POST GRADUATE DEPARTMENT OF AGRICULTURE

SYLLABUS FOR THE BATCH FROM THE YEAR 2024 TO YEAR 2026

Programme Code: MAGR

Programme Name: M.Sc. Ag. (Agronomy)

(Semester I- II)

Examinations:2024-25

Khalsa College, Amritsar

Programme objectives:-

1. To acquaint students with field crops, water and soil management on a sustainable basis.
2. To acquaint students with the changing environment and adjust the production system accordingly.
3. To familiarize students with problems in the production system and their scientific solutions.
4. To familiarize students with the latest advance in the research and its application in crop production.

M.SC. AG. (AGRONOMY)
Program Specific Outcomes (PSOs) & COURSE OUTCOMES (COs)

PROGRAMME SPECIFIC OUTCOMES

PSO-1	To acquaint students with production technology i.e. sowing time, sowing method, seed treatment, nutrient management, weed management and water management of field crops.
PSO-2	To study recent updates in resource conservation. i.e. crop residue, water and soil, cropping and farming systems.
PSO-3	To acquire knowledge about the package of production for organic, sustainable, Integrated farming systems, precision farming and the certification of farm.
PSO-4	To understand biotic and abiotic stresses; dryland agriculture, moisture conservation techniques, water harvesting, climate change and the concept of ideal plant type
PSO-5	To understand the concepts of statistical methods and statistical inference that would help in understanding the importance of statistics. .
PSO-6.	To get knowledge of fertilizers and manures as sources of plant nutrients and apprise about the integrated approach of plant nutrition and sustainability of soil fertility.
PSO-7	To understand the characteristics of Indian monsoon, rainfall distribution, problematic soils and their management.
PSO-8	To familiarize students with the weeds, herbicides and methods of weed control.
PSO-9	To study crop husbandry of oilseed, pulses, fiber, sugar crops, fodder crops
PSO-10	To provide information about how to collect material related to research, how to write thesis, use scientific language in thesis, and publish the research papers in different journals.

SEMESTER–I

Course Code	Course Title	Credit hours	Marks	Total Marks	Page Number
			Theory + Practical + I. Assessment		
AGR-511	Modern Concepts in Crop Production	3(3+0)	75+0+25	100	7-8
AGR- 512	Principles and Practices of Weed Management	3(2+1)	50+25+25	100	9-10
SSC-531	Soil, Water and Air Pollution	3(2+1)	50+25+25	100	11-12
STAT-511	Statistical Methods for Applied Sciences/Social Science	4(3+1)	57 + 18 +25	100	13-14
*PGS-511	Technical Writing & Communications Skills	1(0+1)	100 (Pr)	100	15-16
*PGS-512	Library & Information Services	1(0+1)	100 (Pr)	100	17
*AGR-599	Masters' Research	5(0+5)	--	S/US	18
Total		**20(13+7*)**			

* Non-credit course.
Total Internal Assessment = 25 marks (Mid Semester Test - 10; Attendance - 10; Conduct & Academic, Extra Curricular Activities – 5 Marks)

SEMESTER–II

Course Code	Course Title	Credit hours	Marks	Total Marks	Page Number
			Theory + Practical + I. Assessment		
AGR-521	Cropping Systems and Sustainable Agriculture	2(2+0)	75+0+25	100	19-20
AGR- 522	Principles and Practices of Water Management	3(2+1)	50+25+25	100	21-23
AGR-523	Conservation Agriculture	2(1+1)	38+37+25	100	24-25
SSC-522 (Minor)	Analytical technique and instrumental methods in soil and plant analysis	2(0+2)	0+75+25	100	26-27
STAT-521	Experimental Designs	3(2+1)	50 + 25 +25	100	28-29
*PGS-521	Agricultural Research, Research Ethics and Rural Development Programmes	1(1+0)	100 (Th)	100	30-31
*AGR-599	Masters' Research	5(0+5)		S/US	32
Total		**18 (12+6*)**			

* Non-credit course.

