Ph.D. Agriculture (Genetics and Plant Breeding)

PROGRAM SYLLABUS (EMBEDDED WITH COs)

School of Agriculture,
ITM University, Gwalior, Madhya Pradesh 474001

SYLLABUS

WITH

EMBEDDED

COURSE OUTCOMES (COs)

Course Code: GPB- 601	Course Name: Advances in Plant Breeding Systems	Semester: I

Credits	L	T	P	Marks	Contact Hours (per week)	Independent Study Hour (per week)	Section(Group)
3	0	3	0		3		Ph.D. Ag.
Curriculum level					Information based Critical thinking based Research based	**Student specific course outcome**	Higher Education Placement Research

Objective: To impart theoretical knowledge about advances in plant breeding.

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

CO-1	To develop fundamental principles and theories underlying plant breeding
CO-2	To apply statistical methods and experimental design in plant breeding
CO-3	To critically evaluate different plant breeding programmes and their effectiveness in achieving specific breeding goals.
CO-4	Cultivate idea and design to apply their knowledge to solve real time problem in plant breeding
CO-5	Develop a breeding programme for crop improvement
CO-6	Construct a gene pool with qualitative and physiochemical superiority for the target genome

Teaching Pedagogy:

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

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

Prerequisites	Unit wise contents details	Assessment tools
Course Content	**UNIT-I:** Advances in reproductive biology of crops; Genes governing the whorls formation and various models proposed; Pollen pistil interaction: biochemical and molecular basis, environmental factors governing anthesis and bottlenecks for gene transfer.	Assignment
	UNITII: Plant Breeding methodologies: Classic versus modern; Over view of Pre and Post Mendelian breeding methods in self and cross pollinated crops; Molecular and transgenic breeding approaches; doubled haploid breeding, shuttle breeding, forward	ABL

	and reverse breeding, speed breeding, participatory plant breeding, breeding for organic situations.	
	UNITIII: Principles and procedures in the formation of a complex population; Genetic basis of population improvement in crop plants; Recurrent selection methods in self and cross pollinated crops and their modifications; Convergent selection, divergent selection; Recurrent selection, usefulness in hybrid breeding programs; Reciprocal recurrent selection; Selection in clonally propagated crops – Assumptions and realities.	Presentation
	UNIT IV: Choice of molecular markers for plant breeding efficiency, fingerprinting and genetic diversity assessment, application of MAS for selection of qualitative and quantitative traits; Gene pyramiding, accelerated backcrossing, marker-based utilization of exotic germplasm, Introgression libraries.	Midterm
	UNIT- V: Genetic resources: primary, secondary, tertiary and alien trans gene pool; Molecular and biochemical basis of self-incompatibility and male sterility, nucleocytoplasmic interactions with special reference to male sterility – genetic, biochemical and molecular bases.	Assignments
	UNIT-VI: Genetic engineering technologies to create male sterility, prospects and problems, use of self-incompatibility and sterility in plant breeding – case studies; Fertility restoration in male sterile lines and restorer diversification programs; Conversion of agronomically ideal genotypes into male sterile: Concepts and breeding strategies; Case studies - Generating new cyto-nuclear interaction system for diversification of male sterile; Stability of male sterile lines – Environmental influence on sterility, Environmentally Induced Genic Male Sterility (EGMS) – Types of EGMS; Influence on their expression, genetic studies; Photo and thermo sensitive genetic male sterility and its use in heterosis breeding; Temperature sensitive genetic male sterility and its use heterosis breeding; Apomixis and its use in heterosis breeding; Incongruity: Factors influencing incongruity Methods to overcome incongruity mechanisms.	End term
	UNIT- VII: Breeding for climate change -Improving root systems, abiotic stress tolerance, water use efficiency, flooding and sub-mergence tolerance; Biotic stress tolerance; Nutrient use efficiency, nitrogen fixation and assimilation, greenhouse gases and carbon sequestration; Breeding for bio-fortification.	End term

Resources:	LCD, Black/White Board, Computer
Assignment/Tutorial:	Students are required to submit the given assignments and deliver one power point presentation as a part of their continuous evaluation system.
ListofAssignments	1. DNA fingerprinting for diversity assessment in a given population 2. Molecular and transgenic breeding approaches 3. Gene Pyramiding
ABL	1. Shuttle breeding 2. Speed breeding 3. Use of molecular marker to utilize suitable candidate gene from exotic line

