Integral University, Lucknow
Integral Institute of Agricultural Science and Technology
Evaluation Scheme of Post graduate program
w.e.f. Session 2022-23

M. Sc. (Ag.) Genetics and Plant Breeding

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						
			L	T	P	CT	TA	Total	CT	TA	Total							Employability	Entrepreneurship	Skill Development	Gender Equality	Environment & Sustainability	Human Value	Professional Ethics
GPB 501	**Principles of Genetics**	**Major**	2	0	2	20	10	**30**	-	-	-	20	**50**	**50**	**100**	2:0:1	3			√				√
GPB 502	**Principles of Plant Breeding**		2	0	2	20	10	**30**	-	-	-	20	**50**	**50**	**100**	2:0:1	3			√		√		√
Total																								
GPB 512	**Crop Breeding-II (Rabi Crops)**	**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**																								
MBB 517	**Stress Biology and Genomics**	**Minor**	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*

M. Sc. (Ag.) Genetics and Plant Breeding
SEMESTER-I
Course Title: Principles of Genetics
Course Code: GPB 501
w.e.f. Session 2022-2023

3(2+1)

Unit-I
Beginning of genetics, early concepts of inheritance, Mendel's laws; Discussion on Mendel's paper, Chromosomal theory of inheritance; Multiple alleles, Gene interactions, Sex determination, differentiation and sex-linkage, Sex-influenced and sex-limited traits; Linkage-detection, estimation; Recombination and genetic mapping in eukaryotes, Somatic cell genetics, Extra chromosomal inheritance.

Unit-II
Mendelian population, Random mating population, Frequencies of genes and genotypes, Causes of change: Hardy-Weinberg equilibrium.

Unit-III
Nature, structure and replication of the genetic material; Organization of DNA in chromosomes, Genetic code; Protein biosynthesis, Genetic fine structure analysis, Allelic complementation, Split genes, overlapping genes, Pseudogenes, Oncogenes, Gene families and clusters; Regulation of gene activity in prokaryotes and eukaryotes; Molecular mechanisms of mutation, repair and suppression; Bacterial plasmids, insertion (IS) and transposable (Tn) elements; Molecular chaperones and gene expression, RNA editing.

Unit-IV
Gene isolation, synthesis and cloning, genomic and cDNA libraries, PCR based cloning, positional cloning; Nucleic acid hybridization and immunochemical detection; DNA sequencing; DNA restriction and modification, Anti-sense RNA and ribozymes; Micro-RNAs (miRNAs).

Unit-V
Genomics and proteomics; metagenomics; Transgenic bacteria and bioethics; Gene silencing; genetics of mitochondria and chloroplasts. Concepts of Eugenics, Epigenetics, Genetic disorders.

Practical:
Laboratory exercises in probability and chi-square; Demonstration of genetic principles using laboratory organisms; Chromosome mapping using three-point test cross; Tetrad analysis; Induction and detection of mutations through genetic tests; DNA extraction and PCR amplification; Electrophoresis: basic principles and running of amplified DNA; Extraction of proteins and isozymes; Use of *Agrobacterium* mediated method and Biolistic gun; Detection of transgenes in the exposed plant material; Visit to transgenic glasshouse and learning the practical considerations.

Suggested readings:

- Daniel LH and Maryellen R. 2011. Genetics: "Analysis of Genes and Genomes".
- Gardner EJ and Snustad DP. 1991. Principles of Genetics. John Wiley and Sons. 8th ed. 2006
- Klug WS and Cummings MR. 2003. Concepts of Genetics. Peterson Edu. Pearson Education India; Tenth edition
- Lewin B. 2008. Genes XII. Jones and Bartlett Publ. (International Edition) Paperback, 2018
- Russell PJ. 1998. Genetics. The Benzamin/ Cummings Publ. Co
- Singh BD. 2009. Genetics. Kalyani Publishers (2nd Revised Edition)
- Snustad DP and Simmons MJ. 2006. Genetics. 4th Ed. John Wiley and Sons. 6th Edition International Student Version edition
- Stansfield WD.1991. Genetics.Schaum Outline Series Mc Graw Hill

- Strickberger MW. 2005. Genetics (III Ed). Prentice Hall, New Delhi, India; 3rd ed., 2015
- Tamarin RH. 1999. Principles of Genetics. Wm. C. Brown Publs., McGraw Hill Education; 7 edition
- Uppal S, Yadav R, Singh S and Saharan RP. 2005. Practical Manual on Basic and Applied Genetics. Dept. of Genetics, CCS HAU Hisar.

