Ph.D. Agriculture (Agronomy)

PROGRAM SYLLABUS (EMBEDDED WITH COs)

School of Agriculture,

ITM University, Gwalior, Madhya Pradesh 474001

SYLLABUS

WITH

EMBEDDED

COURSE OUTCOMES (COs)

Semester-I

Course Code: AGRON-601	**Course Name:** Current Trends in Agronomy	**Semester:**I[st]

Credits	**L**	**T**	**P**	**Marks**	**Contact Hours (per week)**	**Independent Study Hour (per week)**	**Section (Group)**
3	3	0	0		3		Ph.D. Agronomy
Curriculum level					Basic, recent and Innovative	**Student specific course outcome**	Research Entrepreneurship and Methodology

Objective:

- To acquaint the students about recent advances in agricultural production.

Course outcomes: After completion of the course, a student will be able to:

CO-1	What are the advances in soil-plant-water relationship for crop production
CO-2	Demonstrate the remote sensing tools and artificial Intelligence
CO-3	Identify the environmental effect through the crop residues management
CO-4	Analyze different tools of the remote sensing and its application in crop production
CO-5	Compare to the different research methodology in Agronomy

Teaching Pedagogy:

T1	Classroom Lectures/Guest lecturers Student Seminars/Presentations
T2	ABL activitiesAssi gnment

Assessment tools	
AT1-1	One Midterm Exam
AT1-2	Seminar, Presentation
AT1-3	Assignment
AT1-4	Activity Based Learning

Prerequisites	**Unit wise contents details**	**Teaching Pedagogy**	**Assessment tools**

Course content	**Unit – 1** Agro-physiological basis of variation in yield, recent advances in soil-plant-water relationship.	Classroom teaching with AV aids	Assignment, Quiz , Mid-term examinations
	Unit – 1I Globalization of agriculture and WTO, precision agriculture, contract farming, organic farming, marketing and export potential of organic products, certification, labelling and accreditation procedures and ITK in organic farming.	Flipped classes teaching model, Discussions, Field demonstration (ABL)	Assignment, Unannounced test Mid and End Term Examinations
	Unit – III Crop residue management in multiple cropping systems; latest developments in plant management Mechanization in crop production: modern agricultural precision tools and technologies, weed management, cropping systems, grassland management, agro-forestry, allelopathy.	Lecture method/ Presentation Field demonstration (ABL)	Skill test , Quiz. end term examinations
	Unit – IV GIS, GPS and remote sensing for crop management, global warming, GM crops, seed production technology; seed certification, seed multiplication, hybrid seed production etc.	Collaborative learning, Lecture method, ABL	Group discussions or debate, Assignment, Extempore, End Term Examinations
	Unit-V Concepts of system agriculture; holistic approach of farming systems, dry land farming, sustainable agriculture and research methodology in Agronomy. Conservation agriculture, principles, prospects and importance, potential benefits of CA under climate change scenario, policy issues.	Flipped classes teaching model, Discussions and Presentation, ABL	Seminar Presentation , Unannounced test, End term examination

Resources:	LCD, OHP, Black Board, Agronomy lab and tools, field for demonstration, Poly house, Net house and Different types of devices.
Assignment/Tutorial:	Students are required to submit the given assignments and deliver one power point presentation as a part of their continuous evaluation system.
List of Assignments	1. Latest trends in precision agriculture 2. Using of precision agricultural tool for maximization of crop production
ABL	3. Soil mapping using AI 4. Visit to Indian institute of remote sensing.
Suggested reading:	1. Agarwal RL. 1995. Seed Technology. Oxford & IBH. 2. Dahiya BS and Rai KN. 1997. Seed Technology. Kalyani. 3. Govardhan V. 2000. Remote Sensing and Water Management in Command Areas: AgroecologicalProspectives. IBDC. Restructured and Revised Syllabi of Post-graduate

Programmes Vol. 2 66.
4. ICAR. 2006. Hand Book of Agriculture. ICAR.
5. Narasaiah ML. 2004. World Trade Organization and Agriculture. Sonali Publ.
6. Palaniappan SP and Annadurai K. 2006. Organic Farming - Theory and Practice. Scientific Publ.
7. Sen S and Ghosh N. 1999. Seed Science and Technology. Kalyani.
8. Tarafdar JC, Tripathi KP and Kumar M. 2007. Organic Agriculture Scientific Publ.
9. Kumar, R, Swarnkar KS, Singh KS and Narayan S. 2016. A Text Book of Seed Technology. Kalyani Publication.
10. Reddy SR and Prabhakara G. 2015. Dryland Agriculture. Kalyani Publishers.
11. Gururajan B, Balasubhramanian R and Swaminath V. 2013. Recent Strategies on Crop Production. Kalyani Publishers.
12. VenkateswarluB and ShankerArun K. 2009. Climate change and agriculture: Adaptation and mitigation strategies. Indian Journal of Agronomy 54(2): 226-230

CourseCode: AGRON-602	CourseName:Recent Trends in Crop Growth and Productivity	Semester:1ST

Credits	L	T	P	Marks			Contact Hours(perweek)	Independent StudyHour(perweek)	Section(Group)
3	2	0	1				4	3	2
Curriculumlevel							Basic, applied andInnovative	Student specificcourseoutcome	Higher EducationPlacementResearchEntrepreneurship

Objective: To study the physiology of vegetative and reproductive growth in relation to productivity of different crops in various environments.

Course outcomes: Throughthiscoursestudentswillbeableto:

CO-1	Getknowledgeaboutthecrop growth for agricultural production
CO-2	Prepareanoutlinebasedoncrop productivity factors, growth analysis concepts andCompetitive relationship with different cropping systems.
CO-3	Apply recentcropmanagementpracticeson crop growth and productivity with proper resource use efficiency.
CO-4	Analysetherecenttrendsincrop growth and productivity under changing climate scenario.

Teaching Pedagogy:

T1	Activitybased learningusingdifferenttools Flipped classes teaching modelCollaborativelearning Socraticmethodofteaching. Power PointPresentations.
T2	ABLactivities FielddemonstrationAssignmentUnannouncedtest Seminarswithopendiscussions Groupdiscussionsordebate Quiz

Assessmenttools	
AT1-1	MidtermExamsandendtermexam
AT1-2	Assignment
AT1-3	Unannouncedtest
AT1-4	ActivityBasedLearning

Prerequisites	Unit wise contents details	Teaching Pedagogy	Assessment tools
Course content	**Unit–1** Plant density and crop productivity; plant and environmental factors, yield, plant distribution, strategies for maximizing solar energy utilization; leaf area; interception of solar radiation and crop growth; photosynthesis: the photosynthetic apparatus, factors essential for photosynthesis; difference in photosynthetic rates among and within species; physiological limitations to crop yield; solar radiation concept and agro-techniques for harvesting solar radiation	Socraticmethod, Presentation	Assignment, Quiz , Mid-termexaminations
	Unit–1I Growth analysis: concept, CGR, RGR, NAR, LAI, LAD, LAR; validity and	Flippedclassesteaching model,Discussions,Fielddemonstration(ABL)	Assignment,Unannounced testMid and EndTermExaminations