Suggested reading:	**A. Textbooks:** ➢ Agarwal RL. 1996. Fundamentals of Plant Breeding and Hybrid Seed Production. Oxford & IBH. ➢ Allard RW. 1966. Principles of Plant Breeding. John Wiley & Sons. ➢ Briggs FN and Knowles PF. 1967. Introduction to Plant Breeding. Reinhold. ➢ Fehr WR. 1987. Principles of Cultivar Development: Theory and Technique. Vol I. ➢ Macmillan. Hayes HK, Immer FR and Smith DC. 1955. Methods of Plant Breeding. McGraw-Hill. ➢ Kang MS and Priyadarshan PM (Edit.). 2007. Breeding Major Food Staples. Blackwell Publishing. **B. Reference Book:** ➢ Kole C. 2013. Genomics and Breeding for Climate-Resilient Crops. Springer. Volume 2-Target Traits. ➢ Mandal AK, Ganguli PK and Banerji SP. 1995. Advances in Plant Breeding. Vol. I, II. CBS. Richards AJ. 1986. Plant Breeding Systems. George Allen &Unwin. ➢ Sharma JR. 1994. Principles and Practice of Plant Breeding. Tata McGraw-Hill. ➢ Simmonds NW. 1979. Principles of Crop Improvement. Longman. ➢ Singh BD. 1997. Plant Breeding: Principles and Methods. 5th Ed., Kalyani Publishers, New Delhi. ➢ Singh P. 1996. Essentials of Plant Breeding. Kalyani Publishers, New Delhi. Welsh JR. 1981. Fundamentals of Plant Genetic and Breeding. John Wiley.

Course Code: GPB-603	Course Name: Molecular Cytogenetics for Crop Improvement	Semester: I

Credits	L	T	P	Marks	Contact Hours (per week)	Independent Study Hour(per week)	Section(Group)
2	0	2	0		2		Ph.D. Ag.
Curriculum level					Information based Critical thinking based Research based	**Student specific course outcome**	Higher Education Placement Research

Objective: This course focuses on applications of cytogenetic techniques for crop improvement.

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

CO-1	Understand the sole of chromosomal analysis in understanding crop genetics
CO-2	Apply molecular cytogenetics technique to identify chromosomal anomalies in crop plants
CO-3	Analyse cytogenetics data to identify chromosomal rearrangement and genomic variation in crop
CO-4	Assess the potential impact of chromosomal manipulation on crop breeding outcomes
CO-5	Design a molecular catalogue based breeding design for crop improvement

Teaching Pedagogy:

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

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

Prerequisites	Unit wise contents details	Assessment tools
Course Contents	**UNIT-I:** Organization and structure of genome, Genome size, Organization of organellar genomes, Nuclear DNA organization, Nuclear and Cytoplasmic genome interactions and signal transduction; Inheritance and expression of organellar DNA; Variation in DNA content - C value paradox; Sequence complexity – Introns and Exons, Repetitive sequences, Role of repetitive sequence.	Assignment Mid term
	UNIT-II: Karyotyping – Chromosome banding and chromosome painting; Tracking introgressions using FISH, GISH, localization and mapping of genes/ genomic segments.	Mid term
	UNIT-III: Pre-breeding and applications of cytogenetical methods for crop improvement; Location and mapping of genes on chromosomes: deficiency method; Interchange genetic consequence, identification of chromosomes involved and gene location; balanced lethal systems, their maintenance and utility; Multiple	ABL

	interchanges-use in producing inbreds, transfer of genes- linked marker methods; Duplication - production and use; Inversions and location of genes; B/ A chromosome translocations and gene location.	
	UNIT- IV: Trisomics- types, production, breeding behavior and location of genes, use of balanced tertiary trisomics in hybrid seed production; Monosomics methods of production, breeding behavior and location of genes; Intervarietal substitutions-allelic and non- allelic interactions; Telocentric method of mapping.	Assignments
	UNIT- V: Cytogenomics: Concept, tools and techniques for crop improvement; Chromosome sorting: Isolation of specific chromosome for development of molecular maps and gene location.	End term
	UNIT- VI: Role of polyploidy in crop evolution and breeding. Auto- and allopolyploids; Distant hybridization, barriers to interspecific and intergeneric hybridization; Behaviour of interspecific and intergeneric crosses.	End term

