Integral University, Lucknow
Integral Institute of Agricultural Science and Technology
Evaluation Scheme of Post Graduate Program
w.e.f. 2022-23
M. Sc. (Ag.) Soil Science
Semester-I

Course Code	Course Title	Type of Course	Periods/ Per week			Evaluation Scheme Theory Mid Sem			Evaluation Scheme Practical Mid Sem			Practical End Sem Exam	Sub Total (Theory + Practical Mid Sem Exam)	End Sem Theory Exam	Subject Total	Credit	Total Credit Points	Attributes							United Nations sustainable development goals (SDGs)
			L	T	P	CT	TA	Total	CT	TA	Total							Employability	Entrepreneurship	Skill Development	Gender Equality	Environment & Sustainability	Human Value	Professional Ethics	
SOIL 501	**Soil Physics**	**Major**	2	0	2	20	10	**30**	-	-	-	20	**50**	**50**	**100**	2:0:1	3	√		√			√	√	
SOIL 502	**Soil Fertility and Fertilizer Use**		2	0	2	20	10	**30**	-	-	-	20	**50**	**50**	**100**	2:0:1	3	√		√		√	√	√	
Total																									
SOIL 505	**Soil Erosion and Conservation**	**Optional**	2	0	2	20	10	**30**	-	-	-	20	**50**	**50**	**100**	2:0:1	3	√	√	√		√			
Total																	*								
***Major Course (Core course + Optional course) should not exceed more than 9 credit**																									
AGRON 506	**Agronomy of Major Cereals and Pulses**	**Minor**	2	0	0	20	10	**30**	-	-	-	-	**30**	**70**	**100**	2:0:0	2$	√		√		√	√	√	
AGRON 511	**Cropping System and Sustainable Agriculture**		2	0	0	20	10	**30**	-	-	-	-	**30**	**70**	**100**	2:0:0	2$	√	√	√		√			
STAT 511	**Experimental Designs**	**Supporting**	2	0	2	20	10	**30**	-	-	-	20	**50**	**50**	**100**	2:0:1	3	√		√		√	√	√	
BIOCHEM 505	**Techniques in Biochemistry**		2	0	4	20	10	**30**	-	-	-	20	**50**	**50**	**100**	2:0:2	4	√	√	√					
MCA 512	**Information Technology in Agriculture**		1	0	2	20	10	**30**	-	-	-	20	**50**	**50**	**100**	1:0:1	2	√	√	√					
Total																	**								
PGS503 (e-Course)	**Intellectual Property and Its Management in Agriculture**	**Common**	1	0	0	20	10	**30**	-	-	-	-	**30**	**70**	**100**	1:0:0	1#	√	√	√				√	
PGS504	**Basic Concepts in Laboratory Techniques**		0	0	2	0	0	**0**	-	25	25	75	**25**	-	**100**	0:0:1	1#	√	√	√					
Grand Total																	***								

*Grand Total (***) = *+**, credit should not exceed more than 22 credit in one semester; $Students can opt for any one of the course from Minor.*

M. Sc. (Ag.) Soil Science
SEMESTER-I
Course Title: Soil Physics
Course Code: SOIL 501
w.e.f. Session 2022-23

3(2+1)

Unit-I

Basic principles of physics applied to soils, soil as a three phase system. Soil texture, textural classes, mechanical analysis, specific surface. Soil consistence; dispersion and workability of soils; soil compaction and consolidation; soil strength; swelling and shrinkage - basic concepts. Alleviation of soil physical constraints for crop production. Soil erosion and edibility.

Unit-II

Soil structure - genesis, types, characterization and management soil structure; Soil aggregation, aggregate stability; soil tilth, characteristics of good soil tilth; soil crusting -mechanism, factors affecting and evaluation; soil conditioners; puddling, its effect on soil physical properties; clod formation. Soil water: content and potential, soil water retention, soil-water constants, measurement of soil water content, energy state of soil water, soil water potential, soil-moisture characteristic curve; hysteresis, measurement of soil-moisture potential.

Unit-III

Water flow in saturated and unsaturated soils, Poiseuille's law, Darcy's law; hydraulic conductivity, permeability and fluidity, hydraulic diffusivity; measurement of hydraulic conductivity in saturated and unsaturated soils. Infiltration; internal drainage and redistribution; evaporation; hydrologic cycle, field water balance; soil-plant-atmosphere continuum.

Unit-IV

Composition of soil air; renewal of soil air - convective flow and diffusion; measurement of soil aeration; aeration requirement for plant growth; soil air management. Modes of energy transfer in soils; energy balance; thermal properties of soil; measurement of soil temperature; soil temperature in relation to plant growth; soil temperature management.

Practical:

Determination of B.D, P.D and mass volume relationship of soil, Mechanical analysis by hydrometer and international pipette method, Measurement of Atterberg limits, Aggregate analysis - dry and wet, Measurement of soil-water content by different methods, Measurement of soil-water potential by using tensiometer and gypsum Blocks, Determination of soil-moisture characteristics curve and computation of pore-size, distribution, Determination of hydraulic conductivity under saturated and unsaturated conditions, Determination of infiltration rate of soil, Determination of aeration porosity and oxygen diffusion rate, Soil temperature measurements by different methods, Estimation of water balance components in bare and cropped fields.

Suggested Readings:

- Ghildyal BP & Tripathi RP. 2001, Soil Physics, New Age International.
- Hanks JR & Ashcroft GL. 1980, Applied Soil Physics. Springer Verlag.
- Hillel D. 1972, Optimizing the Soil Physical Environment toward Greater Crop Yields, Academic Press.
- Applications of Soil Physics- Hillel D. 1980, Academic Press.
- Environmental Soil Physics- Hillel D. 1998, Academic Press.
- Introduction to Environmental Soil Physics- Hillel D. 2003, Academic Press.
- Fundamentals of Soil Science- Indian Society of Soil Science. 2002, ISSS, New Delhi.
- Text Book of Soil Physics- Saha AK. 2004, Kalyani.
- Soil Physics- Jury WA. 2012, Wiley India Pvt Ltd.