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

SEMESTER-III

Course Code	Course Title	Credit hours	Marks	Total Marks	Page Number
			Theory + Practical + I. Assessment		
AGR-531	Agronomy of Major Cereals and Pulses	3(2+1)	50+25+25	100	33-34
AGR-532	Principles and Practices of Organic Farming	3(2+1)	50+25+25	100	35-36
AGM-531 (Minor)	Fundamentals of Agricultural Meteorology	3(2+1)	50+25+25	100	37-38
AGR-591	Credit Seminar	1(0+1)	100	100	39
*PGS-531	Intellectual Property & its management in Agriculture	1(1+0)	100(Th)	100	40-41
*AGR-599	Masters' Research	10(0+10)	--	S/US	42
Total		**21(10+11*)**			

* Non-credit course.
Total Internal Assessment = 25 marks (Mid Semester Test - 10; Attendance - 10; Conduct & Academic, Extra Curricular Activities – 5 Marks)

SEMESTER-IV

Course Code	Course Title	Credit hours	Marks	Total Marks	Page Number
			Theory + Practical + I. Assessment		
AGR-541	Principles and practices of soil fertility and nutrient management	3(2+1)	50+25+25	100	43-44
*PGS-541	Basic concepts in Laboratory Techniques	1(0+1)	100 (Pr)	100	45
*AGR-599	Masters' Research	10(0+10)	--	S/US	46
Total		**14(3+11*)**			

* Non-credit course.
Total Internal Assessment = 25 marks (Mid Semester Test - 10; Attendance - 10; Conduct & Academic, Extra Curricular Activities – 5 Marks)

SEMESTER-I

AGR-511: Modern Concepts in Crop Production

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

Theory: 75

Internal assessment: 25

Credit hours: 3(3+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:

1. To study relationship of environmental factors with growth and development in crops.
2. To understand physiology of yield in relation to biotic and abiotic environment.
3. Basic concepts of crop Ideotypes for maximizing crop yield.
4. To know modern concepts in farming for efficient use of resources.

Theory

Section-A: Crop growth analysis in relation to environment, agro-ecological zones of India. Quantitative agro-biological principles and inverse yield nitrogen law; Mitscherlich yield equation its interpretation and applicability; Baule unit.

Section-B: Effect of lodging in cereals; physiology of grain yield in cereals; optimization of plant population and planting geometry in relation to different resources, concept of ideal plant type and crop modeling for desired crop yield.

Section-C: Scientific principles of crop production; crop response production functions; concept of soil plant relations; yield and environmental stress. Integrated farming systems, organic farming, and resource conservation technology including modern concept of tillage; dry farming; determining the nutrient needs for yield potentiality of crop plants

Section-D:, concept of balance nutrition and integrated nutrient management; precision agriculture. Modern crop production concepts: soil less cultivation, Aeroponic, Hydroponic, Robotic and terrace farming. use of GIS, GPS and remote sensing in modern agriculture, precision farming and protected agriculture.

VIII. Suggested Reading

• Balasubramaniyan P and Palaniappan SP. 2001. *Principles and Practices of Agronomy.*

Agrobios.

• Fageria NK. 1992. *Maximizing Crop Yields*. Marcel Dekker.

• Havlin JL, Beaton JD, Tisdale SL and Nelson WL. 2006. *Soil Fertility and Fertilizers.* 7thEd. Prentice Hall.

• Paroda R.S. 2003. *Sustaining our Food Security*. Konark Publ.

• Reddy SR. 2000. *Principles of Crop Production*. Kalyani Publ.

• Sankaran S and Mudaliar TVS. 1997. *Principles of Agronomy*. The Bangalore Printing & Publ.

• Singh SS. 2006. *Principles and Practices of Agronomy*. Kalyani.

• Alvin PT and kozlowski TT (ed.). 1976. *Ecophysiology of Tropical Crops*. Academia Pul., New York.

• Gardner PP, Pearce GR and Mitchell RL. 1985. *Physiology of Crop Plants*. Scientific Pub. Jodhpur.

• Lal R. 1989. *Conservation tillage for sustainable agriculture: Tropics versus Temperate Environments. Advances in Agronomy* 42: 85-197.

• Wilsie CP. 1961. *Crop Adaptation and Distribution*. Euresia Pub., New Delhi.