Resources:	LCD,Black/WhiteBoard,Computer, Projector
Assignment/Tutorial:	Students are required to submit the given assignments and deliver one power point presentation as a part of their continuous evaluation system.
ListofAssignments	1. Cytogenomics tools and techniques in crop improvement 2. Role of polyploidy breeding in crop improvement 3. Interspecific and Intergeneric hybridization
ABL	1. Using molecular marker to find gene location 2. FISH and GISH for tracking introgression 3. Karyotyping
Suggestedreading:	**Textbooks:** ➢ Clark MS and Wall WJ. 1996. Chromosomes: The Complex Code. Chapman & Hall. 30 June 1996 ➢ Conger BV. (Ed.). 1981. Cloning Agricultural Plants via in-vitro Techniques. CRC Press. 31 January 2018 ➢ Constabel F and Vasil IK. (Eds.). 1988. Cell Culture and Somatic Cell Genetics of Plants. Vol. V. Cell Culture and Phytochemicals in Plant Cell Cultures. Academic Press. ➢ Yao-Shan F. 2002. Molecular Cytogenetics: Protocols and Application. Human Press **ReferenceBook:** ➢ Gupta P K. 2006. Cytogenetics. Rastogi Publisher ➢ Lal R and Lal S. (Eds.). 1990. Crop Improvement Utilizing Biotechnology. CRC Press. ➢ Mantel SH and Smith H. 1983. Plant Biotechnology. Cambridge University Press. ➢ Sen SK and Giles KL. (Eds.). 1983. Plant Cell Culture in Crop Improvement. Plenum Press. 13 July 2013

Course Code: GPB-604	Course Name: Plant Genetic Resources, Conservation and Utilization	Semester: I

Credits	L	T	P	Marks	Contact Hours (per week)	Independent Study Hour(per week)	Section(Group)
2	0	2	0		2		Ph.D. Ag.
Curriculum level					Information based Critical thinking based Research based	Student specific course outcome	Higher Education Placement Research

Objective: To impart knowledge on the methods of germplasm conservation and its utilization

Course outcomes:

CO-1	Define plant genetic resources its utilization and conservation
CO-2	Discuss the importance of genetic material to maintain adequate diversity in arena of crop species
CO-3	Utilization of repository to preserve genetic propagules
CO-4	Examine the role of diversified gene pool to create bridge species
CO-5	Determine the role of biodiversity to maintain species versity

Teaching Pedagogy:

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

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

Prerequisites	Unit wise contents details	Assessment tools
Course Contents	**UNIT-I:**Concept of natural reserves and natural gene banks; In situ conservation of wild species in nature reserves: in situ conservation components, factors influencing conservation value, national plan for in situ conservation; in situ conservation of agro-biodiversity on-farm; scientific basis of in situ conservation on-farm, building on-farm conservation initiatives, implementation of on-farm conservation, management of in situ conserved genetic diversity on-farm, enhancing benefits for farmers from local crop diversity.	Assignment Mid term
	UNIT-II: Ex situ conservation: components, plant genetic resources conservation in gene banks, national gene banks, gene repositories, preservation of genetic materials under natural conditions, perma-frost conservation, guidelines for seed multiplication and exchange to network of active/ working collections, orthodox, recalcitrant seeds-	Mid term

	differences in handling, clonal repositories, genetic stability under long term storage condition.	
	UNIT-III: In-vitro storage, maintenance of in-vitro culture under different conditions, in-vitro bank maintenance for temperate and tropical fruit crop species, spices, tubers, bulbous crops, medicinal and endangered plant species, conservation of embryos and ovules, cell/ suspension cultures, protoplast and callus cultures, pollen culture, micropropagation techniques, problems, prospects of in-vitro gene bank.	ABL
	UNIT- IV: Cryopreservation- procedure for handling seeds of orthodox and recalcitrant-cryo- protectants, desiccation, rapid freezing, slow freezing, vitrification techniques, encapsulation/ dehydration techniques, national facilities, achievements, application of cryopreservation in agricultural, horticultural and forestry crops. Problems and prospects; challenges ahead.	Assignments
	UNIT- V: Concept and procedure for PGR management, germplasm characterization, evaluation and utilization; Concept of core and mini core; collections and registration of plant germplasm.	End term