	Limitations in interpreting crop growth and development; growth curves: sigmoid, polynomial and asymptotic; root systems; root-shoot relationship; principles involved in inter and mixed cropping systems under rainfed and irrigated conditions; concept and differentiation of inter and mixed cropping; criteria in assessing the yield advantages.		
	Unit–III Competitive relationship and competition functions; biological and agronomic basis of yield advantage under intercropping; physiological principles of dry land crop production, constraints and	Lecture method/Presentation Fielddemonstration(ABL)	Skilltest,Quiz.end termexaminations

	remedial measures; heat unit concept of crop maturity: concept and types of heat units.		
	Unit– IV Concept of plant ideotypes: crop physiological and new ideotypes; characteristics of ideotype for wheat, rice, maize, etc.; concept and types of growth hormones; their role in field crop production; efficient use of resources.	Collaborativelearning, Lecturemethod,ABL	Group discussionsordebate,Assignment,Extempore, End TermExaminations

PracticalExercise* (Min-8)	**Listofpracticals(field/labexercises)**	**Assessmenttools**
	1. Field measurement of root-shoot relationship in crops at different growth stages. 2. Estimation of growth evaluating parameters like CGR, RGR, NAR, LAI etc., at different stages of crop growth. 3. Computation of harvest index of various crops. 4. Assessment of crop yield on the basis of yield attributing characters. 5. Construction of crop growth curves based on growth analysis data. 6. Computation of competition functions, viz. LER, IER aggressivity competition index etc in intercropping. 7. Senescence and abscission indices. 8. Analysis of productivity trend in un-irrigated areas. 9. Analysis of productivity trend in irrigated areas.	Activity based learning can be given to implement application aspect
Resources:	Classroom teachingwithAVaids,groupdiscussion,assignment, Agronomy lab	

Assignment/Tutorial:	Studentsarerequiredtosubmitthegivenassignmentsasapartoftheircontinuousevaluationsystem.
ListofAssignments	1. Principles involved in inter and mixed cropping systems under rainfed and irrigated conditions. 2. Concept and types of growth hormones
Suggestedreading:	1. Chopra VL and Paroda RS. 1984. Approaches for Incorporation of Drought and Salinity Resistance in Crop Plants. Oxford & IBH. 2. Delvin RM and Vitham FH. 1986. Plant Physiology. CBS Publ. 3. Evans LT. 1975. Crop Physiology. Cambridge Univ. Press. 4. Evans LT. 1996. Crop Evolution, Adaptation and Yield. Cambridge Univ. Press. 5. Gupta US. (Ed.). 1995. Production and Improvement of Crops for Drylands. Oxford & IBH. 6. Gupta US. 1988. Progress in Crop Physiology. Oxford & IBH. 7. Kramer PJ and Boyer JS. 1995. Water Relations of Plant and Soils. Academic Press. 8. Mukherjee S and Ghosh AK. 1996. Plant Physiology. Tata McGraw Hill. 9. Narwal SS, Politycka B and Goswami CL. 2007. Plant Physiology: Research Methods. Scientific Pub. 10. Tiaz L. and Zeiger E. 2006. Plant Physiology. Sinauer Associates, Inc.
Suggested e-resources(Websites/e-books)	1. https://www.sciencedirect.com/science/article/abs/pii/S0378429097000191 2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6409995/ 3. https://www.mdpi.com/2073-4395/8/6/83 4. https://www.frontiersin.org/articles/10.3389/fpls.2017.01147/full 5. https://extension.oregonstate.edu/gardening/techniques/environmental-factors-affecting-plant-growth 6. https://www.scirp.org/pdf/as_2020033115503350.pdf

Course Code: AGRON- 605	**Course Name:** Integrated Farming Systems and Sustainable	**Semester:Ist**

Credits	**L**	**T**	**P**	**Marks**			**Contact Hours (per week)**	**Independent Study Hour (per week)**	**Section (Group)**
2	2	0	0				3		Ph.D. Agronomy

Curriculum level	Basic, recent and Innovative	**Student specific course outcome**	Research Entrepreneurship and Methodology

Objective:

To apprise about different enterprises suitable for different agroclimatic conditions for sustainable agriculture.

Course outcomes: After completion of the course, a student will be able to:

CO-1	Identify and understand different types of enterprises includes in IFS.
CO-2	Interpretate the components and adaptability of different farming system based on land situations and climatic condition of a region
CO-3	Discover New concepts and approaches of farming system and organic farming.
CO-4	Analyse Possible use of ITK in Integrated farming system
CO-5	Develop different Integrated Farming system Models and its evaluation.

Teaching Pedagogy:

T1	Classroom Lectures/Guest lectures Student Seminars/Presentations
T2	ABL activities Assignments

Assessment tools	
AT-1	One Midterm Exam
AT-2	Seminar, Presentation
AT-3	Assignment
AT-4	Activity Based Learning

Prerequisites	**Unit wise contents details**	**Teaching Pedagogy**	**Assessment tools**

Course Contents	**Unit – I** Integrated Farming systems (IFS): definition, scope and importance; classification of IFS based on enterprises as well as under rainfed/irrigated condition in different land situation. farming systems according to type of rotation, intensity of rotation, degree of commercialization, water supply, enterprises.	Classroom teaching with AV aids	Assignment, Quiz, Mid-term examinations
	Unit – 1I Concept of sustainability in of Integrated farming systems; efficient Integrated farming systems based on economic viability and natural resources - identification and management.	Flipped classes teaching model, Discussions, Field demonstration (ABL)	Assignment, Unannounced test Mid and End Term Examinations
	Unit – III Production potential of different components of Integrated farming systems; interaction and mechanism of different production factors; stability of Integrated Farming system based on research/long term information. in different systems through research; eco-physiological approaches to intercropping. Integration of components and adaptability of different farming system based on land situations and climatic condition of a region; evaluation of IFS.	Lecture method/ Presentation Field demonstration (ABL)	Skill test , Quiz. end term examinations
	Unit – IV Simulation models for intercropping; soil nutrient in intercropping; preparation of different farming system models; evaluation of different farming systems. Formation of different Integrated Farming system Models; evaluation of different Integrated Farming system models. Recycling of organic waste in farming system, in IFS.	Collaborative learning, Lecture method, ABL	Group discussions or debate, Assignment, Extempore, End Term Examinations
	Unit-V New concepts and approaches of farming system and organic farming; value addition, waste recycling, quantification and mitigation of Green House gases; case studies/ success stories of different Integrated	Flipped classes teaching model, Discussions and	Seminar Presentation, Unannounced test, End term examination

	Farming systems. cropping systems and organic farming; case studies on different farming systems. Possible use of ITK in Integrated farming system.	Presentation, ABL	