COURSE OBJECTIVES:

- To gain the knowledge of soil physical properties
- To study about the soil formation factors and processes
- To assess the importance of soil water for plant growth
- To study in detail about soil components
- To study about management of soil physical properties for better crop yield

COURSE OUTCOME (CO):

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

COURSE OUTCOME (CO)	DESCRIPTION
CO1	To gain the knowledge of soil physical properties
CO2	To study about the soil formation factors and processes
CO3	To assess the importance of soil water for plant growth
CO4	To study in detail about soil components
CO5	To study about management of soil physical properties for better crop yield

CO-PO-PSO MAPPING

PO	PO										PSO			
CO	POI	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	3	3	1	2	2	2	3	3	2	2	2
CO2	3	3	1	1	2	1	1	1	2	3	3	2	2	2
CO3	3	2	2	3	3	2	2	3	2	3	3	3	2	2
CO4	3	3	3	3	3	2	1	3	3	3	3	3	3	3
CO5	3	3	3	3	3	2	2	3	3	3	3	3	3	2
3: Strong contribution, 2: average contribution, 1: Low contribution														

M. Sc. (Ag.) Soil Science
SEMESTER-I
Course Title: Soil Fertility and Fertilizer Use
Course Code: SOIL 502
w.e.f. Session 2022-23

3(2+1)

Unit-I
Soil fertility and soil productivity; fertility status of major soils group of India; nutrient sources – fertilizers and manures; Criteria of essentiality, classification, law of minimum and maximum, essential plant nutrients - functions and deficiency symptoms, Nutrient uptake, nutrient interactions in soils and plants; long term effect of manures and fertilizers on soil fertility and crop productivity.

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

Unit-III
Soil and fertilizer phosphorus - forms, immobilization, mineralization, reactions in acid and alkali soils; factors affecting phosphorus availability in soils; phosphatic fertilizers - behavior in soils and management under field conditions. Potassium - forms, equilibrium in soils and its agricultural significance; mechanism of potassium fixation; management of potassium fertilizers under field conditions.

Unit-IV
Sulphur - source, forms, fertilizers and their behavior in soils; role in crops and human health; calcium and magnesium– factors affecting their availability in soils; management of sulphur, calcium and magnesium fertilizers. Micronutrients – critical limits in soils and plants; factors affecting their availability and correction of their deficiencies in plants; role of chelates in nutrient availability.

Unit-V
Common soil test methods for fertilizer recommendations; quantity– intensity relationships; soil test crop response correlations and response functions. Fertilizer use efficiency; site-specific nutrient management; plant need based nutrient management; integrated nutrient management; speciality fertilizers concept, need and category. Current status of speciality fertilizers use in soils and crops of India;

Unit VI
Soil fertility evaluation - biological methods, soil, plant and tissue tests; soil quality in relation to sustainable agriculture, Determination of critical limit, DRIS. Definition and concepts of soil health and soil quality; Long term effects of fertilizers and soil quality.

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

Suggested Readings:

- The Nature and Properties of Soils13th Ed. - Brady NC & Weil RR. 2002, Pearson Edu.
- Trace Elements in Soils and Plants- Kabata-Pendias A & Pendias H 1992, CRC Press.
- Biofertilizers Technology- Kannaiyan S, Kumar K & Govindarajan K 2004, Scientific Publ.
- Nitrogen Fixation at the Millennium- Leigh JG. 2002, Elsevier.
- Principles of Plant Nutrition- Mengel K & Kirkby EA. 1982, International Potash Institute,

Switzerland.
- Micronutrients in Agriculture. 2nd Ed.- Mortvedt JJ, Shuman LM, Cox FR & Welch RM. 1991, SSSA, Madison.
- Soils and Environmental Quality. 2nd Ed.- Pierzinsky GM, Sims TJ & Vance JF. 2002, CRC Press.
- Cycles of Soil: Carbon, Nitrogen, Phosphorus, Sulphur, Micronutrients- Stevenson FJ & Cole MA. 1999, John Wiley & Sons.
- Soil Fertility and Fertilizers. 5th Ed.- Tisdale SL, Nelson SL, Beaton JD & Havlin JL. 1999, Prentice Hall of India.
- Soils and Soil Fertility- Troeh FR & Thompson LM. 2005, Blackwell.
- Soil Fertility- Issaka R. 2014, Intech.
- Soil Fertility Fertilizer and Integrated Nutrient Management- Tolanur S. 2018.

COURSE OBJECTIVES:

- To gain the knowledge of nutrient availability
- To study about the nutrient mobility
- To assess the importance of nutrient use efficiency
- To study about soil fertility and productivity
- To study about fertilizer and manure use

COURSE OUTCOME (CO):

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

COURSE OUTCOME (CO)	DESCRIPTION
CO1	To gain the knowledge of nutrient availability
CO2	To study about the nutrient mobility
CO3	To assess the importance of nutrient use efficiency
CO4	To study about soil fertility and productivity
CO5	To study about fertilizer and manure use

CO-PO-PSO MAPPING

PO	PO										PSO			
CO	POI	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	1	1	2	2	3	3	2	2	2
CO2	3	3	2	1	2	1	2	2	2	3	3	2	2	2
CO3	3	2	2	1	2	2	2	3	2	3	3	2	2	2
CO4	3	3	3	2	3	2	2	3	3	3	3	3	3	2
CO5	3	3	3	2	3	2	3	3	3	3	3	3	3	2
3: Strong contribution, 2: average contribution, 1: Low contribution														

M. Sc. (Ag.) Soil Science
SEMESTER-I
Course Title: Soil Erosion and Conservation
Course Code: SOIL 505
w.e.f. Session 2022-23

3(2+1)

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

Unit-II
Forms of soil erosion; effects of soil erosion and factors affecting soil erosion; types and mechanisms of water erosion; raindrops and soil erosion; rainfall erosivity-estimation as EI30 index and kinetic energy; factors affecting water erosion; empirical and quantitative estimation of water erosion; methods of measurement and prediction of runoff; soil losses in relation to soil properties and precipitation.