Course outcomes:

Course Title: Modern Concepts in Crop Production Course Code: AGR-511

Sr. No.	On completing the course, the students will be able to:
CO1	Understand the advanced concepts of crop growth and productivity in relation to climate change.
CO2	Acquire knowledge on modern concepts in tillage and farm mechanization.
CO3	Gain knowledge on the principles and components of organic farming and resource conservation technology.
CO4	Gain knowledge on ideal plant ideotypes and yield maximization

SEMESTER-I

AGR-512: Principles and Practices of Weed Management

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 objectives:

- To understand importance of weed biology and weed ecology in weed management.
- Classification of weeds, different methods of weed control and weed indices
- Classification of herbicide, formulations, mixtures, resistance and its management
- To understand concept of Integrated weed management bio-herbicides, mycoherbicides and allelopathy in weed management
- Weed management in different crops and their economic study.

Theory:

Section-A: Weed biology and ecology, crop-weed competition including allelopathy; principles and methods of weed control and classification classification management; weed indices, weed shift in different eco-systems

Section-B: Herbicides introduction and history of their development; classification based on chemical, physiological application and selectivity; mode and mechanism of action of herbicides.

Section-C: Herbicide structure activity relationship; factors affecting the efficiency of herbicides; herbicide formulations, herbicide mixtures; sequential application of herbicides, rotation; weed control through use of nano-herbicides and bio-herbicides, myco-herbicides bio-agents, and allelochemicals; movement of herbicides in soil and plant, Degradation of herbicides in soil and plants; herbicide resistance, residue, persistence and management; development of herbicide resistance in weeds and crops and their management, herbicide combination and rotation.

Section-D: Weed management in major crops and cropping systems; alien, invasive and parasitic weeds and their management; weed shifts in cropping systems; aquatic and perennial weed control; weed control in non-crop area. Integrated weed management; recent development in weed

management- robotics, use of drones and aeroplanes, organic etc., cost: benefit analysis of weed management.

Practical

Identification of important weeds of different crops, Preparation of a weed herbarium, Weed survey in crops and cropping systems, Crop-weed competition studies, Weed indices calculation and interpretation with data, Preparation of spray solutions of herbicides for high and low-volume sprayers, Use of various types of spray pumps and nozzles and calculation of swath width, Economics of weed control, Herbicide resistance analysis in plant and soil, Bioassay of herbicide resistance residues, Calculation of herbicidal herbicide requirement

Suggested Reading

• Böger, Peter, Wakabayashi, Ko, Hirai, Kenji (Eds.). 2002. *Herbicide Classes in Development*.

Mode of Action, *Targets*, *Genetic Engineering*, *Chemistry*. Springer.

• Chauhan B and Mahajan G. 2014. *Recent Advances in Weed Management*. Springer.

• Das TK. 2008. *Weed Science: Basics and Applications*, Jain Brothers (New Delhi).

• Fennimore, Steven A and Bell, Carl. 2014. *Principles of Weed Control*, 4th Ed, California

Weed Sci. Soc.

• Gupta OP. 2007. *Weed Management*: *Principles and Practices*, 2nd Ed.

• Jugulan, Mithila (ed). 2017. *Biology, Physiology and Molecular Biology of Weeds*. CRC Press

• Monaco TJ, Weller SC and Ashton FM. 2014. *Weed Science Principles and Practices*, Wiley

• Powles SB and Shaner DL. 2001. Herbicide Resistance and World Grains, CRC Press.

• Walia US. 2006. *Weed Management*, Kalyani.

• Zimdahl RL. (ed). 2018. *Integrated Weed Management for Sustainable Agriculture, B. D.*

Course Title: Principles and Practices of Weed Management Course Code: AGR-521

Sr. No.	On completing the course, the students will be able to:
CO1	Get knowledge on weed biology and survey weeds in varied ecosystem.
CO2	Identify the nature, types and economic uses of weeds in varied habitats.
CO3	Gain knowledge on herbicide application techniques
CO4	Formulate integrated weed management practices for different ecosystems

SEMESTER-I

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:

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 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 ammoniacal nitrogen and phosphorus, heavy metal content in effluents, Heavy metals in contaminated soils and plants, Management of contaminants in soil and plants to safe guard food safety, Air sampling and determination of particulate matter and oxides of sulphur, NO2 and O2 conc. Visit to various industrial sites to study the impact of pollutants on soil and plants.