Resources:	LCD, Black/ White Board, Computer
Assignment/Tutorial:	Students are required to submit the given assignments and deliver one power point presentation as a part of their continuous evaluation system.
List of Assignments	1. Sustainable integrated farming system: A solution for national food security and sovereignty 2. Analysis to develop a program for energy-integrated farm systems 3. Role of ITK in Conservation Agriculture: Blending Indigenous and Scientific Knowledge 4. The Indigenous Technical Knowledge (ITK) & its application for sustainability in agriculture
ABL	1. Planning of IFS for the university **2.** Visit to different states for studying the specific kind of IFS models

Suggested Reading:	1. Ananthakrishnan TN. (Ed.). 1992. Emerging Trends in Biological Control of Phytophagous Insects. Oxford & IBH. 2. Baishya A, Borah M, Das AK, Hazarika J, Gogoi B and Borah AS 2017. Waste Recycling Through Integrated Farming systems. An Assam Agriculture Experience. Omni Scriptum Gmbh& Co. KG, Germany. 3. Balasubramanian P and Palaniappan SP. 2006. Principles and Practices of Agronomy. Agrobios. 4. Edens T. 1984. Sustainable agriculture and integrated farming system. Michigan State Univ. press. Jayanthi C. 2006. Integrated Farming systems-A way to sustainable Agriculture. Tamil Nadu Agricultural University, Coimbatore. 5. Joshi M and Parbhakarasetty TK. 2005. Sustainability through Organic Farming. Kalyani. 6. Kolhapure A and Madhukar D. A text book of farming system and sustainable agriculture. 7. Palaniappan SP and Anandurai K. 1999. Organic Farming - Theory and Practice. Scientific Publ. 8. Panda SC. 2004. Cropping systems and Farming Systems. Agribios. 9. Lampin N. 1990. Organic Farming. Farming Press Books. Ravisankar D and Jayanthi C. 2015. Farming systems: concepts and approaches. Agrobios,

Course Code: AGRON-606	**Course Name:** Soil Conservation and Watershed Management	**Semester:Ist**

Credits	L	T	P	Marks			Contact Hours (per week)	Independent Study Hour (per week)	Section (Group)
3	2	0	1				4		Ph.D. Agronomy
Curriculum level							Basic, recent and Innovative	**Student specific course outcome**	Research Entrepreneurship and Methodology

Objective:

To acquaint the students aboutabout different soil moisture conservation technologies for enhancing the agricultural productivity through holistic approach watershed management.

Course outcomes: After completion of the course, a student will be able to:

CO-1	Understand the basic knowledge on soil erosion and watershed and
CO-2	Identify the different ways of soil conservation: including agronomic and engineering measures.
CO-3	Interpretate agronomic and mechanical measures for soil conservation according to the various regions.
CO-4	Examine the reasons behind the soil erosion and steps in implementation of watershed accordingly.
CO-5	Evaluate the factors, nature and extent of soil erosion in an area.
CO-6	Development of different types of cropping system for watershed areas.

Teaching Pedagogy:

T1	Classroom Lectures/Guest lectures Student Seminars/Presentations
T2	ABL activities Assignments

Assessment tools	
AT-1	One Midterm Exam
AT-2	Seminar, Presentation
AT-3	Assignment
AT-4	Activity Based Learning

Prerequisites	Unit wise contents details	Teaching Pedagogy	Assessment tools

Course Contents	**Unit – 1** Soil erosion: definition, nature and extent of erosion; types of erosion, factors affecting erosion.	Classroom teaching with AV aids	Assignment, Quiz, Mid-term examinations
	Unit – 1I Soil conservation: definition, methods of soil conservation; agronomic measures - contour cultivation, strip cropping, cover crops; mulching, tillage, cropping system vegetative barriers; improved dry farming practices; mechanical measures - bunding, gully control, bench terracing; role of grasses and pastures in soil conservation; wind breaks and shelter belts.	Flipped classes teaching model, Discussions, Field demonstration (ABL)	Assignment, Unannounced test Mid and End Term Examinations
	Unit – III Watershed management: definition, objectives, concepts, approach, components, steps in implementation of watershed; development of cropping systems for watershed areas.	Lecture method/ Presentation Field demonstration (ABL)	Skill test, Quiz. end term examinations
	Unit – IV Land use capability classification, alternate land use systems; agro-forestry; ley farming; jhum management - basic concepts, socio-ethnic aspects, its layout.	Collaborative learning, Lecture method, ABL	Group discussions or debate, Assignment, Extempore, End Term Examinations
	Unit-V Drainage, methods of drainage, Drainage considerations and agronomic management; rehabilitation of abandoned jhum lands and measures to prevent soil erosion.	Flipped classes teaching model, Discussions and Presentation, ABL	Seminar Presentation, Unannounced test, End term examination

Resources:	LCD, Black/ White Board, Computer	
Practical Exercise	**Course Modules**	**Assessment tools**

	1. Study of different types of erosion 2. Determination of dispersion ratio 3. Estimation of soil loss by Universal Soil Loss Equation 4. Estimation of soil loss by wind erosion 5. Measurement of runoff and soil loss 6. Field studies of different soil conservation measures 7. Laying out run-off plot and deciding treatments 8. Identification of different grasses and trees for soil conservation 9. Visit to watershed areas 10. Visit to a soil conservation research centre, demonstration and training centre	Activity based learning can be given to implement application aspect
Assignment/Tutorial:	Students are required to submit the given assignments and deliver one power point presentation as a part of their continuous evaluation system.	
List of Assignments	1. Global perspective of watershed management 2. Watershed management in Gwalior 3. Adaptive Management Fitness of Watersheds 4. Watershed Management Optimization Support Tool (WMOST)	
ABL	1. Visit to dam 2. Visit to the ICAR-Indian Institute of Soil and Water Conservation (ICAR-IISWC)	

Suggested Reading:	1. Arakeri HR and Roy D. 1984. Principles of Soil Conservation and Water Management. Oxford & IBH. 2. Dhruvanarayana VV. 1993. Soil and Water Conservation Research in India. ICAR. 3. FAO. 2004. Soil and Water Conservation in Semi-Arid Areas. Soils Bull., Paper 57. 4. Frederick RT, Hobbs J, Arthur D and Roy L. 1999. Soil and Water Conservation: Productivity and Environment Protection. 3rd Ed. Prentice Hall. Gurmel Singh, Venkataraman CG, Sastry B and Joshi P. 1990. Manual of Soil and Water Conservation Practices. Oxford & IBH. 5. Murthy VVN. 1995. Land and Water Management Engineering. Kalyani. 6. Tripathi RP and Singh HP. 1993. Soil Erosion and Conservation. Wiley Eastern. 7. Yellamanda Reddy T and Sankara Reddy GH. 1992. Principles of Agronomy. Kalyani.