Resources:	LCD, Black/White Board, Computer, Projector
Assignment/Tutorial:	Students are required to submit the given assignments and deliver one power point presentation as a part of their continuous evaluation system.
List of Assignments	1. Scientific basis of in-situ conservation 2. PGR management, germplasm characterization, evaluation and utilization 3. Genetic stability under long term storage condition
ABL	1. PGR Management 2. Germplasm collection and characterization 3. Germplasm registration and passport data filling
Suggested reading:	**Textbooks:** ➢ Ellis RH, Roberts EH and White Head J. 1980. A New More Economic and Accurate Approach to Monitor the Viability of Accessions During Storage in Seed Banks. FAO/ IBPGR Pl. Genet. Resources News 41-3-18. ➢ Frankel OH and Hawkes JG. 1975. Crop Genetic Resources for Today and Tomorrow. Cambridge University Press, Cambridge. ➢ Paroda RS and Arora RK.1991. Plant Genetic resource Conservation and management, NBPGR, New-Delhi. ➢ Simmonds NW. 1979. Principles of Crop Improvement, Longman **Reference Book:** ➢ Westwood MN. 1986. Operation Manual for National Clonal Germplasm Repository. Processed Report. USDA-ARS and Oregon State Univ. Oregon, USA. ➢ Withers LA. 1980. Tissue Culture Storage for Genetic Conservation. IBPGR Tech. Rep. IBPGR, Rome, Italy.

Course Code: SST-601	Course Name: Hybrid Seed Production Technology	Semester: I

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

Objective: To provide students a comprehensive knowledge and practical exposure on hybrid seed production techniques in agricultural and horticultural crops.

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

CO-1	To understand the various tools involved in hybrid seed production of crop plants
CO-2	To acquire the knowledge on conventional and molecular breeding methods to obtain yield improved crop varieties.
CO-3	Apply the advanced breeding tools for quality seed production
CO-4	Analyzethe descriptors in various crops for selection of superior genotype
CO-5	Evaluate the techniques of hybrid seed production in major agricultural crops
CO-6	Develop biotic and abiotic resistance variety for higher yield

Teaching Pedagogy:

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

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

Prerequisites	Unit wise contents details	Assessment tools
Course Contents	**UNIT-I:** Introduction – history – scope – importance of hybrid development – national and international scenario of seed industry – popular public sector hybrids in various crops. Heterosis – definition – expression – types – utilization of heterosis in hybrid development, hybrid vigour and seed vigour.	Assignment Mid term
	UNIT-II: Types of hybrids – intra-specific, inter-specific hybrids, single, double, three way cross, top cross hybrids – apomixes; generation system of seed multiplication in different types of hybrids. Development and maintenance of inbred lines – male sterile – maintainer lines – fertility restoration – transgenic hybrids – principles and method of development.	Mid term

	UNIT-III: Breeding tools – genetic mechanism – male sterility – types: CMS, GMS, CGMS, TGMS, PGMS – barnase and barstar system – pistillateness – self incompatibility. Manual creation of male sterility – emasculation and pollination – gametocides – mode of action, mechanism. Synchronization of flowering – problems – methods to achieve synchrony – planting ratio and supplementary pollination methods.	ABL
	UNIT- IV: Techniques of hybrid seed production in major agricultural crops – cereals (wheat, rice), millets (maize, sorghum, bajra), pulses (red gram), oilseeds (sunflower, castor, mustard), cotton and forage crops.	Assignments
	UNIT- V: Hybrid seed production techniques in horticultural crops – tomato, brinjal, chilli, bhendi, onion, bitter gourd, bottle gourd, ridge gourd, cucumber, melon, cabbage, cauliflower, potato, coconut and papaya.	End term