COURSE OBJECTIVES:

- Introduction to genetics and historical perspective of genetics.
- Detection of linkage and estimation.
- To aware the students about the fine structure of genes
- To impart the knowledge of induction, detection and mechanism of mutation.
- To study about the extranuclear inheritance and polygenic inheritance.

.**COURSE OUTCOME (CO):**

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

COURSE OUTCOME (CO)	DESCRIPTION
CO1	able to know what are the basic laws and discoveries in genetics.
CO2	able to detect and estimate the linkage and recombination frequency
CO3	Students learned about the fine structure of gene or gene concept
CO4	Students know how to induce, detect and the knowledge of mechanism of mutation.
CO5	Learned about the inheritance of cytoplasmic genes and polygenes.

CO-PO-PSO mapping

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

M. Sc. (Ag.) Genetics and Plant Breeding
SEMESTER-I
Course Title: Principles of Plant Breeding
Course Code: GPB 502
w.e.f. Session 2022-2023

3(2+1)

Unit-I
Early Plant Breeding; Accomplishments through plant breeding; Objectives of plant breeding; Patterns of Evolution in Crop Plants: Centre of Origin, Agro-biodiversity and its significance. Pre-breeding and plant introduction and role of plant genetic resources in plant breeding.

Unit-II
Genetic basis of breeding: self and cross pollinated crops including mating systems and response to selection; Nature of variability, components of variation; Heritability and genetic advance, genotype environment interaction; General and specific combining ability; Types of gene actions and implications in plant breeding.

Unit-III
Pure line theory, pure line and mass selection methods; pedigree, bulk, backcross, single seed descent and multiline breeding; Population breeding in self-pollinated crops with special reference to diallel selective mating; Transgressive breeding.

Unit-IV
Breeding methods in cross pollinated crops; Population breeding: mass selection and ear-to-row methods; S1 and S2 progeny testing, progeny selection schemes, recurrent selection schemes for intra and inter-population improvement and development of synthetics and composites. Hybrid breeding: genetical and physiological basis of heterosis and inbreeding, production of inbreeds, breeding approaches for improvement of inbreeds, predicting hybrid performance; seed production of hybrid and their parent varieties/ inbreeds. Self-incompatibility, male sterility and apomixes in crop plants and their commercial exploitation.

Unit-V
Breeding methods in asexually/ clonally propagated crops, clonal selection. Special breeding techniques: Mutation breeding, Breeding for abiotic and biotic stresses; Concept of plant ideotype and its role in crop improvement, concept of MAS, concept of polyploidy and wide hybridization, doubled haploidy. Cultivar development: testing, release and notification, maintenance breeding, Participatory Plant Breeding, Plant breeders' rights and regulations for plant variety protection and farmers rights.

Practical:
Floral biology in self and cross pollinated species; Selfing and crossing techniques; Selection methods in segregating populations and evaluation of breeding material; Analysis of variance (ANOVA); Estimation of heritability and genetic advance; Maintenance of experimental records; Learning techniques in hybrid seed production using male-sterility in field crops; Prediction of performance of double cross hybrid.