Suggested websites:	1. https://www.soilodisha.nic.in/ 2. https://www.universitydunia.com/courses/doctor-of-philosophy/ph-d-soil-conservation-water-management 3. https://www.academia.edu/27763344/Soil_Conservation_and_Watershed_Management_Programs_Activities_Ministry_of_Forests_and_Soil_Conservation_Department_of_Soil_Conservation_and_Watershed_Management 4. https://iiswc.icar.gov.in/about-us/about-institute

Course Code: SOIL- 602	Course Name: Modern Concept of Soil Fertility	Semester:I[st]

Credits	L	T	P	Marks	Contact Hours (per week)	Independent Study Hour (per week)	Section (Group)
02	2	0	0		02		Ph.D. Agronomy
Curriculum level					Basic, recent and Innovative	**Student specific course outcome**	Research Entrepreneurship and Methodology

Objective:

To provide knowledge of modern concepts of soil fertility and nutrient use in crop production.

Course outcomes: After completion of the course, a student will be able to:

CO-1	To assemble the knowledge about the Nutrient availability their relationships between the soil & plant system.
CO-2	Demonstrate the mechanism of nutrient transport from soil to plant system.
CO-3	Identify the Chemical equilibria involving nutrientions in soils
CO-4	Evaluate the, nutrient use efficiency and nutrient budgeting.
CO-5	Compare physical, chemical and biological changes in soils

Teaching Pedagogy:

T1	Class room Lectures/Guestlecturers Student Seminars/Presentations
T2	ABL activitiesAssignme nts

Assessment tools	
AT1-1	One Midterm Exam
AT1-2	Seminar, Presentation
AT1-3	Assignment
AT1-4	Activity Based Learning

Prerequisites	Unit wise contents details	Teaching Pedagogy	Assessment tools

Course Contents	**Unit – 1** Nutrient availability-concept and relationships, modern concepts of nutrient s availability; soil colloids and nutrient availability; soil amendments and availability maintenance of nutrients, soil solution and plant growth; nutrient response functions and availability indices.	Classroom teaching with AV aids	Assignment, Quiz , Mid-term examinations
	Unit – 1I Nutrient movement in soils; nutrient absorption by plants; mechanistic approach to nutrient supply and uptake by plants; models for transformation and movement of major micronutrients in soils.	Flipped classes teaching model, Discussions, Field demonstration (ABL)	Assignment, Unannounced test Mid and End Term Examinations
	Unit – III Chemical equilibria (including solid-solution equilbria) involving nutrientions in soils, particularly in submerged soils; Kinetic studies of nutrients in soils.	Lecture method/ Presentation Field demonstration (ABL)	Skill test , Quiz. end term examinations
	Unit – IV Modern concepts of fertilizer evaluation, nutrient use efficiency and nutrient budgeting.	Collaborative learning, Lecture method, ABL	Group discussions or debate, Assignment, Extempore, End Term Examinations
	Unit-V Modern concepts in fertilizer application; soil fertility evaluation techniques; role of soil tests in fertilizer use recommendations; site-specific nutrient management for precision agriculture	Flipped classes teaching model, Discussions and Presentation, ABL	Seminar Presentation , Unannounced test, End term examination
	Unit-VI Monitoring physical, chemical and biological changes in soils; permanent manurial trials and long-term fertilizer experiments; soil productivity under long-term intensive cropping; direct, residual and cumulative effect of fertilizer use.	Flipped classes teaching model, Discussions and Presentation, ABL	Group discussions or debate, Assignment, Extempore, End Term Examinations
	Unit-VII Carbon– a nutrient central to soil fertility; carbon cycle in nature, stocks, pools and fluxes; greenhouse effect and climate change; carbon sequestration vis-à-vis sustenance of soil quality and crop productivity.		Seminar Presentation , Unannounced test, End term examination
Resources:	LCD, Black/ White Board, Computer		

Assignment/Tutorial:	Studentsarerequiredtosubmitthegivenassignmentsanddeliveronepowerpointpresentation asapartoftheircontinuousevaluationsystem.
List of Assignments	1. Assignments on Mechanistic approach to nutrient supply and uptake by plants 2. Assignments on Carbon sequestration vis-à-vis sustenance of soil quality and crop productivity
ABL	1. Soil Fertility evolution 2. UseofRapid test Method 3. Prepare Soil Quality Index
Suggested Reading:	▪ Brady NC and Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Educ. ▪ Cooke GW. 1979. *The Control of Soil Fertility*. Cross by Lockwood & Sons. ▪ Kabata- Pendias Alina 2001. *Trace Elements in Soils and Plants*. CRC / Taylor & Francis. ▪ Kannaiyan S, Kumar K and Govindarajan K. 2004. *Biofertilizers Technology*. Scientific Publ. ▪ Mortvedt JJ, Shuman LM, Cox FR and Welch RM. (Eds.). 1991. *Micronutrients in Agriculture.* 2nd Ed. Soil Science Society of America, Madison. ▪ Prasad R and Power JF. 1997. *Soil Fertility Management for Sustainable Agriculture*. CRC Press. ▪ Stevenson FJ and Cole MA. 1999. *Cycles of Soil: Carbon, Nitrogen, Phosphorus, Sulphur, Micronutrients.* John Wiley & Sons. ▪ Stevenson FJ. (Ed.). 1982. *Nitrogen in Agricultural Soils*. Soil Science Society of America, Madison. ▪ Tisdale SL, Nelson WL, Beaton JD and Havlin JL. 1990. *Soil Fertility and Fertilizers.* 5th Ed. Macmillan Publ. ▪ Wild A. (Ed.). 1988. *Russell's Soil Conditions and Plant Growth*. 11th Ed. Longman.

Credits	L	T	P	Marks	Contact Hours (per week)	Independent Study Hour (per week)	Section (Group)
02	02	0	0		02		Ph.D. Agronomy
Curriculum level					Basic, recent and Innovative	**Student specific course outcome**	Research Entrepreneurship and Methodology

Objective:

To impart knowledge related to chemistry and reactions of organic substances and their significance in soils.

Course outcomes: After completion of the course, a student will be able to:

CO-1	To assemble the knowledge about the Soil organic matter and Characteristic.
CO-2	Demonstrate the different pathways for humus synthesis in soil
CO-3	Identify the Chemical equilibria involving nutrientions in soils
CO-4	Evaluate the, Nutrient transformation from soil to plant system.
CO-5	Compare the Humus-pesticide interactions in soil.

