of dyadic communication- message pacing and message chunking, self-disclosure mirroring, expressing conversation intent; paraphrasing; vocabulary building- word roots, prefixes, Greek and Latin roots.

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-501**

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 502 Library and Information Services**

Time:-3 hours **Max. Marks: 100**
Practical: 100
Credit hours per week: 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 carry 15 marks 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: Five laws of library science: type of documents; classification and cataloguing; organization of documents; sources of information-primary, secondary and tertiary; current awareness and SDI services; tracing information from references sources; library survey; preparation of bibliography; use of Online Public Access Catalogue; use of CD-Rom databases and other computerized library services, CeRA, J-Gate; use of Internet including search engines and its resources, e-resources and access methods.

Course Outcomes:

Course Title: Library and Information Services Course Code: PGS-502

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-600** **Masters' Research**

Credits hours: 4(0+4)
S/US

SEMESTER-II

SSC-521 Soil Mineralogy, Genesis, Classification and Survey

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. Classification, structure, chemical composition and properties of clay minerals. Genesis and transformation of crystalline clay minerals. Amorphous soil constituents and other non-crystalline silicate minerals. Clay minerals in Indian soils.

Section-B: Soil formation - factors, models, processes. Weathering of rocks and mineral transformations. Soil profile.

Section-C: Soil classification systems - historical developments and modern systems of soil classification. Soil survey- types, techniques. Soil series- characterization and procedure for establishing soil series, benchmark soils and soil correlations. Soil survey interpretations. Techniques for generation of soil maps.

Section-D: Landform- soil relationship, major soil groups of India with special reference to respective states. Land capability and land irrigability classification. Land evaluation and land use type. Approaches for managing soils and landscapes in the framework of agro-ecosystem.

Practical:

Identification and quantification of minerals in soils. Morphological properties of soil profile in different landforms. Classification of weathering indices and its application in soil formation. Grouping soils using available data base in terms of soil quality. Cartographic techniques for

preparation of maps, processing of field sheets, compilation and obstruction of maps in different scales. Land use planning exercises using conventional and RS tools

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, Classification and Survey 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 **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 organisms. Soil microbial biomass, microbial interactions, un-culturable soil biota. Microbiology and biochemistry of root-soil interface. Phyllosphere.

Section-B: Soil enzymes, origin, activities and importance. Soil characteristics influencing growth and activity of microflora. Microbial transformations of N, P, S, Fe and Mn in soil.

Section-C: Biochemical composition and biodegradation of soil organic matter and crop residues. Humus formation. Cycles of important organic nutrients. Biodegradation of pesticides, organic wastes and their use for production of biogas and manures.

Section-D: Biotic factors in soil development. Microbial toxins in the soil. Preparation and preservation of organic manures, rural and urban composts and vermicompost. Biofertilizers - definition, classification, specifications, method of production and role in crop production.

Practical:

Determination of soil microbial population. Soil microbial biomass. 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 micro nutrients. Study of rhizosphere effect.

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-522**

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-II

AGR-523 **Farm Cropping System (Minor)**

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 impart knowledge of farming systems and their role in sustainable agriculture.
- Students will learn about different crop yield appraisal and indices.
- Give knowledge about cropping systems for different agro climatic conditions.
- Also get information about agroforestry concepts**.**

Theory

Section-A: Farming systems-introductions terms and definitions ; Concept and its role in sustainability of agriculture; Factor effecting choice of farming system; Resource management in relation to farm cropping system;

Section-B: Crop yield appraisals; Plant interaction, criteria for assessing yield advantages ;Indices for evaluating productivity and efficiency; Agronomic consideration interaction in sequential cropping ;

Section-C: Evaluation and productivity of multiple cropping systems; Cropping systems in dry land farming; Cropping systems for irrigated areas; Cropping systems in high rainfall areas;

Section-D: Cropping systems with perennials; Introduction to agro forestry concept; Physiological and actual maturity of crop and criteria of crop harvest; Comparison of chemical and organic farming;

Practical:

Visit to farming system and agro-based industries; Farm lay out plan, cropping scheme; Practical study of raising crops: Wheat, Rice, Maize Sugarcane, Groundnut, Toria, Gobi Sarson; Estimation of crop yield, calculation of harvest index, land equitant ratio in mixed crops/ intercrops.