Unit-III
Wind erosion- types, mechanism and factors affecting wind erosion; extent of problem in the country. Principles of erosion control; erosion control measures – agronomical and engineering; erosion control structures - their design and layout.

Unit-IV
Soil conservation planning; land capability classification; soil conservation in special problem areas such as hilly, arid and semi-arid regions, waterlogged and wet lands. Watershed management - concept, objectives and approach; water harvesting and recycling; flood control in watershed management; socio economic aspects of watershed management; case studies in respect to monitoring and evaluation of watersheds; use of remote sensing in assessment and planning of watersheds, sediment measurement

Practical:
Determination of different soil erodibility indices - suspension percentage; dispersion ratio, erosion ratio, clay ratio, clay/moisture equivalent ratio, percolation ratio, raindrop erodibility index; Computation of kinetic energy of falling rain drops; Computation of rainfall erosivity index (EI30) using rain gauge data; Land capability classification of a watershed; Visits to a watersheds.

Suggested Readings:

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

COURSE OBJECTIVES:
- To gain the knowledge of soil and its conservation.
- To study about the types of erosion
- To assess the measures to be taken for controlling soil erosion to conserve soil and water
- To study about soil conversation planning methods in different areas.

COURSE OUTCOME (CO):
After completion of the course, a student will be able to

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Knowledge of soil and its different types
CO2	Experience on the knowledge of soil conservation
CO3	Utilization of the knowledge in research for solving field problem.

CO-PO-PSO MAPPING

	PO										PSO			
CO	**POI**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	2	2	2	1	1	2	2	3	3	2	2	2
CO2	3	3	2	1	2	1	2	2	2	3	3	2	2	2
CO3	3	2	2	1	2	2	2	3	2	3	3	2	2	2
3: Strong contribution, 2: average contribution, 1: Low contribution														

M. Sc. (Ag.) Agronomy
SEMESTER-I
Course Title: Agronomy of Major Cereals and Pulses
Course Code: AGRON 506
w.e.f. Session 2022-23

2(2+0)

Unit-I
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 Rabi cereals.

Unit-II
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 Kharif cereals.

Unit-III
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 Rabi pulses.

Unit-III
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 Kharif pulses.

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.

Suggested Readings:

- 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 FieldCrops. Oxford & IBH.
- Singh SS. 1998. Crop Management. Kalyani.
- Yadav DS. 1992. Pulse Crops. Kalyani.

COURSE OBJECTIVES:
- To impart knowledge of crop husbandry of cereals and pulse crops.

- Processing and handling of Rabi and Kharif cereals.
- Processing and handling of Rabi and Kharif pulses.

COURSE OUTCOMES (CO):

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

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Basic knowledge on cereals and pulse growing in the country
CO2	Estimation of different growth and yield attributes
CO3	Practical knowledge of different indices of crop harvest.

CO-PO-PSO MAPPING

	PO												PSO		
CO	**POI**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	2	3	3	2	2	3	2	2	2	3	3	3	2
CO2	3	3	2	3	2	2	2	1	2	1	3	3	3	3	3
CO3	2	3	3	2	2	1	3	2	3	2	2	3	2	3	2
3: Strong contribution, 2: average contribution, 1: Low contribution															

M. Sc. (Ag.) Agronomy
SEMESTER-I
Course Title: Cropping System and Sustainable Agriculture
Course Code: AGRON 511
w.e.f. Session 2022-23

2(2+0)

Unit-I
Cropping systems: definition, indices and its importance; physical resources, soil and water management in cropping systems; assessment of land use.

Unit-II
Concept of sustainability in cropping systems and farming systems, scope and objectives; production potential under monoculture cropping, multiple cropping, alley cropping, sequential cropping and intercropping, mechanism of yield advantage in intercropping systems.

Unit-III
Above and below ground interactions and allelopathic effects; competition relations; multi-storied cropping and yield stability in intercropping, role of non-monetary inputs and low cost technologies; research need on sustainable agriculture.

Unit-IV
Crop diversification for sustainability; role of organic matter in maintenance of soil fertility; crop residue management; fertilizer use efficiency and concept of fertilizer use in intensive cropping system. Advanced nutritional tools for big data analysis and interpretation.

Unit-V
Plant ideotypes for drylands; plant growth regulators and their role in sustainability. Artificial Intelligence- Concept and application.

Suggested Readings:

- 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 OBJECTIVES:
- Knowledge and concept of sustainable agriculture
- To acquaint the students about prevailing cropping systems in the country.
- To study of different cropping systems for sustainable agriculture
- To acquaint the students about practices to improve their productivity.

COURSE OUTCOMES (CO):
After completion of the course, a student will be able to

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Basic knowledge on cropping system for sustainable agriculture.

CO2	Concept of sustainable agriculture including its relevance to India and global agriculture and future prospects
CO3	Knowledge of intercropping systems
CO4	Crop diversification for sustainability, role of different chemicals in sustainability

CO-PO-PSO MAPPING

	PO												**PSO**		
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	2	3	3	2	2	3	2	2	2	3	3	3	2
CO2	3	3	2	3	2	2	2	1	2	1	3	3	3	3	3
CO3	2	3	3	2	2	1	3	2	3	2	2	3	2	3	2
CO4	3	2	2	3	3	3	2	1	2	1	3	3	3	3	3
3: Strong contribution, 2: average contribution, 1: Low contribution															

M. Sc. (Ag.)/M.Sc. (Hort.)
SEMESTER-I
Course Title: Experimental Designs
Course Code: STAT 511
w.e.f. Session 2022-23

3(2+1)

Unit-I
Experiments: Absolute Experiments, Comparative experiments, need for designing of experiments, characteristics of a good design. Treatment, experimental unit, blocks, yield, uniformity trials, size and shape of plots and blocks. Principles of design of experiment: randomization, replication and local control.