Resources:	LCD, Black/White Board, Computer, projector, Field	
Practical Exercise	**Course Modules**	**Assessment tools**
	• Characteristics features of parental lines and their hybrids; • Floral biology of rice, maize, pearlmillet, sunflower, castor and cotton; • Studyonfloralbiologyofvegetablecrops– solanaceousandothervegetables; • Study on floral biology of cucurbitaceous crops; • Production and maintenance of A, B and R lines; • Practicing planting design and border rows – rice, maize, pearlmillet, sunflower and red gram; brinjal and chillies; • Practicing planting design and border rows in tomato, cotton and cucurbitaceous vegetables; • Manipulation for synchronization – rice, sunflower, pearlmillet and sorghum; • Practicing supplementary pollination – rice and sunflower; • Practicingfieldin section inhybridseedproductionplot– cropsplantedinratio– sunflower, pearlmillet, sorghum, etc.; • Practicingfieldin section inhybridseedproductionfield– redgram,castor,cotton, cucurbits and tomato; • Practicing roguing and identification of off-types – pollen shedders – shedding tassel – selfed fruits; • Visit to hybrid seed production fields; • Visit to potato seed production plots; • Determination of cost benefit of hybrid seed production; • Visit to seed Industry and assessing problems and perspectives in hybrid seed production.	Activity based learning can be given to implement application aspect
Assignment/Tutorial:	Students are required to submit the given assignments and deliver one power point presentation as a part of their continuous evaluation system.	
List of Assignments	1. Self-incompatibility 2. Transgenic Male Sterility 3. Transgenic Hybrids	
ABL	1. Hybrid seed production in tomato 2. Exploitation of heterosis in hybrid line development	
	A. Textbooks: ➢ Agarwal RL. 2012. Seed Technology. 3rd Ed. Oxford & IBH Publishers, New Delhi. ➢ Basra A. 1999. Heterosis and Hybrid Seed Production in Agronomic Crops. CRC Press., Florida, United States ➢ Chhabra AK. 2006. Practical Manual of Floral Biology of Crop	

Suggested reading:	Plants. Department of Plant Breeding, CCSHAU, Hisar. ➢ Dar SH. 2018. Methods of Hybrid Seed Production in Major Crops. Educreation Publishing, Chhattisgarh. ➢ Frankel R and Galun E. 1977. Pollination Mechanisms, Reproduction and Plant Breeding. Springer Verlag, New York. **B. Reference Book:** ➢ Hebblethwaite PD. 1980. Seed Production. Butterworth Heinemann Ltd., London, UK. ➢ Joshi AK and Singh BD. 2004. Seed Science and Technology. Kalyani Publishers, New Delhi. ➢ Krishnan M. 2012. Plant breeding and Hybrid Seed Production. Dominand Publishers & Distributors, New Delhi, India. ➢ Kulkarni GN. 2011. Principles of Seed Technology. Kalyani Publishers, New Delhi. ➢ Maiti RK, Sarkar NC and Singh VP. 2006. Principles of Post-Harvest Seed Physiology and Technology. Agrobios., Jodhpur, India.	
Suggested websites	1. www.agriquest.info 2. www.agriinfo.in 3. www.seedquest.com 4. https://agriinfo.in/botany/18/ 5. http://www.fao.org/3/a-e8935e.pdf 6. http://www.agriquest.info/seed_production.php 7. http://agritech.tnau.ac.in/seed_certification/seedtech_index.html	

Course Code: STAT- 522	Course Name: Data Analysis Using Statistical Packages	Semester: I

Credits	L	T	P	Marks	Contact Hours (per week)	Independent Study Hour (per week)	Section(Group)
3	0	2	1		4		Ph.D. Ag.
Curriculum level					Information based Critical thinking based Research based	**Student specific course outcome**	Higher Education Placement Research

Objective: Exposing student in the usage of various statistical packages for data analyses.