Suggested Reading

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:**
O1	To know about the different kind of soil pollution, their sources and effluents
O2	Gain knowledge about CPC standards
O3	Help to learn about remote sensing and its use in management of soil pollution.

SEMESTER-I

STAT-511 Statistical Methods for Applied Sciences/ Social science

Time: 3 Hours **Credit Hours: 4(3+1)**

Max. Marks:100

Theory: 57

Practical: 18

Internal assessment: 25

Instructions for the Paper Setter

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:

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

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 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 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:

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

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

Course Title: Technical writing & communication skills , library & information services
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 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; 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 Outcome:

The student will be able to:

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

***AGR-599** **Masters' Research**

S/US

Credits hours:5(0+5) SEMESTER-II

SEMESTER-II

AGR-521: Cropping Systems and Sustainable Agriculture

Time: 3 Hours **Maximum marks: 100**
Theory: 75
Internal assessment =25
Credit hours per week: 2(2+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 of10 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 to the students on the fundamentals of farming systems and sustainable agriculture
- To study the various components of organic agriculture

Theory

Section-A: Cropping systems: definition, indices and its importance; physical resources, soil and water management in cropping systems; assessment of land use. Concept of sustainability in cropping systems and farming systems, scope and objectives;

Section-B: Production potential under monoculture cropping, multiple cropping, alley cropping, sequential cropping and intercropping, mechanism of yield advantage in intercropping systems. Above and below ground interactions and allelopathic effects; competition relations; multi-storied cropping and yield stability in intercropping,

Section-C: Role of non-monetary inputs and low cost technologies; research need on sustainable agriculture. Crop diversification for sustainability; role of organic matter in maintenance of soil fertility; crop residue management;

Section-D: fertilizer use efficiency and concept of fertilizer use in intensive cropping system. Plant ideotypes for drylands; plant growth regulators and their role in sustainability. Artificial Intelligence- Concept and application.

Suggested Reading

• Panda SC. 2017. *Cropping Systems and Sustainable Agriculture*. Agrobios (India)

• Panda SC. 2018. *Cropping and Farming Systems*. Agrobios.

• Palaniappan SP and Sivaraman K. 1996. *Cropping Systems in the Tropics; Principles and Management.* New Age.

• Panda SC. 2003. *Cropping and Farming Systems*. Agrobios.

• Reddy SR. 2000. *Principles of Crop Production*. Kalyani.

• Sankaran S and Mudaliar TVS. 1997. *Principles of Agronomy.* The Bangalore Printing & Publ. Co.

• Singh SS. 2006. *Principles and Practices of Agronomy*. Kalyani.

• Tisdale SL, Nelson WL, Beaton JD and Havlin JL. 1997. *Soil Fertility and Fertilizers*. Prentice Hall.

Course Title: Cropping Systems and Sustainable Agriculture Course Code: AGR-512

Sr. No.	On completing the course, the students will be able to:
CO1	Prepare cropping schemes, evaluate cropping system and workout input requirements for crops.
CO2	Understand interaction between different farm enterprises.
CO3	Prepare integrated farming system models for different eco systems.
CO4	Gain knowledge about drought mitigation strategies
CO5	Evaluate different resource management techniques in the conservation agriculture.

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. 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 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; rain water 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

• Majumdar DK. 2014. *Irrigation Water Management: Principles and Practice*. PHL Learning private publishers

• Mukund Joshi. 2013. *A Text Book of Irrigation and Water Management Hardcover*, Kalyani publishers

• Lenka D. 1999. *Irrigation and Drainage*. Kalyani.

• Michael AM. 1978. *Irrigation: Theory and Practice*. Vikas Publ.

• Paliwal KV. 1972. *Irrigation with Saline Water*. IARI Monograph, New Delhi.

• Panda SC. 2003. *Principles and Practices of Water Management*. Agrobios.

• Prihar SS and Sandhu BS. 1987. *Irrigation of Food Crops - Principles and Practices*. ICAR.

• Reddy SR. 2000. *Principles of Crop Production*. Kalyani.

• Singh Pratap and Maliwal PL. 2005. *Technologies for Food Security and Sustainable Agriculture*. Agrotech Publ.

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

AGR-523: Conservation Agriculture

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

Theory: 38

Practical: 37

Internal assessment: 25

Credit hours per week: 2(1+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 (7).