Unit-II
Designs of experiments: Completely Randomized Design, Randomized Block Design and Latin square design and their analysis of variance. factorial design; symmetrical and asymmetrical. Confounding in symmetrical factorial experiments, factorial experiments with control treatment, advantages and disadvantages of confounding.

Unit-III
Analysis of covariance for two-way classification (Randomized Block Design). Split plot design: comparison between split-plot design and factorial design, advantages and disadvantages of split plot design. Missing Plot techniques: Analysis of missing plot design (Fisher's Rule), analysis of Randomized Block Design with one missing observation, analysis of Latin Square Design with one missing observation

Unit-IV
Balanced Incomplete Block Design (BIBD), parameters of BIBD, Incidence matrix, Symmetric BIBD, Analysis of BIBD, efficiency of BIBD relative to Randomized Block Design, Response Surfaces.

Practical:
Uniformity trial data analysis, formation of plots and blocks, Analysis of data obtained from Completely Randomized Design, Randomized Block Design, Latin Square Design; Analysis of factorial experiments without and with confounding; Analysis with missing data; Split plot designs; Transformation of data; Fitting of response surfaces.

Suggested Readings:

- Cochran, W.G. and Cox, G.M. Experimental Design. Asia Publishing House.
- Kempthorne, O. (1965): The Design and Analysis of Experiments. John Wiley.
- Montgomery, D. C. (2008): Design and Analysis of Experiments, John Wiley.
- Goon, A.M., Gupta, M.K. and Dasgupta, B. (2005): Fundamentals of Statistics. Vol. II, 8thEdn. World Press, Kolkata.
- Casella, G, (2008). Statistical Design. Springer.
- Gupta, S.C. and Kapoor, V.K. Latest Revised Edition 2015. Fundamentals of Applied Statistics.

COURSE OBJECTIVES:
- Basic concepts of Experiments, designs and analysis of covariance
- Comparative experiments, need for designing of experiments
- In depth knowledge of principles of design of experiment: randomization, replication and local control
- Knowledge of completely randomized design, Randomized Block Design and Latin square design and their analysis of variance
- Balanced Incomplete Block Design (BIBD) and its parameters

- Analysis of missing plot design (Fisher's Rule),analysis of Randomized Block Design with one missing observation

COURSE OUTCOMES (CO):

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

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Students will have basic knowledge of Experiments, designs and analysis of covariance
CO2	Students will have knowledge of Comparative experiments
CO3	The students will be able to prepare their experimental fields on the basis of designs
CO4	Students can have the knowledge of completely Randomized Design, Randomized Block Design and Latin square design and their analysis of variance
CO5	Students can analyze their results according to the designs

CO-PO-PSO MAPPING

	PO												PSO		
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	3	2	2	2	2	1	1	2	2	1	3	2	2	2
CO2	2	3	2	2	2	2	1	1	1	3	1	3	2	2	2
CO3	2	3	2	2	2	2	1	1	2	3	1	3	2	2	2
CO4	2	3	2	2	2	2	1	1	2	3	1	3	3	2	2
CO5	2	3	2	2	2	2	1	1	2	3	1	3	3	3	2
3: Strong contribution, 2: average contribution, 1: Low contribution															

M. Sc. (Ag.)/M.Sc. (Hort.)
SEMESTER-I
Course Title: Techniques in Biochemistry
Course Code: BIOCHEM 505
w.e.f. Session 2022-23

4(2+2)

Unit-I
General scheme for purification of biocomponents. Methods of studying cells and organelles, sub cellular fractionation and marker enzymes. Methods for lysis of plant, animal and microbial cells. Ultra-filtration, sonication, freeze drying and fractional precipitation. Principles of centrifugation, concepts of RCF, different types of instruments and rotors, preparative, differential and density gradient centrifugation, analytical ultra-centrifugation, determination of molecular weights and other applications, subcellular fractionation.

Unit-II
Basic principles, instrumentation, working and applications of partition chromatography, paper, thin layer, ion exchange and affinity chromatography, gel permeation chromatography, HPLC and FPLC.

Unit-III
Electrophoretic techniques - slab, capillary, 2-D, pulse field, polyacrylamide/agarose gel electrophoresis. Blotting techniques: Western, Southern and Northern blotting- principle and methodology.

Unit-IV
Fundamental principles of flourescene & phosphorescence, absorption, transmission of light, Beer – Lamberts law, Colorimeter, flame photometry. Principle, instrumentation, working and application of – UV, visible and IR spectroscopy, atomic absorption spectrometry, Nuclear Magnetic Resonance (NMR), Mass spectroscopy - GC-MS, HPLC-MS and LC-MS/MS, Matrix-assisted laser desorption/ionization- Time-of-Flight Mass spectroscopy (MALDI-TOF MS), X-ray crystallography.

Unit-IV
Basic principles, instrumentation and applications of microscopy. Bright field, phase contrast, fluorescence and confocal microscopy. Electron microscope – scanning and transmission electron microscopy. Nature of radioactivity, decay and types of radiation. Radiation hazards and precautions taken while handling radioisotopes. Radiation detection and measurements: Geiger Muller counter, scintillation counter and pulse height analyzer. Application of radioisotopes in biological science-autoradiography.

Practical:
Methods for lysis of plant and microbial cells; Centrifugation; Verification of Beer-Lambert's law and determination of absorption coefficients; Paper chromatography – Separation of amino acids and carbohydrates in a mixture; Thin layer chromatography of fatty acids; Column chromatography – Separation of a mixture of proteins and salt using Sephadex column; Electrophoresis. Staining of bacteria – Simple staining, differential staining, staining of spores.

Suggested Readings:

- Principles and Techniques of Practical Biochemistry by Keith Wilson, John Walker (eds), Cambridge University Press; 5th edition.
- Principles and Techniques of Practical Biochemistry by Wilson, K., Walker, J. (eds.), Cambridge University Press, Cambridge, 2000, 5th edition.
- Lehninger Principles Of Biochemistry by David L. Nelson, Michael M. Cox, W. H. Freeman, 6th edition.