Suggested Reading

1. Farming System and Sustainable Agriculture: SR Reddy
2. Cropping and Farming Systems (Pb) by Panda, S C, Agrobios
3. Cropping and Farming Systems Practices (First Edition) by Nasreen Akhter
4. Cropping Systems In The Tropics -Principles And Management by Dr. S P Palaniappan, Dr. K. Sivaraman, New Age International (P) Ltd., Publishers

Course outcomes:

Course Title: Farm Cropping System (Minor) **Course Code: AGR-523**

Sr. No.	On completing the course, the students will be able to:
CO1	To know about the different farming systems and cropping systems.
CO2	To learn about evaluation and productivity of multiple cropping systems.
CO3	Get knowledge about different agronomic crop yield appraisals and indices.
CO4	Comparison of chemical and organic farming.

SEMESTER-II

STA-524: Experimental Designs for Research Workers

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- randomization, replication and local control, uniformity trials- size and shape of plots and blocks, analysis of variance and interpretation of data.

Section-B: Completely randomized, randomized block and latin square design, multiple comparison tests, factorial experiments- interpretation of main effects and interactions,

Section-C: Orthogonality and partitioning of degrees of freedom confounding in 2^3 , 2^4 and3^3 designs, split and strip plot designs, crossover designs and balanced incomplete block designs, response surface designs, switch over trials and long term experiments;

Section-D: Selection of experimental design, mechanical errors in field experiments and methods of reducing it, presentation of research results.

Practical:

Uniformity trials, completely randomized, randomized block and latin square designs, missing plot and analysis, of covariance, 2^3, 2^4 and3^3 simple and confounded experiments, split and strip plot designs, cross over Uniformity trials, completely randomized, randomized block and latin square designs, missing plot and analysis, of covariance, 2^3, 2^4 and3^3 simple and confounded experiments, split and strip plot designs, cross over and balanced incomplete block 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 for Research Workers Course Code: STA-524

Sr. No.	On completing the course, the students will be able to:
CO1	The course Experimental Design for Research Workers enables students to learn about the formation of Experimental units, plots and blocks, random implementation of considered factors on experimental units, and the procurement of samples representing the whole experimental population.
CO2	The context of this course enables students to analyze agricultural experimental data such as to identify the factors effectively different in their effects.
CO3	Study of different layout of designs enable students to analyze data generated from various layouts of factors applied.
CO4	Also the topics taught to students in last section enable them to represent their results derived from research in technical and expressive way.

SEMESTER-II

***PGS-503 Agricultural Research and Publication Ethics**

Time: 3 Hours **Maximum Marks: 100**
Theory: 100
Credits 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 of 2 marks 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: Introduction to philosophy: definition, nature and scope, concept, branches. Ethics: definition, moral philosophy, nature of moral judgments and reactions.

Section-B: Publication ethics: definition, introduction and importance. Best practices/standards setting initiative and guidelines: COPE, WAME, etc. Conflicts of interest. Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice versa, type.

Section-C: Violation of publication ethics, authorship and contributor ship. Identification of publication misconduct, complaints and appeals. Predatory publishers and journals. Ethics with respect to science and research; Intellectual honesty and research integrity;

Section-D: Scientific misconduct: Falsification, Fabrication, and Plagiarism (FFP); Redundant publication: duplicate and overlapping publication, salami slicing; selective reporting and misrepresentation of data.

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 and publication ethics Course Code: PGS-503

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-600** **Masters' Research**

Credits hours: 4(0+4)

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 WileyInterscience.
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.
5. Air, Water and Soil pollution-Singh k.k., Juwarkar Asha, Singh A.K., Tomar Alka
6. Fundamentals of Soil Science -ISSS,New Delhi
7. Nature and properties of Soil Science-Nyle C Brady

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 Analytical Techniques and Instrumental Methods

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 15 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 (15).

Course objectives:

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

Theory:

Section-A: Atomic structure. Radioisotopes-properties and decay principles. Principles and use of radiation monitoring instruments.

Section-B: Isotopic dilution techniques. Doses of radiation exposure, radiation safety aspects. Storage and handling of radioactive materials.

Section-C: Principles of visible, ultraviolet and infrared spectrophotometery, inductively coupled plasma spectrometry,

Section-D: Chromatographic techniques, mass spectrometry and X-ray defractrometery.