Teaching Pedagogy:

T1	Class room Lectures/Guest lecturersStudent Seminars/Presentations
T2	ABL activitiesAssignments

Assessment tools	
AT1-1	One Midterm Exam
AT1-2	Seminar, Presentation
AT1-3	Assignment
AT1-4	Activity Based Learning

Prerequisites	Unit wise contents details	Teaching Pedagogy	Assessment tools

Course Contents	**Unit – I** Organic matter in soils and its maintenance Role of organic matter in soil productivity; humus levels in soils; current thinking on the maintenance of organic matter in the soils. Carbon retention and sequestration	Classroom teaching with AV aids	Assignment, Quiz , Mid-term examinations
	Unit – 1I Biochemistry of the humus formation; different pathways for humus synthesis in soil; soil carbohydrates and lipids	Flipped classes teaching model, Discussions, Field demonstration (ABL)	Assignment, Unannounced test Mid and End Term Examinations
	Unit – III Nutrient transformation–N, P, S; tracemetal interaction with humic substances, significance of chelation reactions in soils.	Lecture method/ Presentation Field demonstration (ABL)	Skill test , Quiz. end term examinations
	Unit – IV Reactive functional groups of humic substances, adsorption of organic compounds by clay and role of organic substances in pedogenic soil aggregation processes; clay organic matter complexes.	Collaborative learning, Lecture method, ABL	Group discussions or debate, Assignment, Extempore, End Term Examinations
	Unit-V Humus-pesticide interactions in soil, mechanisms	Flipped classes teaching model, Discussions and Presentation, ABL	Seminar Presentation , Unannounced test, End term examination

Resources:	LCD, Black/ White Board, Computer
Assignment/ Tutorial:	Studentsarerequiredtosubmitthegivenassignmentsanddeliveronepowerpointpresentation asapartoftheircontinuousevaluationsystem.
List of Assignments	1. Assignments on Biochemistry of the humus formation; different pathways for humus 2. Assignments on Humus-pesticide interactions in soil
ABL	1. Evaluate the, Nutrient transformation 2. Extraction of Humic Substances from organic matter 3. Field demonstration
Suggested Reading	▪ Lynch JM, Willey JM. Soil Biotechnology. ▪ Paul EA and Clark FE. Soil Microbiology and Biochemistry ▪ Sherwood LM and Woolverton CJ. Prescott's Microbiology. ▪ Subba Rao NS. Advances In Agricultural Microbiology

Semester-II

Course Code: AGRON-603	Course Name: Irrigation Management	Semester:II[nd]

Credits	L	T	P	Marks	Contact Hours (Per week)	Independent Study Hour (per week)	Section (Group)
3	2	0	1		4		**Ph.D. Agronomy**
Curriculum level					Basic, applied and Innovative	Student specific course outcome	Higher Education Placement Research Entrepreneurship

Objective: To teach students about optimization of irrigation in different crops under variable agro climatic conditions.

Course outcomes: Through this course students will be able to:

CO1	Discuss the fundamental knowledge of global and Indian water resources, irrigation projects of pre and post-independence and their significance on Indian agriculture, Soil water and plant relationship, mapping arid and semi-arid regions, evaporation, transpiration and evapotranspiration, mulching, irrigation requirement.
CO2	Understanding the soil-water movement under saturated and unsaturated conditions, Poiseulle's and Darcy's law, Crop water stress, integrated water management in command areas, soil and water potential.
CO3	Apply the knowledge of strategies of using limited water supply, designing and operation of irrigation projects,
CO4	Analysis of Economics of irrigation and crop planning for optimum use of water, equation of saturated and unsaturated flow of water in soil.
CO5	Assess practical knowledge of consumptive use and water requirement, Strategies of using limited water supply, Land suitability for irrigation,
CO6	Designing, planning and installation of drip irrigation system and Sprinkler irrigation system and designing of drainage channels.

Teaching Pedagogy:

T1	Activity based learning using different tools Flipped classes teaching model Collaborative learning Socratic method of teaching. Power Point Presentations.
T2	ABL activities Field demonstration of cultivation practices, Assignment Unannounced test Seminars with open discussions Group discussions or debate Quiz

Assessment tools	
AT1-1	Mid- term Exams and end term exam
AT1-2	Assignment

AT1-3	Unannounced test
AT1-4	Activity Based Learning
AT1-5	Group discussions or debate
AT1-6	Skill test
AT1-7	Quiz
AT1-8	Extempore (student needs to explain the instant given topic as a teacher to all other students)
AT1-9	Seminar Presentation

Prerequisites	Unit wise contents details	Teaching Pedagogy	Assessment tools
Course Contents	**Unit I** Global water resources; Water resources of India, irrigation projects during pre and post-independence period and their significance in crop production; irrigation needs, atmospheric, soil, agronomic, plant and water factors affecting irrigation need; water deficits and crop growth.	Socratic method, Presentation	Assignment, Quiz , Mid-term examinations
	Unit II Movement of water in soil-water movement under saturated and unsaturated conditions, Poiseulle's and Darcy's law, general equation of saturated and unsaturated flow of water in soil. Soil-plant-water relationships, evaporation, transpiration and evapotranspiration, significance of transpiration, energy utilization in transpiration, physiological processes and crop productivity.	Flipped classes teaching model, Discussions, Field demonstration (ABL)	Assignment, Unannounced test Mid and End Term Examinations
	Unit – III Water requirement, irrigation needs, factors affecting irrigation need; water use efficiency, Infiltration; water movement under saturated and unsaturated conditions; management practices for improving water use efficiency of crops.	Lecture method/ Presentation Field demonstration (ABL)	Skill test , Quiz. end term examinations
	Unit IV Soil and plant water potential, SPAC, transpiration and evapotranspiration, significance of transpiration, energy utilization in transpiration, factors affecting ET, control of ET by mulching and use of anti-transpirents; fertilizer use in relation to irrigation	Collaborative learning, Lecture method, ABL	Group discussions or debate, Assignment, Extempore, End Term Examinations
	Unit V Crop water stress – water deficits and crop growth, adoptability to the crops. Water availability with relation to nutrient availability.	Flipped classes teaching model, Discussions and Presentation, ABL	Seminar Presentation , Unannounced test, End term examination

	Unit VI Application of irrigation water, conveyance and distribution system, irrigation efficiency; agronomic considerations in the design and operation of irrigation projects; characteristics of irrigation and farming systems affecting irrigation management.	Collaborative learning, Lecture method, ABL	Group discussions or debate, Assignment, Extempore, End Term Examinations
	Unit VII Strategies of using limited water supply; factors affecting ET, control of ET by mulching and use of anti-transpirants; fertilizer use in relation to irrigation; optimizing the use of given irrigation supplies.	Flipped classes teaching model, Discussions and Presentation, ABL	Seminar Presentation , Unannounced test, End term examination
	Unit VIII Land suitability for irrigation, land irrigability classification; integrated water management in command areas, institution of water management in commands, farmer's participation in command areas; irrigation legislation.	Collaborative learning, Lecture method, ABL	Group discussions or debate, Assignment, Extempore, End Term Examinations
	Unit IX Economic analysis of irrigation and cop planning for optimum use of irrigation water	Flipped classes teaching model, Discussions and Presentation, ABL	Seminar Presentation , Unannounced test, End term examination
	Unit X Crop water production function.	Collaborative learning, Lecture method, ABL	Group discussions or debate, Assignment, Extempore, End Term Examinations