COURSE OBJECTIVES:

- Knowledge and concept of Biomolecules.
- Basic concepts and principles of different biochemical techniques.
- Applications of different bioanalytical techniques.

COURSE OUTCOMES (CO):

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

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Understand about the cells and apply the concept of centrifugation.
CO2	Explain classification, principle and application of chromatography.
CO3	Discuss principle and application of electrophoresis and blotting techniques
CO4	Understand working principle of spectrophotometer and able to handle different spectrophotometric techniques
CO5	Understand the concept of microscopy and radiations.

CO-PO-PSO MAPPING

	PO												PSO		
CO	**POI**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	1	2	1	2	1	2	1	2	2	3	3	3	2
CO2	3	2	1	1	2	2	1	1	1	1	3	3	3	3	3
CO3	3	3	2	1	2	1	1	2	2	1	2	3	2	3	2
CO4	3	2	1	2	1	1	2	1	1	1	3	3	3	3	2
CO5	3	3	1	1	1	1	1	2	1	1	2	3	2	2	2
3: Strong contribution, 2: average contribution, 1: Low contribution															

M. Sc. (Ag.)/M.Sc. (Hort.)
SEMESTER-I
Course Title: Information Technology in Agriculture
Course Code: MCA 512
w.e.f. Session 2022-23

2(1+1)

Unit-I
Introduction and Applications of e-Agriculture, Introduction to Online Agricultural resources: Consortium for e-resources in Agriculture (CeRA), e-agriculture community, Agriculture: National Portal of India. Agricultural Datasets and Databases: Agricola, Agris. Need of Biological databases in Agricultural Sciences.

Unit-II
Smartphone Apps in Agriculture for farm advisory, Weather forecasting, types, methods, tools & techniques, Use of ICT in Agriculture, Computer Models for understanding plant processes.

Unit-III
Crop models, concepts & techniques, types of crop models, spatial data and their management in GIS; Remote sensing concepts and application in agriculture, Global positioning system (GPS), components and its functions.

Unit-IV
Agricultural Journalism – Meaning, Scope and Importance, Sources of news, Kisan call centers, e-chaupal, RRA, PRA tools and techniques KVK, Adopter categories, MANAGE, EEI: extension education institute.

Practical:
Uniformity trial data analysis, formation of plots and blocks, Analysis of data obtained from Completely Randomized Design, Randomized Block Design, Latin Square Design; Analysis of factorial experiments without and with confounding; Analysis with missing data; Split plot designs; Transformation of data; Fitting of response surfaces.

Suggested Readings:

- Agri Informatics: An Introduction (Industry Series), by R Chakravarthy, ICFAI University Press.
- E-Agriculture: Concepts and Applications (Agriculture Series), Rahul Gupta (Author), ICFA University Press.
- Yadav, D S, Foundations of IT, New Age, Delhi.
- Introduction to Bioinformatics by Teresa Attwood, David Parry-Smith 1st edition; Prentice Hall publications
- Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by Andreas D. Baxevanis and B. F. Francis Ouellette (Eds), 2nd Edition; Willey & Sons publications.
- Bioinformatics: Sequence, Structure, and Databanks: A Practical Approach by Des Higgins, Willie Taylor; OUP.
- BIOS Instant Notes in Bioinformatics by Charlie Hodgman, Andrew French, David Westhead, Taylor & Francis publishing; 2 edition.

COURSE OBJECTIVES:
- To gain basic knowledge of information technology in agriculture
- The aim of improving communication and learning processes between various sectors in agriculture locally, regionally and worldwide
- They gain knowledge of weather forecasting to increase the production and productivity of Agriculture
- Type of education and Agricultural Journalism
- Knowledge of Innovative Information sources.

COURSE OUTCOMES (CO):

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

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Use of Information and Communication Technology in Agriculture
CO2	Know about crop models concepts & techniques
CO3	Know about computer models for understanding plant processes.
CO4	Knowledge of education and their Characteristics and Agricultural Journalism
CO5	Knowledge of contact methods, Kissan Call center and e-Chaupal.

CO-PO-PSO MAPPING

	PO												PSO		
CO	**POI**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	1	3	3	1	1	2	3	3	3	3	2	2
CO2	3	3	3	2	1	3	2	1	3	2	3	3	2	3	2
CO3	3	3	1	2	2	2	3	1	2	3	3	3	2	3	3
CO4	3	3	3	2	3	3	2	1	3	2	3	3	3	1	2
CO5	3	3	2	3	1	3	1	1	2	2	3	3	3	3	2
3: Strong contribution, 2: average contribution, 1: Low contribution															

M. Sc. (Ag.)/M.Sc. (Hort.)/MBA Agribusiness Management
SEMESTER-I
Course Title: Intellectual Property and Its Management in Agriculture
Course Code: PGS503
w.e.f. Session 2018-19

1(1+0)

Unit-I
Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs;

Unit-II
Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks.

Unit-III
Protection of plant varieties and farmers' rights and bio-diversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture.

Unit-IV
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 OBJECTIVES:
- Knowledge, concept and introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement
- Basics of Legislations for the protection of various types of Intellectual Properties
- Fundamentals of patents, copyrights, geographical indications, designs and layout
- Basic concepts of Protection of plant varieties and farmers' rights and bio-diversity protection, Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture
- Study of Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement

COURSE OUTCOMES (CO):
After completion of the course, a student will be able to

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Concept of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement
CO2	Knowledge of Legislations for the protection of various types of Intellectual Properties
CO3	Concepts of Protection of plant varieties and farmers' rights and bio-diversity protection, Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture
CO4	Knowledge of Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture
CO5	Knowledge of Socio-economic impact, Research collaboration Agreement, License Agreement

CO-PO-PSO MAPPING:

	PO												PSO			
CO	**POI**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	3	3	3	1	1	1	3	3	2	3	3	3	2	2	2
CO2	2	3	2	2	1	1	1	1	2	3	1	3	2	2	2	2
CO3	3	3	3	3	1	1	2	2	3	3	2	3	2	2	2	2
CO4	3	3	2	2	1	1	1	1	2	3	3	3	3	2	2	2
CO5	3	3	2	3	1	1	1	3	3	3	3	1	3	3	2	2
3: Strong contribution, 2: average contribution, 1: Low contribution																

M. Sc. (Ag.)/M.Sc. (Hort.)
SEMESTER-I
Course Title: Basic Concepts in Laboratory Techniques
Course Code: PGS504
w.e.f. Session 2018-19

1(0+1)

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; Neutralization 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 & Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.