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

CO-1	Describe various statistical methodologies and statistical packages
CO-2	Illustrate suitable data analysis methods
CO-3	Demonstrate various statistical packages of data sufficiency
CO-4	Analyse multivariate study using suitable statistical testing tool
CO-5	Evaluate the data accuracy and precision by carried out by different packages

Teaching Pedagogy:

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

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

Prerequisites	Unit wise contents details	Assessment tools
Course Contents	**UNIT-I:** Introduction to various statistical packages: Excel, S, SAS, SPSS; Data preparation; Descriptive statistics; Graphical representation of data**,** Exploratory data analysis.	Assignment Mid term
	UNITII: Test for normality; Testing of hypothesis using chi-square, t, F Statistics and Z-test.	ABL
	UNITIII: Data preparation for ANOVA, ANCOVA, factorial experiment, Contrast analysis, multiple comparison, Analyzing crossed and nested classified designs.	Assignments

	UNIT IV: Analysis of mixed models; Estimation of various components; Correlation and Regression analysis, Probit, Logit and Tobit models	End term
	UNIT- V: Discriminant function; Factor analysis; Principle component analysis; Analysis of time series data; Fitting of non-linear models; Neural network	End term

Resources:	LCD, Black/White Board, Computer, Statistical packages	
Practical Exercise	**Course Modules**	**Assessment tools**
	Demonstration &Report Preparation 1. Data preparation for ANOVA and Factorial experiment 2. Graphical presentation of data **Lab Analysis & Report Preparation** 1. Descriptive Statistics 2. Exploratory Statistics	Activity based learning can be given to implement application aspect
Assignment/Tutorial:	Students are required to submit the given assignments and deliver one power point presentation as a part of their continuous evaluation system.	
List of Assignments	1.Introduction and use of different statistical packages: R, SPSS, SAS 2. Test of normality, testing of hypothesis using chi- square, F, T and Z Test. 3. Analysis and interpretation of time series data	
ABL	1. Use of software packages for data summarization, tabulation and representation 2. Multivariate analyses 3. Design of experiment and their utility in field/lab level	
Suggested reading:	**A. Textbooks:** ➢ Anderson C.W. and Loynes R.M. 1987. The Teaching of practical Statistics. John Wiley. ➢ Atkinson A.C. 1985. Plots Transformation and Regression. Oxford University Press. ➢ Chambers J.M., Cleveland W.S., Kleiner B and Tukey P.A. 1983 Graphical Methods for Data Analysis. Wadsworth, Belmount, California. ➢ Chatfield C. 1983. Statistics for Technology. 3rd Ed. Champan& Hall. ➢ Chatfield C. 1995. Problem Solving: A Statistician Guide .Champan& Hall. **B. Reference Book:** ➢ Snell E.J and Simpson HR. 1991. Applied Statistics: A Handbook of GENSTAT Analyses. Champan and Hall. ➢ Sprent. P. 1993. A /non-Parametrical Statistical Methods. 2nd Ed. Champan and Hall.	

Course Code: GPB-602	Course Name: Advances in Biometrical Genetics	Semester: II

Credits	L	T	P	Marks	Contact Hours (per week)	Independent Study Hour(per week)	Section(Group)
3	0	2	1		4		Ph.D. Ag.
Curriculum level					Information based Critical thinking based Research based	**Student specific course outcome**	Higher Education Placement Research

Objective: To impart theoretical knowledge and computation methods for non-allelic interactions, mating designs and component analysis and their significance in plant breeding.

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

CO-1	Identify the fundamental principles of inheritance of quantitative genetics
CO-2	Describe and explain the role of genetic variation in population studies
CO-3	Apply biometrical methods to analyse genetic data and estimate genetic figures
CO-4	Assess the strategies and limitation of biometrical methods in genetic research
CO-5	Create a research design for biometrical studies
CO-6	

Teaching Pedagogy:

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

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

Prerequisites	Unit wise contents details	Assessment tools
Course Content	**UNIT-I:**Continuous variation-evolutionary studies; Genetic principles of continuous variation, Qualitative and quantitative techniques-differences, population types, approaches; various types of metrics, F_2, F and mixed; Selection of parents Simultaneous selection models; Use of Multiple regression analysis in selection of genotypes.	Assignment Mid term
	UNITII: Components of mean- Additive effect, breeding value, coefficient of gene dispersion, dominance; Simple scaling test, expectation of mean of character in various types of families in coupling and dispersed phase; Epistasis- Specification, weighted and un-weighted joint scaling test; Effect of linkage to generation mean, specification of mean to G × E interaction.	ABL