Practical:

Oxidation-reduction and complexo- metric titration. Soil, water and plant sampling techniques, their processing and handling. Determination of nutrient potentials and potential buffering capacities of soils for P and K. Identification of minerals by different methods. Electrochemical titration of clay. Estimation of root CEC. Analysis of soil and plant samples for N, P, K, Ca, Mg, S, Zn, Cu, Fe, Mn, B and Mo. Analysis of plant materials by digesting plant material by wet and dry ashing and soil by wet digestion methods. Drawing normalized exchange isotherms. Measurement of redox potential. Preparation of soil and plant samples for radioactive measurements. Determination of half life and decay constant.

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 Course Code: SSC-532

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-III

SSC-533 Fertilizer Technology (Minor)

Time: 3 Hours **Max. 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 15 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 (15).

Course objectives:

- To impart knowledge about fertilizers, their manufacturing processes.
- This course also provides knowledge on classification of fertilizers, their properties and use.
- Students get knowledge about slow release fertilizers.

Theory:

Section-A: Fertilizer industry in India; Raw materials; Manufacture of different types of fertilizers including reactions and flow diagrams;

Section-B: Granulation, segregation, caking, drying and cooling of fertilizers;

Section-C: Complex, mixed, liquid, suspension and slow release fertilizers;

Section-D: Production of fertilizers containing secondary and micronutrients; changing trends in fertilizer technology.

Practical:

Collection of soil and fertilizer samples; Preparation of standard solutions. Colorimetric and flame photometric methods; Analysis of soil for fertilizer recommendations and suitability for orchard plantation; Gypsum and lime requirements of soil; Analysis of fertilizer for quality control; Planning and formulation of project on establishment of soil and fertilizer testing laboratories. Visit to fertilizer factories.

Suggested Reading

1. Fertilizer Technology and Management by Brahma Mishra, Wiley India: Brahma Mishra
2. Fertilizers Manufacturing Handbook
3. Textbook of Fertilizers by Biswas Dipak Ranjan, New India Publishing Agency
4. Fertilizers: A Text Book by Ranjan Kumar Basak
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.
Tandon HLS. 1993. Methods of Analysis of Soils, Fertilizers and Waters. FDCO, New

Course outcomes:

Course Title: Fertilizer Technology (Minor) **Course Code: SSC-533**

Sr. No.	On completing the course, the students will be able to:
CO1	To know about the fertilizers and soil fertility management.
CO2	Gain knowledge about the composition of different fertilizers.
CO3	Help to learn about industrial preparation of various fertilizers and changing trends in fertilizer industry.

SEMESTER-III

AGM-533 Fundamentals of Agroclimatology (Minor)

Time: 3 Hours **Max. 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 15 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 (15).

Course objectives:

- To impart knowledge about atmosphere, various meteorological processes
- This course also familiarizes students with climate, its various processes and their influence on plants, animals and pests.
- To learn about agro climatic classification w.r.t crop production.

Theory:

Section-A: Survey of the atmosphere; introduction to basic meteorological processes; nature, receipt and disposal of solar radiation;

Section-B: Atmospheric humidity and forms condensation; Evaporation and evapotranspiration; Winds, air masses and disturbance;

Section-C: Influence of climate on plants, animals and pests; Meterological droughts; indices in agroclimatology;

Section-D: Agroclimatic classifications and their application; field climate modification.

Practical:

Meteorological instruments and their use in the measurement of agroclimatic environment; Measurement of field climate; Computation of agroclimatic indices-GDD, PTU, PET etc; Determining crop production sensitivity to weather.

Suggested Reading

1.Ahrens. 2008. *Meteorology today*, 9th Edition. Wadsworth Publishing Co Inc.
2.Barry RG and Richard JC. 2003. *Atmosphere, Weather and Climate*. Tailor & Fransics Group.
3.Bishnoi OP. 2007. *Principles of Agricultural Meteorology*. Oxford Book Co.
4.Ghadekar SR. 2001. *Meteorology*. Agromet Publishers (Nagpur).
5.Ghadekar SR. 2002. *Practical Meteorology*. Agromet Publishers (Nagpur).
6.Mcllveen R. 1992. *Fundamentals of Weather and Climate*. Chapman & Hall.

7.Petterson S. 1958. *Introduction to Meteorology*. McGraw Hill.
8.Trewartha Glenn T. 1954. *An Introduction to Climate*. McGraw Hill.
9.Varshneya MC and Pillai PB. 2003. *Text Book of Agricultural Meteorology*. ICAR.