COURSE OBJECTIVES:
- Basic concepts of Safety measures while handling instruments, chemicals, glasswares, etc. in lab
- Use of different instruments, chemicals, glasswares, etc. of lab
- Preparation of different agrochemical doses in field and pot applications
- Preparation of buffers of different strengths and pH values
- Preparation of media and methods of sterilization
- Seed viability testing, testing of pollen viability

COURSE OUTCOMES (CO):
After completion of the course, a student will be able to

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Students will have basic knowledge of handling and safety measures of instruments, chemicals, glasswares, etc. in lab before and after use
CO2	Students will have knowledge of usage of different type of lab equipments, instruments, glasswares, plasticwares, etc.
CO3	The students will be able to prepare different agrochemical doses in field and pot applications
CO4	Students can have the knowledge to prepare media, acid and bases of different strengths and buffer solutions
CO5	Students can also perform seed and pollen viability testing

CO-PO-PSO MAPPING:

	PO												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	2	1	2	1	2	2	2	1	3	2	2	2	2
CO2	2	2	2	2	1	2	1	2	1	2	1	3	2	2	2	2
CO3	3	3	3	2	1	2	1	2	2	2	1	3	2	2	2	2

CO4	3	3	3	2	1	2	1	2	2	2	1	3	2	2	2	2
CO5	3	3	3	2	2	2	1	2	2	2	1	3	2	2	2	2
3: Strong contribution, 2: average contribution, 1: Low contribution																

Integral University, Lucknow
Integral Institute of Agricultural Science and Technology
Evaluation Scheme of Post Graduate Program
w.e.f. 2022-23
M. Sc. (Ag.) Soil Science
Semester-II

Course Code	Course Title	Type of Course	Periods/ Per week			Evaluation Scheme Theory Mid Sem			Evaluation Scheme Practical Mid Sem			Practical End Sem Exam	Sub Total (Theory + Practical Mid Sem Exam)	End Sem Theory Exam	Subject Total	Credit	Total Credit Points	Attributes							United Nations sustainable development goals (SDGS)
			L	T	P	CT	TA	Total	CT	TA	Total							Employability	Entrepreneurship	Skill Development	Gender Equality	Environment & Sustainability	Human Value	Professional Ethics	
SOIL 503	**Soil Chemistry**	**Major**	2	0	2	20	10	**30**	-	-	-	20	**50**	**50**	**100**	2:0:1	3	√		√			√	√	
SOIL 504	**Soil Mineralogy, Genesis and Classification**		2	0	2	20	10	**30**	-	-	-	20	**50**	**50**	**100**	2:0:1	3	√		√		√	√	√	
Total																									
SOIL 506	**Soil Biology and Biochemistry**	**Optional**	2	0	2	20	10	**30**	-	-	-	20	**50**	**50**	**100**	2:0:1	3	√	√	√		√			
Total																	*								
***Major Course (Core course + Optional course) should not exceed more than 9 credit**																									
AGRON 504	**Principles and Practices of Water Management**	**Minor**	2	0	0	20	10	**30**	-	-	-	-	**30**	**70**	**100**	2:0:0	2	√		√		√	√	√	
		Supporting																							
Total																	**								
PGS502	**Technical Writing and Communications Skills**	**Common**	0	0	2	0	0	**-**	-	-	-	25	**75**	**0**	**100**	0:0:1	1	√		√				√	
PGS505 (e-Course)	**Agricultural Research, Research Ethics and Rural Development Programmes**		1	0	0	20	10	**30**	-	-	-	0	**0**	**70**	**100**	1:0:0	1	√		√			√	√	
SOIL 591	**Master's Seminar**		-	-	-	-	-	-	-	-	-	-	-	-	**100**	0:0:1	1			√					
SOIL 599	**Master's Research**		-	-	-	-	-	-	-	-	-	-	-	-	S/US	0:0:5	5$	√		√			√	√	
Grand Total																	***								

*Grand Total (***) = *+**, credit should not exceed more than 22 credit in one semester; $Master's Research credit to be counted in Final Semester examinations; S/US=Satisfactory/Unsatisfactory*

M. Sc. (Ag.) Soil Science
SEMESTER-II
Course Title: Soil Chemistry
Course Code: SOIL 503
w.e.f. Session 2022-23

3(2+1)

Unit-I
Chemical (elemental) composition of the earth's crust, soils, rocks and minerals. Elements of equilibrium thermodynamics, chemical equilibria, electrochemistry and chemical kinetics.

Unit-II
Soil colloids: inorganic and organic colloids - origin of charge, concept of point of zero-charge (PZC) and its dependence on variable-charge soil components, surface charge characteristics of soils; diffuse double layer theories of soil colloids, zeta potential, stability, coagulation/flocculation and peptization of soil colloids; electrometric properties of soil colloids; sorption properties of soil colloids; soil organic matter - fractionation of soil organic matter and different fractions, Characterization of OM; clay-organic interactions.