Suggested Readings:

- Allard RW. 1981. Principles of Plant Breeding. John Wiley & Sons.
- Chahal GS and Gossal, SS. 2002. Principles and Procedures of Plant Breeding Biotechnological and Conventional approaches. Narosa Publishing House.
- Chopra VL. 2004. Plant Breeding. Oxford & IBH.
- George A. 2012. Principles of Plant Genetics and Breeding. John Wiley & Sons.
- Gupta SK. 2005. Practical Plant Breeding. Agribios.
- Jain HK and Kharakwal MC. 2004. Plant Breeding and–Mendelian to Molecular Approach, Narosa Publications, New Delhi

- Roy D. 2003. Plant Breeding, Analysis and Exploitation of Variation. Narosa Publ. House.
- Sharma JR. 2001. Principles and Practice of Plant Breeding. Tata McGraw-Hill.
- Sharma JP. 2010. Principles of Vegetable Breeding. Kalyani Publ, New Delhi.
- Simmonds NW.1990. Principles of Crop Improvement. English Language Book Society.
- Singh BD. 2006. Plant Breeding. Kalyani Publishers, New Delhi.
- Singh S and Pawar IS. 2006. Genetic Bases and Methods of Plant Breeding. CBS.

COURSE OBJECTIVES:

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- Detection of linkage and estimation.
- To aware the students about the fine structure of genes
- To impart the knowledge of induction, detection and mechanism of mutation.
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Course Outcome (CO):

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CO1	able to know what are the basic laws and discoveries in genetics.
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CO-PO-PSO mapping

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

M. Sc. (Ag.) Genetics and Plant Breeding
SEMESTER-I
Course Title: Crop Breeding-II (Rabi Crops)
Course Code: GPB 512
w.e.f. Session 2022-2023

3(2+1)

Unit-I

Wheat: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc., breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement.

Oats: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc., breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, released varieties, examples of MAS used for improvement.

Barley: Origin, evolution, center of origin, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc., breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, released varieties, examples of MAS used for improvement.

Unit-II

Chickpea: Origin, evolution mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc., breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, released varieties, examples of MAS used for improvement.

Other pulses: Lentil, field pea, Rajma, Horse gram: Origin, evolution, mode of reproduction, chromosome number; Genetics. cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc., breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement. Interspecific crosses attempted and its implications, reasons for failure, ways of overcoming them.

Unit-III

Rapeseed and Mustard: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives; yield, quality characters, biotic and abiotic stress resistance, etc., breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement, Oil quality, Improvement for oil quality.

Sunflower, Safflower: Origin, mode of reproduction, chromosome number; Genetics, cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc., breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement.

Unit-IV

Mesta and minor fibre crops: Origin, mode of reproduction, chromosome number; Genetics– cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc., breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, released varieties, examples of MAS used for improvement.

Forage crops: Origin, evolution mode of reproduction, chromosome number; Genetics–cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc., breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance.

Unit-V

Seed spices: Origin, evolution, mode of reproduction, chromosome number; Genetics–cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc., breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, scope of heterosis breeding, released varieties, examples of MAS used for crop improvement.

Practical:

Floral biology, emasculation and pollination techniques in wheat, oats, barley, chickpea, rajma, rapeseed mustard, sunflower; Study of range of variation for yield and yield components; Study of segregating populations in cereal, pulses and oilseed crops; Use of descriptors for cataloguing; Learning on the crosses between different species; Trait based screening for stress resistance; Learning on the Standard Evaluation System (SES) and descriptors; Use of software for database management and retrieval.

Suggested Readings:

- Agarwal RL. 1996. Identifying Characteristics of Crop Varieties. Oxford & IBH.
- Bahl PN and Salimath PM. 1996. Genetics, Cytogenetics and Breeding of Crop Plants. Vol. I. Pulses and Oilseeds. Oxford & IBH.
- Gupta SK. 2012. Technological Innovations in Major World Oil crops. Vol. I. Springer, USA.
- Gupta SK. 2012. Technological Innovations in Major World Oil crops. Vol. II. Springer, USA.
- Gupta SK. 2016. Breeding of Oilseed Crops for Sustainable Production. Academic Press, USA.
- Kannaiyan S, Uthamasamy S, Theodore RK and Palaniswamy S. 2002. New Dimensions and
- Approaches for Sustainable Agriculture. Directorate of Extension Education, TNAU, Coimbatore.
- Parthasarathy VA. 2017. Spices and Plantation Crops Vol.1 (Part A) Breeding of Breeding and Genetics. John Wiley & Sons.