Course outcomes:

Course Title: Fundamentals of Agroclimatology (Minor) **Course Code: AGM-533**

Sr. No.	**On completing the course, the students will be able to:**
CO1	To know about atmosphere and different processes like air humidity, condensation, evaporation etc.
CO2	Studies effect of climate on plants, humans and pests.
CO3	To learn about field modification of climate
CO4	To gain knowledge about the impact of climate on crop production, plant disease and pest.

SEMESTER-III

BOT-533 Physiology of Growth and Development (Minor)

Time: 3 Hours **Max. 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 15 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 (15).

Course objectives:

- To learn about the growth and development factors of different crops.
- To provide knowledge on hormones and growth regulators
- Learn how the physiology of plants are related to agriculture.

Theory:

Concepts of growth, differentiation and pattern formation; growth curves, meristems, growth kinetics, factors affecting growth and general aspects of development, level of differentiation, control of development at genetic level. Hormones and growth regulators - auxins, gibberellins, cytokinins, ethylene, ABA, other inhibitors, retardants, polyamines, aliphatic alcohols, brassins, hormonal regulation of growth and development, plant movements; photoperiodism, phytochrome, flowering hormones, vernalization, abscission, ageing, senescence; physiology of seed and fruit development; seed germination; seed and bud dormancy. Plant physiology and agriculture.

Practical:

Experiments on growth measurements, hormonal bioassays, plant movements; experiments on quality of light on seed germination, breaking of dormancy. Experiments on photoperiodism. Experiments on hormonal regulation of development.

Suggested Reading

1. Fundamentals of Plant Physiology, 20th Edition by V.K. Jain
2. Fundamentals of Plant Physiology by V.K. Jain
3. Plant Growth and Development by Nautiyal, Medtech
4. Plant Physiology, 4th Edition by S.N. Pandey.

Course outcomes

Course Title: Physiology of Growth and Development (Minor) Course Code: BOT-533

Sr. No.	On completing the course, the students will be able to:
CO1	To know about the growth and various factors affecting growth.
CO2	Gain knowledge about the various hormones and growth regulators, their functions and effects on plant metabolism.

SEMESTER-III

SSC-591 **Credit Seminar**

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

SEMESTER-III

***PGS-504 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. 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:

1. To equip students with knowledge of Intellectual Property Rights (IPR) related protection systems, their significance.
2. 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 DevelopingCountries: A Compendium on Law and Policies. Daya Publ. House.

Course Outcomes

Course Title: Intellectual Property & its Management in Agriculture Course Code: PGS 504

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-600** **Masters' Research**

Credits hours: 6(0+6)

S/US

SEMESTER-IV

SSC-541 Management of Problem Soils and Water

Time: 3 Hours **Max. 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. 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 knowledge on problematic soils, their characterization, distribution and area
- Learn how problematic soils affect soil properties and plant growth.
- Students should learn to manage the problematic soils and their reclaiming for proper crop production and other uses.
- To know about the quality of irrigation water, and cropping patterns for its utilization.

Theory:

Section-A: Area, distribution, origin and basic concepts of problematic soils. Morphological features and characterization of salt-affected soils. Management of salt- affected soils. Salt tolerance of crops - mechanism and ratings. Monitoring of soil salinity in the field.

Section-B: Management principles for sandy, clayey, red lateritic and dry land soils. Acid soils - nature, sources, management and effect on plant growth. Lime requirement of acid soils.

Section-C: Biological sickness of soils and its management. Quality of irrigation water, management of brackish water

Section-D: Salt balance under irrigation. Characterization of brackish waters, area and extent. Agronomic practices in relation to problematic soils. Cropping pattern for utilizing poor quality ground waters.

Practical:

Characterization of acid, acid sulfate, salt- affected and calcareous soils. Determination ofcations [(Na+, K+, Ca++, and Mg++)] in ground water and soil samples. Determination of anions [(CI-, SO4 2-, CO3 2- and HCO3-)] in ground waters and soil samples. Lime and gypsum requirement of acid and sodic soil.

Suggested Readings

1. Bear FE. 1964. *Chemistry of the Soil*. Oxford & IBH.
2. Jurinak JJ. 1978. *Salt-affected Soils*. Department of Soil Science & Biometeorology. Utah
3. State University
4. USDA Handbook No. 60. 1954. *Diagnosis and improvement of Saline and Alkali Soils*. Oxford & IBH.