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

Unit-IV
Potassium, phosphate and ammonium fixation in soils covering specific and non specific sorption; precipitation-dissolution equilibria; Concept of quantity/intensity (Q/I) relationship; step and constant-rate K; management aspects. Chemistry of acid soils; active and potential acidity; lime potential, chemistry of acid soils; sub-soil acidity. Chemistry of salt-affected soils and amendments; soil pH, ECe, ESP, SAR and important relations; soil management and amendments. Chemistry and electrochemistry of submerged soils, geochemistry of micronutrients, environmental soil chemistry

Practical:
Preparation of saturation extract, measurement of pH, EC, CO, HCO, Ca, Mg, K and Na; Determination of CEC and AEC of soils; Analysis of equilibrium soil solution for pH, EC, Eh by the use of Eh-pH meter and conductivity meter; Determination of point of zero-charge and associated surface charge characteristics by the serial potentiometric titration method; Extraction of humic substances; Potentiometric and conductometric titration of soil humic and fulvic acids; (E4/E6) ratio of soil humic and fulvic acids by visible spectrophotometric studies and the D (E4/E6) values at two pH values; Adsorption-desorption of phosphate/sulphate by soil using simple adsorption isotherm; Construction of adsorption envelope of soils by using phosphate/fluoride/sulphate and ascertaining the mechanism of the ligand exchange process involved; Determination of titratable acidity of an acid soil by $BaCl_2$-TEA method; Determination of Q/I relationship of potassium; Determination of lime requirement of an acid soil by buffer method; Determination of gypsum requirement of an alkali soil.

Suggested Readings:

- Bear RE. 1964. Chemistry of the Soil. Oxford and IBH.
- Bolt GH and Bruggenwert MGM. 1978. Soil Chemistry. Elsevier.
- Greenland DJ and Hayes MHB. 1981. Chemistry of Soil Processes. John Wiley & Sons.
- Greenland DJ and Hayes MHB. Chemistry of Soil Constituents. John Wiley & Sons.
- McBride MB. 1994. Environmental Chemistry of Soils. Oxford University Press.
- Sposito G. 1981. The Thermodynamics of Soil Solutions. Oxford University Press.

- Sposito G. 1984. The Surface Chemistry of Soils. Oxford University Press.
- Sposito G. 1989. The Chemistry of Soils. Oxford University Press.
- Stevenson FJ. 1994. Humus Chemistry. 2nd Ed. John Wiley & Sons.
- Van Olphan H. 1977. Introduction to Clay Colloid Chemistry. John Wiley & Sons.

COURSE OBJECTIVES:

- To study earth's elemental composition and basics of physical chemistry
- To learn properties of soil colloids
- Knowledge of soil organic matter
- To study ion exchange processes in soil
- To know chemistry of NPK in soil
- To know chemistry of problematic soils

COURSE OUTCOMES (CO):

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

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Knowledge about earth's elemental composition and physical chemistry
CO2	Understand the properties of inorganic and organic soil colloids
CO3	Understand the ion exchange processes in soil
CO4	Knowledge of sorption-desorption mechanisms and NPK chemistry in soil
CO5	Understand the chemistry of problematic soils

CO-PO-PSO MAPPING:

	PO										PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	1	2	1	2	1	1	1	1	1	2	3	2	2	2
CO2	2	2	1	2	1	1	1	1	1	2	3	2	2	2
CO3	2	2	1	1	1	2	1	1	1	2	3	2	2	3
CO4	2	2	1	1	1	2	1	2	1	2	3	3	2	3
CO5	2	3	1	1	1	2	1	2	1	2	3	3	2	3
3: Strong contribution, 2: average contribution, 1: Low contribution														

M. Sc. (Ag.) Soil Science
SEMESTER-II
Course Title: Soil Mineralogy, Genesis and Classification
Course Code: SOIL 504
w.e.f. Session 2022-23

3(2+1)

Unit-I
Fundamentals of crystallography, space lattice, coordination theory, isomorphism and polymorphism.

Unit-II
Classification, structure, chemical composition and properties of clay minerals; genesis and transformation of crystal line and non-crystal line clay minerals; identification techniques; amorphous soil constituents and other non-crystalline silicate minerals and their identification; clay minerals in Indian soils, role of clay minerals in plant nutrition, interaction of clay with humus, pesticides and heavy metals.

Unit-III
Factors of soil formation, soil formation models; soil forming processes; weathering of rocks and mineral transformations; soil profile; weathering sequences of minerals with special reference to Indian soils.

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

Practical:
Separation of sand, silt and clay fraction from soil; Determination of specific surface area and CEC of clay; Identification and quantification of minerals in soil fractions; Morphological properties of soil profile in different land forms; Classification of soils using soil taxonomy; Calculation of weathering indices and its application in soil formation; Grouping soils using available database in terms of soil quality.

Suggested Readings:

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

COURSE OBJECTIVES:

- To acquaint students with basic structure of alumino-silicate minerals
- To study the genesis of clay minerals; soil genesis in terms of factors and processes of soil formation.
- To enable students conduct soil survey and interpret soil survey reports in terms of land use planning.

COURSE OUTCOME (CO):

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

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Students will be able to know of basic structure of alumino-silicate minerals
CO2	Students will have the knowledge of genesis of clay minerals; soil genesis in terms of factors and processes of soil formation.
CO3	Students can conduct soil survey and interpret soil survey reports,
CO4	Students will have the idea of different soil classification systems

CO-PO-PSO MAPPING

	PO										PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	2	2	2	1	1	2	2	3	3	2	2	2
CO2	3	3	2	1	2	1	2	2	2	3	3	2	2	2
CO3	3	2	2	1	2	2	2	3	2	3	3	2	2	2
CO4	3	3	3	2	3	2	2	3	3	3	3	3	3	2
3: Strong contribution, 2: average contribution, 1: Low contribution														

M. Sc. (Ag.) Soil Science
SEMESTER-II
Course Title: Soil Biology and Biochemistry
Course Code: SOIL 506
w.e.f. Session 2022-23

3(2+1)

Unit-I
Soil biota, soil microbial ecology, types of organisms in different soils; soil microbial biomass; microbial interactions; un-culturable soil biota.

Unit-II
Microbiology and biochemistry of root-soil interface; phyllosphere; soil enzymes, origin, activities and importance; soil characteristics influencing growth and activity of microflora; Root rhizosphere and PGPR.