Course objectives:

- To impart knowledge of conservation of agriculture for economic development.
- To impart the knowledge of management practices in conservation agriculture.

Theory

Section-A Conventional and conservation agriculture systems, sustainability concerns, conservation agriculture: Historical background and present concept, global experiences, present status in India.

Section-B Nutrient management in CA, water management, weed management, energy use, insect-pest and disease management, farm machinery, crop residue management, cover crop management.

Section-C Climate change mitigation and CA, C-sequestration, soil health management, soil microbes and CA

Section-D CA in agroforestry systems, rainfed / dryland regions. Economic considerations in CA, adoption and constraints, CA: The future of agriculture

Practicals

Study of long-term experiments on CA. Evaluation of soil health parameters. Estimation of C-sequestration, Machinery calibration for sowing different crops, weed seedbank estimation under CA, energy requirements, economic analysis of CA.

Suggested Reading

• Arakeri HR and Roy D. 1984. Principles of Soil Conservation and Water Management. Oxford & IBH.

• Bisht JK, Meena VS, Mishra PK and Pattanayak A. 2016. Conservation Agriculture-An approach to combat climate change in Indian Himalaya. Publisher: Springer Nature. Doi: 10/1007/978-981-10-2558-7.

• Dhruvanarayana VV. 1993. Soil and Water Conservation Research in India. ICAR.

• FAO. 2004. Soil and Water Conservation in Semi-Arid Areas. Soils Bull., Paper 57.

• Gracia-Torres L, Benites J, Martinez-Vilela A and Holgado-Cabera A. 2003. Conservation

Agriculture- Environment Farmers experiences, innovations Socio-economic policy.

• Muhammad F and Kamdambot HMS. 2014. Conservation Agriculture. Publisher: Springer Cham Heidelberg, New Yaork Dordrecht London. Doi: 10.1007/978-3-319-11620-4

. • Yellamanda Reddy T and Sankara Reddy GH. 1992. Principles of Agronomy. Kalyani

Course Title: Conservation Agriculture **Course Code: AGR-522**

Sr. No.	On completing the course, the students will be able to:
CO1	Understand the principles involved in conservation agriculture
CO2	Gain knowledge on various resource conservation technologies
CO3	Acquire knowledge on management practices under various situations

SEMESTER-II

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

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. 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 objective:

- The students are expected to gain theoretical as well as practical knowledge on analytical techniques and instrumental methods used soil and plant analysis.

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 defractrometery; 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 Readings

- Hesse P. 971. *Textbook of Soil Chemical Analysis*. William Clowes & Sons.
- Jackson ML. 1967. *Soil Chemical Analysis*. Prentice Hall of India.
- Keith A Smith 1991. *Soil Analysis; Modern Instrumental Techniques*. Marcel Dekker.
- Kenneth Helrich 1990. *Official Methods of Analysis*. Association of Official Analytical Chemists.
- Page AL, Miller RH and Keeney DR. 1982. *Methods of Soil Analysis*. Part II. SSSA, Madison.
- Piper CE. *Soil and Plant Analysis*. Hans Publ.
- Singh D, Chhonkar PK and Pandey RN. 1999. *Soil Plant Water Analysis - A Methods Manual*. IARI, New Delhi.
- Tan KH. 2003. *Soil Sampling, Preparation and Analysis*. CRC Press/Taylor & Francis.
- Tandon HLS. 1993. *Methods of Analysis of Soils, Fertilizers and Wat*ers. FDCO, New Delhi.
- Vogel AL. 1979. *A Textbook of Quantitative Inorganic Analysis*. ELBS Longman.

Course Title: Analytical Technique and Instrumental Methods in Soil and Plant Analysis (Minor) **Course Code: SSC-522**

Sr. No.	On completing the course, the students will be able to:
CO1	get experience on advanced analytical and instrumentation methods in the estimation of soil, water, fertilizer and agricultural chemicals.
CO2	gain knowledge on various methods of sample collection.
CO4	understand working of various automatic analyzers
CO5	analyse nutrient availability in soil, plants and 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:

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

Course Title: Experimental Designs **Course Code: STA-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:

- Bhalla GS and Singh G. 2001. Indian Agriculture - Four Decades of Development. Sage Publ.