Course outcomes:

Course Title: Management of Problem Soils and Water **Course Code: SSC-541**

Sr. No.	On completing the course, the students will be able to:
CO1	To know about problematic soils in India.
CO2	Gain knowledge about the composition of different manures and fertilizers.
CO3	Help to learn about different nutrient transformations.
CO4	Help to get information about different problematic soils in various states of India and their characteristics features as well as to know about various reclaiming processes.

SEMESTER-IV

SSC-542 **Soil Chemistry**

Time: 3 Hours **Max. 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 15 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 (15).

Course objectives

1. To provide knowledge on chemical composition of earth crust and about electro chemistry in soil.
2. Learn about the different types of colloids, their properties and how they effect soil properties and plant growth.
3. Students should learn about the fractionations of organic matter, cation exchange theories, and equilibrium concept, thermodynamics and characters of various oxyanions and anions.
4. To know about nutrient fixation and their processes.
5. To deliver knowledge regarding chemistry of problematic soils and their management.

Theory:

Section-A: Chemical composition of earth's crust and soils. Elements of equilibrium thermodynamics, chemical equilibria, electrochemistry and chemical kinetics.

Section-B: Inorganic and organic colloids-surface charge characteristics, diffuse double layer theories, zeta potential stability, coagulation/ flocculation, peptization, electrometric and sorption properties of soil colloid.

Section-C: Soil organic matter-fractionation, clay-organic interactions. Cation exchange-theories, adsorption isotherms, Donnan-membrane equilibrium concept, clay-membrane electrodes and ionic activity measurement, thermodynamics, anion and ligand exchange inner sphere and outer-sphere surface complex formation, fixation of oxyanions, hysteresis in sorption-desorption of oxy-anions and anions.

Section-D: Experimental methods to study ion exchange phenomena and practical implications in plant nutrition. Potassium, phosphate and ammonium fixation in soils and management aspects. Chemistry of acid, salt-affected and submerged soils and management aspects.

Practical:

Analysis of equilibrium soil solution for electrochemical properties. Determination of point of zero-charge and associated surface charge characteristics. Potentiometric and conductometric titration of soil humic and fulvic acids. E4/E6 ratio of soil humic and fulvic acids. Adsorption-desorption of phosphate/ sulphate. Construction of adsorption envelop 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.

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-542**

Sr. No.	**On completing the course, the students will be able to:**
CO1	To know about earth crust's composition and electrochemistry in soil.
CO2	Help to learn about colloids, its types and their various properties in detail.
CO3	To acquire information about soil organic matter, its fractionations, related theories and isotherms, sorption-desorption hysteresis of oxyanions and anions.
CO4	To get knowledge about management of problematic soils and nutrient fixations along with their effect on plant growth.

SEMESTER-IV

***PGS-505 Disaster Management**

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 15 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 (15).

Course objectives:

- To impart knowledge about natural and man-made disasters.
- To impart knowledge about different management strategies during disasters

Theory

Section-A: Definition and types of disaster Hazards and Disasters, Risk and Vulnerability in disasters, Natural and Man-made disasters, earthquakes, floods drought, landslide, land subsidence, cyclones, volcanoes, tsunami, avalanches, global climate extremes. Man-made disasters: terrorism, gas and radiations leaks, toxic waste disposal, oil spills, forest fires.

Section-B: Study of Important disasters

Earthquakes and its types, magnitude and intensity, seismic zones of India, major fault systems of India plate, flood types and its management, drought types and its management, landslides and its managements case studies of disasters in Sikkim (e.g. Earthquakes, Landslide). Social, Economics and Environmental impact of disasters.

Section-C: Mitigation and Management techniques of disasters

Basic principles of disaster management, Disaster Management cycle, Disaster Management policy, National and State bodies for disaster management, Early Warming Systems, Building design and construction in highly seismic zones, retrofitting of buildings.

Section-D: Training, awareness program and project on disaster management

Training and drills for disaster preparedness, Awareness generation program, Usages of GIS and Remote sensing techniques in disaster management, Mini project on disaster risk assessment and preparedness for disasters with reference to disasters in Sikkim and its surrounding areas.

Course Outcomes
Course Title: Disaster Management **Course Code: PGS-505**

Sr. No.	On completing the course, the students will be able to:
CO1	Study the different hazards, disasters, risk and vulnerability during disasters,
CO2	mitigation and management techniques of different natural and man-made hazards
CO3	training and awareness programs to control the risk of different kind of hazards
CO4	use of remote sensing tools for risk assessments and preparedness

SEMESTER-IV

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

Credits hours: 6 (0+6)

S/US