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

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

Unit-V
Biological indicators of soil quality; bioremediation of contaminated soils; microbial transformations of heavy metals in soil; role of soil organisms inpedogenesis – important mechanisms and controlling factors; soil genomics and bioprospecting; soil sickness due to biological agents; xenobiotics; antibiotic production in soil.

Practical:
Determination of soil microbial population; Soil microbial biomass carbon; Elemental composition, fractionation of organic matter and functional groups; Decomposition of organic matter in soil; Soil enzymes; Measurement of important soil microbial processes such as ammonification, nitrification, N_2 fixation, S oxidation, P solubilization and mineralization of other micronutrients.

Suggested Readings:

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

COURSE OBJECTIVES:
- To learn about the soil biology
- To provide knowledge various methods of enzymatic activities in soil
- To know the essential micro nutrients
- To learn about soil biochemistry
- To study about biofertilizers

COURSE OUTCOMES (CO):

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

COURSE OUTCOME (CO)	DESCRIPTION
CO1	To learn about the soil biology
CO2	To provide knowledge various methods of enzymatic activities in soil
CO3	To know the essential micro nutrients
CO4	To learn about soil biochemistry
CO5	To study about bio fertilizers

CO-PO-PSO MAPPING:

	PO										PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	2	2	1	1	1	2	2	3	3	3	3	2
CO2	3	1	3	2	1	1	1	2	2	3	3	3	3	2
CO3	3	1	3	3	1	1	1	2	2	2	3	3	3	2
CO4	3	1	3	2	1	1	1	1	2	2	3	2	2	1
CO5	3	2	3	3	1	1	1	2	2	3	3	2	2	2
3: Strong contribution, 2: average contribution, 1: Low contribution														

M.Sc. (Ag.) Agronomy
SEMESTER-II
Course Title: Principles and Practices of Water Management
Course Code: AGRON 504
w.e.f. Session 2022-23

3(2+1)

Unit-I
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.

Unit-II
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.

Unit-III
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.

Unit-IV
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.

Unit-V
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.

Unit-VI
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 method; 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 Readings:

- 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 OBJECTIVES:

- To teach the students about water resources available for agriculture
- To teach the students about principles of water management practices
- To study the quality of irrigation water in relation to crop requirement
- Best management strategies as per nature and demand of crops for water
- Maximization of water use efficiency.

COURSE OUTCOMES (CO):

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

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Students will be able to describe the water resources availability in agriculture
CO2	Students know about principles of water management practices
CO3	Efficient irrigation management in crop production
CO4	Higher water use efficiency as per crop
CO5	Reduction in water losses in crop cultivation

CO-PO-PSO MAPPING:

	PO												PSO		
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	2	3	3	2	2	3	2	2	2	3	3	2	2
CO2	3	3	2	3	2	2	2	2	2	1	3	3	3	3	3
CO3	2	3	3	2	3	1	3	2	3	2	2	3	3	3	3
CO4	2	3	3	3	3	3	1	1	2	1	3	3	3	3	2
CO5	2	2	2	3	2	3	2	3	3	2	2	3	2	2	2
3: Strong contribution, 2: average contribution, 1: Low contribution															

M. Sc. (Ag.)/M.Sc. (Hort.)/MBA Agribusiness Management
SEMESTER-II
Course Title: Technical Writing and Communications Skills
Course Code: PGS 502
w.e.f. Session 2018-19

1(1+0)

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

Suggested Readings

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

COURSE OBJECTIVES:

- To give knowledge about the various forms of scientific writings
- To give knowledge about the various parts of thesis, research communications
- To give knowledge about writing of abstracts, summaries, citations etc
- To give knowledge about research communications, illustrations, photograph, drawings
- To give knowledge about pagination, scientific write ups, editing and proof reading, and writing of review article

COURSE OUTCOMES (CO):

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

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Learn that what are the various forms of scientific writings
CO2	Learn how to write the various parts of thesis, research communications
CO3	Learn how to do writing of abstracts, summaries and what are citations etc
CO4	Learn research communications, illustrations, photograph, drawings

CO5	Learn pagination, scientific write ups, editing and proof reading, and writing of review article

CO-PO-PSO MAPPING:

	PO												PSO		
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	1	2	0	0	2	0	1	1	3	3	2	2	1
CO2	3	3	1	2	0	3	2	0	0	0	3	2	2	2	2
CO3	3	3	1	0	0	1	2	0	0	0	3	3	2	2	2
CO4	3	3	2	3	0	2	2	0	0	0	3	3	2	2	2
CO5	3	3	2	3	0	3	2	1	0	0	3	3	2	2	1
3: Strong contribution, 2: average contribution, 1: Low contribution															

M. Sc. (Ag.)/M.Sc. (Hort.)/MBA Agribusiness Management
SEMESTER-II
Course Title: Agricultural Research, Research Ethics and Rural Development Programmes
Course Code: PGS505 (e-Course)
w.e.f. Session 2018-19

1(0+1)

Unit-I

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centers (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

Unit-II

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

Unit-III

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/Non-Governmental Organizations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings:

- Bhalla GS & 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 OBJECTIVES:

- To know the objective and principle of extension education
- To obtain idea on various development programmes in agriculture and allied area to help farmers.
- To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

COURSE OUTCOMES (CO):

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

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Students capable, efficient, and self-reliant in character.
CO2	They gain knowledge to help rural families in better appreciation of SWOT in the village.
CO3	They know about to open new opportunities for developing talents and leadership of rural people.
CO4	To provide knowledge and help for better management of farms and increase incomes.

CO5	To promote better social, natural recreational intellectual and spiritual file among the people.

CO-PO-PSO MAPPING:

	PO												PSO		
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	2	1	1	3	3	3	2	3	1	1	1	1	1
CO2	3	3	3	1	1	3	3	3	2	3	3	2	2	2	2
CO3	3	2	1	1	1	2	3	3	2	1	2	1	1	1	2
CO4	3	2	2	2	1	3	3	3	2	2	3	1	2	2	2
CO5	3	1	1	1	1	2	3	3	2	2	3	3	1	1	1
3: Strong contribution, 2: average contribution, 1: Low contribution															