Practical Exercise* (Min-8)	**List of practicals (field/lab exercises)**	**Assessment tools**
	1. Determination of water infiltration characteristics and water holding capacity of soil profiles. 2. Determination Moisture extraction pattern of crops. 3. Determination of water balance component of transplanted rice by drum culture technique. 4. Determination of consumptive use and water requirement of a given cropping pattern. 5. Determination of crop efficient of one important crop 6. Planning, designing and installation of drip irrigation system 7. Planning, designing and installation of sprinkler irrigation system. 8. Designing of drainage channel. 9. Measurement of irrigation efficiencies. 10. Determination of irrigation timing under different methods of irrigation. 11. Visit to irrigation command area.	Practical Activity Practical Record Attendance Viva voce

Resources:	LCD, OHP, Black Board, Classroom teaching with AV aids, group discussion, oral presentation by students.
Assignment/Tutorial:	Students are required to submit the given assignments and deliver one power point presentation as a part of their continuous evaluation system.
List of Assignments	
Suggested reading:	1) FAO. 1984. Irrigation Practice and Water Management. Oxford & IBH. 2) MP. Singh 2017. Recent advances in Irrigation water management. Kalyani Publishers 3) Michael AM. 1978. Irrigation: Theory and Practice. Vikas Publ. 4) Mishra RR & Ahmad M. 1987. Manual on Irrigation and Agronomy. Oxford & IBH. 5) Panda SC. 2003. Principles and Practices of Water Management. Agrobios. 6) Reddy SR. 2000. Principles of Crop Production. Kalyani. 7) Sankara Reddy GH &Yellamananda Reddy 1995. Efficient Use of Irrigation Water. In: Gupta US. (Ed.). Production and Improvement of Crops for Drylands. Oxford & IBH. 8) Singh SS. 2006. Principles and Practices of Agronomy. In: Gupta US. (Ed.). Production and Improvement of Crops for Drylands. Oxford & IBH
Suggested e-resources (Websites/e-books)	▪ https://link.springer.com/book/10.1007/978-1-4419-6335-2 ▪ https://www.intechopen.com/books/water-quality-soil-and-managing-irrigation-of-crops ▪ https://www.routledge.com/Research-Advances-in-Sustainable-Micro-Irrigation/book-series/AAPRESADVSUS ▪ https://www.asabe.org/ISM ▪ https://www.booktopia.com.au/books-online/non-fiction/engineering-technology/agriculture-farming/agricultural-engineering-machinery/irrigation-water-management/cTVDR-p1.html ▪ https://www.appleacademicpress.com/sustainable-micro-irrigation-design-systems-for-agricultural-crops-methods-and-practices/9781771882743 ▪ https://agrimoon.com/water-management-including-micro-irrigation-icar-ecourse-pdf-book/ ▪ https://bmpbooks.com/publications/irrigation-management/

Course Code: AGRON-604	**Course Name:** Recent Trends in Weed Management	**Semester:II[nd]**

Credits	L	T	P	Marks	Contact Hours (per week)	Independent Study Hour (per week)	Section (Group)

2	2	0	0				3		Ph.D. Agronomy
Curriculum level							Basic, recent and Innovative	**Student specific course outcome**	Research Entrepreneurship and Methodology

Objective:

To acquaint the students about recent changes in weed flora, new herbicides, their resistance, toxicity, antidotes and residue management under different cropping systems.

Course outcomes: After completion of the course, a student will be able to:

CO-1	Understand the knowledge on weed biology and survey of weeds in varied ecosystem.
CO-2	Identify the nature, type and economic uses of weeds in varied habitat.
CO-3	Solve the issues related to weed control and residue management of herbicides.
CO-4	Evaluate and judge the combining effects of herbicides on soil health and environment.
CO-5	Formulate integrated weed management practices for different ecosystems

Teaching Pedagogy:

T1	Classroom Lectures/Guest lectures Student Seminars/Presentations
T2	ABL activities Assignments

Assessment tools	
AT-1	One Midterm Exam
AT-2	Seminar, Presentation
AT-3	Assignment
AT-4	Activity Based Learning

Prerequisites	**Unit wise contents details**	**Teaching Pedagogy**	**Assessment tools**

Course Contents	**Unit – 1** Crop-weed competition in different cropping situations; changes in weed flora, various causes and effects; different methods of weed management. Migration, introduction, adaptation of weeds, Invasive weeds – biology and management. Different mechanisms of invasion – present status and factors influencing weed invasion	Classroom teaching with AV aids	Assignment, Quiz, Mid-term examinations
	Unit – 1I Physiological and biological aspects of herbicides, their absorption, translocation, metabolism and mode of action; selectivity of herbicides and factors affecting them.	Flipped classes teaching model, Discussions, Field demonstration (ABL)	Assignment, Unannounced test Mid and End Term Examinations
	Unit – III Climatic factors and phytotoxicity of herbicides; fate of herbicides in soil and factors affecting them, Degradation of herbicides in soil and plants- factors affecting it, primary and secondary metabolites, residue management of herbicides, adjuvants.	Lecture method/ Presentation Field demonstration (ABL)	Skill test, Quiz. end term examinations
	Unit – IV Advances in herbicide products and application techniques and methods; herbicide resistance; antidotes and crop protection compatibility of herbicides of different groups; compatibility of herbicides with other pesticides; herbicide rotation and herbicide mixtures.	Collaborative learning, Lecture method, ABL	Group discussions or debate, Assignment, Extempore, End Term Examinations
	Unit-V Development of transgenic herbicide resistant crops; herbicide development, registration procedures.	Flipped classes teaching model, Discussions and Presentation, ABL	Seminar Presentation, Unannounced test, End term examination
	Unit-VI Relationship of herbicides with tillage, fertilizer, and irrigation, cropping system; bioherbicides, allelochemical and alleloherbicides, herbicide bioassays. Recent advances in nonchemical weed management including deleterious rhizobacteria, robotics, biodegradable film, etc.	Flipped classes teaching model, Discussions and Presentation, ABL	Seminar Presentation, Unannounced test, End term examination

Resources:	LCD, Black/ White Board, Computer
Assignment/Tutorial:	Students are required to submit the given assignments and deliver one power point presentation as a part of their continuous evaluation system.
List of Assignments	1. Emerging Challenges and Opportunities for Education and Research in Weed Science 2. The future for weed control and technology. 3. Estimation of dose-response models for discrete and continuous data in weed science 4. Weeds in a Changing Climate: Vulnerabilities, Consequences, and Implications for Future Weed Management
ABL	1. Weed population processes 2. Weed identification and manual formation
Suggested reading:	1. Böger, Peter, Wakabayashi, Ko, Hirai, Kenji (Eds.). 2002. Herbicide Classes in Development. Mode of Action, Targets, Genetic Engineering, Chemistry. Springer. 2. Das TK. 2008. Weed Science: Basics and Applications, Jain Brothers (New Delhi). 3. 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. 4. Jugulan M, (ed). 2017. Biology, Physiology and Molecular Biology of Weeds. CRC Press. 5. Monaco TJ, Weller SC and Ashton FM. 2014. Weed Science Principles and Practices, Wiley. 6. Powles SB and Shaner DL. 2001. Herbicide Resistance and World Grains, CRC Press. 7. Walia US. 2006. Weed Management, Kalyani. 8. Zimdahl RL. (ed). 2018. Integrated Weed Management for Sustainable Agriculture, B. D. Sci. Pub

Course Code: SOILS-609	**Course Name:** Recent Trends in Soil Microbial Biodiversity	**Semester:IInd**

Credits	**L**	**T**	**P**	**Marks**	**Contact Hours (per week)**	**Independent Study Hour (per week)**	**Section (Group)**
3	2	2	1		4		Ph.D. Soil Science
Curriculum level					Basic, recent and Innovative	**Student specific course outcome**	Research Entrepreneurship and Methodology

Objective:

To impart knowledge about the Research trends in soils microbial to acquaint with the microbial study of soil.