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

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	IIdentify the publication misconduct, scientific misconduct, complaints and appeals

SEMESTER-II

***AGR-599** **Masters' Research**

S/US

Credits hours: 5(0+5)

SEMESTER-III

AGR-531: Agronomy of Major Cereals and Pulses
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. 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:

- To know about the origin, history, growing areas, climatic requirement, Taxonomy and classification, morphology, physiology of *Kharif* and *Rabi* crops
- To study about the phenology, varieties, cropping systems and production technology of *Kharif* and *Rabi* crops at regional and national level
- To know about the quality parameters, post-harvest handling, and industrial use of the main and by products

V. Theory

Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition, quality components, handling and processing of the produce for maximum production of:
Section A: *Rabi* cereals. Wheat, Barley, Oats,
Section B: *Kharif* cereals. Rice, Maize,
Section C: *Rabi* pulses. Gram, Pea, Lentil, Summer Moong, Summer Mash, French bean,
Section D: *Kharif* pulses Moong, Mash, Arhar, Soybean, Cowpea, Moth bean

Practical

Phenological studies at different growth stages of crop • Estimation of crop yield on the basis of yield attributes. Formulation of cropping schemes for various farm sizes and calculation of cropping and rotational intensities. Working out growth indices (CGR, RGR, NAR, LAI, LAD, LAR, LWR, SLA, SLW etc). Assessment of land use and yield advantage (Rotational intensity, Cropping intensity, Diversity Index, Sustainable Yield Index Crop Equivalent Yield, Land Equivalent ration, Aggressiveness, Relative Crowding Coefficient, Competition Ratio and ATER etc). Estimation of protein content in pulses. Planning and layout of field experiments. Judging of physiological maturity in different crops. Intercultural operations in different crops.

Determination of cost of cultivation of different crops. Working out harvest index of various crops. Study of seed production techniques in selected crops. Visit of field experiments on cultural, fertilizer, weed control and water management aspects. Visit to nearby villages for identification of constraints in crop production

IX. Suggested Reading

- Das NR. 2007. Introduction to Crops of India. Scientific Publ.
- Hunsigi G and Krishna KR. 1998. Science of Field Crop Production. Oxford & IBH.
- Jeswani LM and Baldev B. 1997. Advances in Pulse Production Technology.ICAR.
- Khare D and Bhale MS. 2000. Seed Technology. Scientific Publ.
- Kumar Ranjeet and Singh NP. 2003. Maize Production in India: Golden Grain in Transition. IARI, New Delhi.
- Pal M, Deka J and Rai RK. 1996. Fundamentals of Cereal Crop Production.Tata McGraw Hill.
- Prasad Rajendra. 2002. Text Book of Field Crop Production. ICAR.
- Singh C, Singh P and Singh R. 2003. Modern Techniques of Raising Field Crops. Oxford & IBH.
- Singh SS. 1998. Crop Management. Kalyani.
- Yadav DS. 1992. Pulse Crops. Kalyani.

Course Title: Agronomy of Major Cereals and Pulses Course Code: AGR-531

Sr. No.	On completing the course, the students will be able to:
CO1	Get knowledge on the staple food crops and their cultivation practices with post harvest technologies
CO2	Assess the nature of the farm site and develop a new cropping system with the available resources
CO3	Understand recent crop management practices on crop productivity and resource use efficiency.
CO4	Gain knowledge on the recent trends in the cultivation of crops
CO5	Develop post harvest management practices and value addition.

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: 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 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:

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

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

AGM-531: Fundamentals of Agricultural Meteorology

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 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 understand the concepts and nature of atmosphere as well as solar radiations
- To study the different meteorological variables and their impact on plants as well as animals.

Theory

Section-A: Meaning and scope of agricultural meteorology; components of agricultural meteorology; role and responsibilities of agricultural meteorologists. Importance of meteorological parameters in agriculture; efficiency of solar energy conversion into dry matter production; meteorological factors in photosynthesis, respiration and net assimilation;

Section-B: basic principles of water balance in ecosystems; soil-water balance models and water production functions. Crop weather calendars; weather forecasts for agriculture at short, medium and long range levels; agromet advisories, preparation, dissemination and economic impact analysis.