COURSE OBJECTIVES:

- Botanical features, reproductive systems, genetics involved
- Important breeding techniques are essential to undertake any crop improvement programme.
- This course is designed for important/ major Rabi field crops.
- The student will know about plant breeding research in different rabi crops.

COURSE OUTCOME (CO):

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

COURSE OUTCOME (CO)	DESCRIPTION
CO1	It will help in the knowledge of basic knowledge of botanical features, reproductive systems, genetics involved
CO2	The students will be able to know the origin, evolution mode of reproduction and breeding objectives of different crops.
CO3	Students will be able to use the knowledge of genetics of different crops.
CO4	The student will understand about plant breeding research in different rabi crops.

CO-PO-PSO mapping

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

M. Sc. (Ag.)
SEMESTER-I
Course Title: Stress Biology and Genomics
Course Code: MBB 517
w.e.f. Session 2022-23

2(2+0)

Unit-I

Different kinds of stresses (biotic and abiotic) and adaptation strategies: Plant cell as a sensor of environmental changes; role of cell membranes in signal perception; Ways of signal transduction in cells and whole plants as a response to external factors. Abiotic stresses affecting plant productivity – Drought, salinity, water logging, temperature stresses, light stress and nutrient stress; Drought stress – Effects on plant growth and development; Components of drought resistance; Physiological, biochemical and molecular basis of tolerance mechanisms; Biotic stress (insect and pathogen) resistance mechanism.

Unit-II

Strategies to manipulate drought tolerance – Osmotic adjustment and Osmoprotectants - synthesis of proline, glycine betaine, poly amines and sugars; ROS and antioxidants; hormonal metabolism - ABA signaling; signaling components – transcription factors. Water logging stress – effects on plant growth and metabolism; adaptation to water logging, tolerance mechanisms -hormones and flooding tolerance. Strategies for improving submergence tolerance. Salinity stress – effects on physiology and metabolism of plants, SOS pathways and ion homeostasis,Strategies to improve salinity tolerance in plants. Water logging stress – effects on plant growth and metabolism; tolerance mechanisms. Physiological and biochemical changes – High & Low temperature tolerance mechanisms - molecular basis of thermo tolerance. Morphological and physiological changes in plants due to high and low light stresses - photo oxidation -plastid development. Characters of heliophytes and sciophytes – solar tracking – sieve effect and light channeling. Heavy metal stress – Al and Cd stress - effects on plant growth and development, biotech Strategies to overcome heavy metal stress Nutrient stress effects on plant growth and development. Genetic manipulation strategies to overcome the stress effects.

Unit-III

Genomics; transcriptomes, small RNAs and epigenomes; functional genomics; transfer of tolerance/resistant genes to model plants and validation of gene function. Different techniques for the functional validation of genes. Signaling pathway related to defense gene expression, R proteins, RNAi approach and genes from pathogens and other sources, coat protein genes, detoxification genes, transgenic and disease management. Bt proteins, resistance management strategies in transgenic crops, ecological impact of field release of transgenic crops. Bioinformatics approaches to determine gene function and network in model plants under stress.

Suggested Readings:

- Buchanan, B.B., Gruissem, W. and Jones R. 2015. Biochemistry and Molecular Biology of Plants, 2nd edition, Wiley and Blackwell Publications.
- Sarwat, M., Ahmad, A., Abdin, M.Z. 2013. Stress Signaling in Plants: Genomics and Proteomics Perspective, Volume 1, Springer.
- Heribert Hirt. 2010. Plant Stress Biology: From Genomics to Systems Biology, John Wiley.
- Pandey, G.K. 2015. Elucidation of Abiotic Stress Signaling in Plants, Stringer.

COURSE OBJECTIVES:

- Knowledge and concept of different kind of stress
- To provide advanced knowledge on genomics with reference to abiotic stress tolerance and biotic stress resistance in plants tolerance
- Basic concepts of plant bioinformatics

COURSE OUTCOMES (CO):

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

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Concept of different kind of biotic and a biotic stresses
CO2	Basics of crop biotechnology and its application
CO3	Study of morphological and physiological changes in plants
CO4	Concept of functional genomics; transfer of tolerance/resistant genes to model plants

CO-PO-PSO MAPPING

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