Course outcomes: After completion of the course, a student will be able to:

CO-1	Investigate the research trend in soil microbial biodiversity
CO-2	Understand the Qualitative ecology of microorganisms; Biomass and activities.
CO-3	Identify the Nitrogen fixing organisms and their characteristics
CO-4	Analyze Serological and molecular characterization of soil microorganism
CO-5	Evaluate bioremediation of xerobiotic pollutants and bacterial fertilizers.

Teaching Pedagogy:

T1	Class room Lectures/Guest lecturersStudent Seminars/Presentations
T2	ABL activitiesAssignments

Assessment tools	
AT1-1	One Midterm Exam
AT1-2	Seminar, Presentation
AT1-3	Assignment
AT1-4	Activity Based Learning

Prerequisites	Unit wise contents details	Teaching Pedagogy	Assessment tools
Course Contents	**Unit – 1** Microbial evaluation and biodiversity, Microbial communities in ecosystems, New insights in below ground diverse of plant performance.	Classroom teaching with AV aids	Assignment, Quiz , Mid-term examinations
	Unit – 1I Qualitative ecology of microorganisms; Biomass and activities.	Flipped classes teaching model, Discussions, Field demonstration (ABL)	Assignment, Unannounced test Mid and End Term Examinations
	Unit – III Nitrogen fixing organisms, Trends in diversity of N fixing organisms. Molecular approaches in characterising N fixing microorganisms.	Lecture method/ Presentation Field demonstration (ABL)	Skill test , Quiz. end term examinations
	Unit – IV Serology and molecular characterization, ecological aspects of bio determination, soil waste and water management	Collaborative learning, Lecture method, ABL	Group discussions or debate, Assignment, Extempore, End Term Examinations
	Unit-V Biodegradability, testing and monitoring of the bioremediation of xerobiotic pollutants and bacterial fertilizers.	Flipped classes teaching model, Discussions and Presentation, ABL	Seminar Presentation , Unannounced test, End term examination

Practical Exercise* (Min-8)	List of practicals (field/lab exercises)	Assessment tools
	1. Determination of soil microbes using classical techniques. 2. Determination of soil microbial diversity using molecular techniques 3. Estimation of soil microbial biomass carbon, nitrogen and phosphorus. 4. Estimation of key soil enzyme activities. 5. Community level physiological profiling of microbial diversity.	Practical Activity Practical Record Attendance Viva voce
Resources:	LCD, Black/ White Board, Computer	
Assignment/Tutorial:	Studentsarerequiredtosubmitthegivenassignmentsanddeliveronepowerpointpresentation asapartoftheircontinuousevaluationsystem.	

List of Assignments	1. Qualitative ecology of microorganisms; Biomass and activities. 2. Nitrogen fixing organisms, Trends in diversity of N fixing organisms
ABL	1. Microbial identification techniques 2. Serology and molecular characterization 3. Field Demonstrations
Suggested reading:	▪ Lynch JM, Willey JM. Soil Biotechnology. ▪ Paul EA and Clark FE. Soil Microbiology and Biochemistry. ▪ Sherwood LM and Woolverton CJ. Prescott's Microbiology. ▪ Subba Rao NS. *Advances In Agricultural Microbiology.*

Course Code: STAT 502	**Course Name:** Statistical Methods for Applied Sciences	**Semester:1Ind**

Credits	L	T	P	Marks			Contact Hours (per week)	Independent Study Hour (per week)	Section (Group)
4	3	0	1				5		**Ph.D. Agronomy**
Curriculum level							Informationbased Critical thinkingbased Research based	**Student specific course outcome**	Placement Research Higher education

Objective: To understand different statistical concepts and its utility in agriculture research and gets hands on end-to-end solutions of statistical techniques using calculator/MS Excel/R

Course outcomes: Through this course students will be able to:

CO-1	To acquaint with the understanding of basic concept of Statistics and Probability in the field of agriculture
CO-2	Understand the concepts of probability distributions and various statistical tools used for agricultural data analysis
CO-3	Calculate the various statistical parameters of given data samples using parametric and non-parametric tests
CO-4	Able to perform multivariate analysis using different software
CO-5	Evaluate the use/role of various statistical software used for agricultural data sets test/analysis

Teaching Pedagogy:

T1	Classroom Lectures/Guest lectures Student Seminars/Presentations
T2	ABL activities Assignments

Assessment tools	
AT-1	One Midterm Exam
AT-2	Seminar, Presentation
AT-3	Assignment
AT-4	Activity Based Learning

Prerequisites	Module wise details	Assessment tools
Course Contents	**Unit – 1** Box-plot, Descriptive statistics, Exploratory data analysis, Theory of probability, Random variable and mathematical expectation.	Classroom teaching ABL
	Unit – 2 Discrete and continuous probability distributions, Binomial, Poisson, Negative Binomial, Normal distribution, Beta and Gamma distributions 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.	Assignment Unannounced test Mid Term examination
	Unit – 3 Introduction to theory of estimation and confidence-intervals, Simple and multiple correlation coefficient, partial correlation, rank correlation, Simple and multiple	Quiz Assignment

	linear regression model, test of significance of correlation coefficient and regression coefficients, Coefficient of determination, Fitting of quadratic models.	
	Unit – 4 Non-parametric tests – sign, Wilcoxon, Mann-Whitney U-test, Run test for the randomness of a sequence. Median test	ABL Assignment Quiz
	Unit-V Introduction to ANOVA: One way and Two Way, Introduction to Sampling Techniques, Introduction to Multivariate Analysis, Transformation of Data.	End term examination ABL Viva Voce