Section-C: Use of satellite imageries in weather forecasting; synoptic charts and synoptic approach to weather forecasting Concept, definition, types of drought and their causes; prediction of drought; crop water stress index, crop stress detection; air pollution and its influence on vegetation, meteorological aspects of forest fires and their control.

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

Practical

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

Suggested Reading

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

Course Title: Fundamentals of Agricultural Meteorology Course Code: AGM 531

Sr. No.	On completing the course, the students will be able to:
CO1	Acquire knowledge on agro meteorology and its different variables affecting crop production
CO2	Understand the concept of onset and withdrawal of monsoon in relation to crop production
CO3	Gain knowledge on evapotranspiration and its effect on crop production
CO4	Understand weather forecasting and the impact of weather in relation to pest and disease management
CO5	Design crop weather calendar for various agro climatic zones

SEMESTER-III

AGR-591 **CREDIT SEMINAR**

Total Marks: 100
Credits per week: 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. 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:

- 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:

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

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

***AGR-599** **Masters' Research**

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

SEMESTER-IV

AGR-541: Principal and Practices of Soil Fertility and Nutrient

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:

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 the first question of 10 marks (Comprising of10 short answer type questions covering the whole syllabus) will be compulsory.
8. 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 objectives:

- To impart knowledge about Nutrients, fertilizers and their application.
- This course also provides knowledge about organic manures, composition, response, residual effects and use.
- To impart knowledge about INM and their economics.

Theory

Section-A: Soil fertility and productivity - factors affecting; features of good soil management; problems of supply and availability of nutrients; relation between nutrient supply and crop growth; organic farming - basic concepts and definitions.

Section-B: Criteria of essentiality of nutrients; Essential plant nutrients – their functions, nutrient deficiency symptoms; transformation and dynamics of major plant nutrients. Preparation and use of farmyard manure, compost, green manures, vermicompost, biofertilizers and other organic concentrates their composition, availability and crop responses; recycling of organic wastes and residue management. Soil less cultivation.

Section-C: Commercial fertilizers; composition, relative fertilizer value and cost; crop response to different nutrients, residual effects and fertilizer use efficiency; agronomic, chemical and physiological, fertilizer mixtures and grades; methods of increasing fertilizer use efficiency; nutrient interactions.

Section-D: Time and methods of manures and fertilizers application; foliar application and its concept; relative performance of organic and inorganic nutrients; economics of fertilizer use; integrated nutrient management; use of vermincompost and residue wastes in crops.

Practical

Determination of soil pH and soil EC. Determination of soil organic C. Determination of available N, P, K and S of soil. Determination of total N, P, K and S of soil. Determination of total N, P, K, S in plant. Computation of optimum and economic yield

Suggested Reading

• Brady NC and Weil RR. 2002. *The Nature and Properties of Soils.* 13th Ed. Pearson Edu.

• Fageria NK, Baligar VC and Jones CA. 1991. *Growth and Mineral Nutrition of Field Crops.* Marcel Dekker.

• Havlin JL, Beaton JD, Tisdale SL and Nelson WL. 2006. *Soil Fertility and Fertilizers.* 7th Ed. Prentice Hall.

• Prasad R and Power JF. 1997. *Soil Fertility Management for Sustainable Agriculture*. CRC Press.

• Yawalkar KS, Agrawal JP and Bokde S. 2000. *Manures and Fertilizers*. Agri-Horti Publ.

• Reddy SR. 2000. *Principles of Crop Production*. Kalyani.

• Sankaran S and Mudaliar TVS. 1997. *Principles of Agronomy.* The Bangalore Printing & Publ. Co.

• Singh SS. 2006. *Principles and Practices of Agronomy*. Kalyani.

• Tisdale SL, Nelson WL, Beaton JD and Havlin JL. 1997. *Soil Fertility and Fertilizers*. Prentice Hall.

Course title: Principal and Practices of Soil Fertility and Nutrient **Course code:AGR-541**

Sr. No.	On completing the course, the students will be able to:
CO1	know soil fertility and productivity, factor affecting and organic farming.
CO2	know inorganic and organic manures their interactions and uses
CO3	know methods of nutrient management and their economics.

SEMESTER-IV

***PGS-541 Basic Concepts 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:

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

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.

***AGR-599** **Masters' Research**

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