Practical Exercise* (Min-8)	**Course Modules**	**Assessment tools**
	1. Exploratory data analysis, fitting of distributions ~ Binomial, Poisson, Negative Binomial, Normal. 2. Large sample tests, testing of hypothesis based on exact sampling distributions ~ chi square, t and F. 3. Confidence interval estimation and Correlation and regression analysis, fitting of Linear and Quadratic Model. 4. Non-parametric tests. ANOVA: One way, Two Way, SRS.	Practical Activity Practical Record Viva voce
Resources:	LCD, White Board, Computer Lab.	
Assignment/Tutorial:	Students are required to submit one assignment and attend quiz as a part of their continuous evaluation system.	
List of Assignments	1. Example of Binomial and Poisson distribution fitting 2. Example of Principal Component analysis 3. Example of Path Analysis	
Suggested reading:	**A. Textbooks:** 1. Gupta, S. C. and Kapoor, V. K. 2014. Fundamentals of Mathematical Statistics. Sultan Chand and sons. New Delhi 2. Gupta, V.,2002. *Comdex Computer Kit*. Dream Tech Press, New Delhi. 3. Chandel SRS. 1999. A handbook of Agricultural Statistics. AchalPrakashan 4. Anderson TW. 1958. An Introduction to Multivariate Statistical Analysis. John Wiley. 5. Dillon WR & Goldstein M. 1984. Multivariate Analysis - Methods and Applications. John Wiley. 6. Goon AM, Gupta MK &Dasgupta B. 1977. An Outline of Statistical Theory. Vol. I. The World Press. 7. Goon AM, Gupta MK &Dasgupta B. 1983. Fundamentals of Statistics. Vol. I. The World Press. **Reference books:** 1) Rangaswamy, R.1995. *A Text Book of Agricultural Statistics*. New Age International Publishing Limited, Hyderabad. 2) Gupta, S. C. and Kapoor, V. K. 2014. Fundamentals of Mathematical Statistics. Sultan Chand and sons. New	

	Delhi	

Credits	L	T	P	Marks			Contact Hours (per week)	Independent Study Hour (per week)	Section (Group)
3	2	0	1				4		Ph.D. Agronomy
Curriculum level							Informationbased Critical thinkingbased Research based	Student specific course outcome	Placement Research Higher education

Objective: To understand different statistical packages like Excel, SPSS, SAS, R, and Python for enhancing practical proficiency in data analysis.

Course outcomes: Through this course students will be able to:

CO-1	To Gain a solid understanding of fundamental statistical concepts and develop skills to explore and visualize data effectively using statistical packages, fostering the ability to identify patterns, trends, and outliers.
CO-2	Develop skills to clean and preprocess raw data effectively and acquire proficiency in conducting statistical inference
CO-3	Learn advanced techniques in multivariate analysis, such as ANOVA and MANOVA, to analyze complex relationships among multiple variables simultaneously.
CO-4	Able to develop the ability to interpret statistical results in the context of the problem domain, translating findings into actionable insights for decision-makers.
CO-5	Gain hands-on experience with popular statistical packages like Excel, SPSS, SAS, R, and Python for enhancing practical proficiency in data analysis.
CO-6	Apply data analysis techniques to real-world scenarios, solving practical problems and making data-driven decisions in the field of Agriculture and cultivate a mindset for continuous learning in the rapidly evolving field of data analysis, staying informed about new statistical methods and tools.

Teaching Pedagogy:

T1	Classroom Lectures/Guest lectures Student Seminars/Presentations
T2	ABL activities Assignments

Assessment tools:	
AT-1	One Midterm Exam
AT-2	Seminar, Presentation
AT-3	Assignment
AT-4	Activity Based Learning

Prerequisites	Module wise details	Assessment tools

Course Contents	**Unit – I** Introduction to various statistical packages: Excel, R, SAS, SPSS. Data Preparation; Descriptive statistics; Graphical representation of data, Exploratory data analysis.	Classroom teaching ABL
	Unit – II Test for normality; Testing of hypothesis using chi-square, t and F statistics and Z-test.	Assignment Unannounced test Mid Term examination
	Unit – III Data preparation for ANOVA and ANCOVA, Factorial Experiments, contrast analysis, multiple comparisons, Analyzing crossed and nested classified designs.	Quiz Assignment
	Unit – IV Analysis of mixed models; Estimation of variance components; Correlation and regression analysis, Probit, Logit and Tobit Models.	ABL Assignment Quiz
	Unit-V Discriminant function; Factor analysis; Principal component analysis; Analysis of time series data, Fitting of non-linear models; Neural networks.	End term examination ABL Viva Voce

Practical Exercise* (Min-8)	**Course Modules**	**Assessment tools**
	1. Use of software packages for summarization and tabulation of data, obtaining descriptive statistics, graphical representation of data 2. Testing the hypothesis for one sample t-test, two sample t-test, paired t-test, test for large samples - Chi-squares test, F test, one-way analysis of variance 3. Designs for Factorial Experiments, fixed effect models, random effect models, mixed effect models, estimation of variance components 4. Linear regression, Multiple regression, Regression plots 5. Discriminant analysis - fitting of discriminant functions, identification of important variables 6. Factor analysis. Principal component analysis - obtaining principal component.	Practical Activity Practical Record Viva voce
Resources:	LCD, White Board, Computer Lab.	
Assignment/ Tutorial	Students are required to submit one assignment and attend quiz as a part of their continuous evaluation system.	
List of Assignments	1. Data analysis using SPSS software. 2. Data analysis using SAS software. 3. Data analysis using R software. 4. Data analysis using Python software.	

ABL	Short term courses of Python, SPSS, SAS and R Software.	
Suggested reading:	**B.** Textbooks: **1)** Anderson C.W. and Loynes R.M. 1987. The Teaching of Practical Statistics. John Wiley. **2)** Atkinson A.C. 1985. Plots Transformations and Regression. Oxford University Press. **3)** Chambers J.M., Cleveland W.S., Kleiner B and Tukey P.A. 1983. Graphical Methods for Data Analysis. Wadsworth, Belmount, California. **4)** Chatfield C. 1983. Statistics for Technology. 3rd Ed. Chapman & Hall. Chatfield C. 1995. Problem Solving: A Statistician's Guide. Chapman & Hall. **5)** Cleveland W.S. 1985. The Elements of Graphing Data. Wadsworth, Belmont, California. **6)** Ehrenberg ASC. 1982. A Primer in Data Reduction. John Wiley. **7)** Erickson B.H. and Nosanchuk T.A. 1992. Understanding Data. 2nd Ed. Open University Press, Milton Keynes. **8)** Snell E.J. and Simpson HR. 1991. Applied Statistics: A Handbook of GENSTAT Analyses. Chapman and Hall. **9)** Sprent P. 1993. Applied Non-parametric Statistical Methods. 2nd Ed. Chapman & Hall. **10)** Tufte ER. 1983. The Visual Display of Quantitative Information. Graphics Press, Cheshire, Conn. **11)** Velleman PF and Hoaglin DC. 1981. Application, Basics and Computing of Exploratory Data Analysis. Duxbury Press Reference books: 3) Rangaswamy, R.1995. *A Text Book of Agricultural Statistics*. New Age International Publishing Limited, Hyderabad. 4) Gupta, S. C. and Kapoor, V. K. 2014. Fundamentals of Mathematical Statistics. Sultan Chand and sons. New Delhi	