	UNITIII: Component of variances-advantages, variances of different generations, balance sheet of variance; estimation of parameters-weighted and unweighted, least square analysis; random mating population; experimental population-BIPs, NCD-I, II, III, Triple test cross for random mating population and inbreds; Estimates of linkage and non-allelic interactions; Combining ability analysis, Hayman's Approach.	Assignments
	UNIT IV: G × E Interaction, stability and adaptability; Advanced models in stability analysis - Pattern analysis - Additive Main Effect and Multiplicative Interaction (AMMI) analysis and other related models; Merits and limitation of different stability analysis methods; Analysis and selection of genotypes; Methods and steps to select the best model - Biplots and mapping genotypes.	End term
	UNIT- V: Construction of saturated linkage maps, concept of framework map development; QTLs-different types of markers and mapping populations, linkage maps, mapping- Strategies for QTL mapping - desired populations, statistical methods; MAGIC populations, Marker Assisted Selection (MAS) - Approaches to apply MAS in Plant breeding - selection based on markers - simultaneous selection based on marker and phenotype - Factors influencing MAS; Heritability of the trait, proportion of genetic variance, linkage disequilibrium between markers and traits and selection methods; Use of advanced software packages for biometrical analysis, interpretation of analysed data.	End term

Resources:	LCD, Black/White Board, Computer, Statistical packages	
Practical Exercise	**Course Modules**	**Assessment tools**
	Demonstration &Report Preparation 1. Generation mean analysis using scaling test and its interpretation 2. Stability analysis using Eberhart and Russel Model and its interpretation **Lab Analysis & Report Preparation** a. Construction of linkage map and QTL Mapping b. Use of advanced statistical software in biometrical analysis	Activity based learning can be given to implement application aspect
Assignment/Tutorial:	Students are required to submit the given assignments and deliver one power point presentation as a part of their continuous evaluation system.	
List of Assignments	1. MAS in plant breeding 2. Merit and limitation in different stability models 3. MAGIC Population	
ABL	1. AMMI analysis 2. Use of different statistical model for QTL mapping	
Suggested reading:	**A. Textbooks:** ➢ Bos I and Caligari P. 1995. Selection Methods in Plant Breeding. Chapman & Hall. ➢ Dabholkar AR.1993. Elements of Biometrical Genetics. Concept Publishing Co. New Delhi. Falconer DS and Mackay J. 1996. Introduction to Quantitative Genetics (4 Ed.). ELBS/ Longman, London. ➢ Mather K and Jinks JL. 1985. Biometrical Genetics (3rd Ed.). Chapman and Hall, London. ➢ Nandarajan N and Gunasekaran M. 2008. Quantitative Genetics and Biometrical Techniques in Plant Breeding. Kalyani Publishers, New Delhi. ➢ Roy D. 2000. Plant Breeding, Analysis and Exploitation of Variation. Narosa Publishing House, New Delhi. ➢ Singh P and Narayanan SS. 1993. Biometrical Techniques in Plant Breeding. Kalyani Publishers, New Delhi.	

	B. Reference Book: ➢ Singh RK and Choudhary BD. 1987. Biometrical Methods in Quantitative Genetics. Kalyani Publishers, New Delhi. ➢ Weir DS. 1990. Genetic Data Analysis. Methods for Discrete Population Genetic Data. Sinauer Associates. ➢ Wricke G and Weber WE. 1986. Quantitative Genetics and Selection in Plant Breeding. Walter de Gruyter.	

Course Code: GPB- 605	Course Name: Genomics in Plant Breeding	Semester: II

Credits	L	T	P	Marks	Contact Hours (per week)	Independent Study Hour(per week)	Section(Group)
3	0	3	0		3		Ph.D. Ag.
Curriculum level					Information based Critical thinking based Research based	**Student specific course outcome**	Higher Education Placement Research

Objective: To impart practical skills in advanced molecular techniques in genome mapping structural/ functional genomics.

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

CO-1	Identify key terms and cell basic concept of genomics related to plant system
CO-2	Explain and summarize principles and application of plant genomics in relation to breeding
CO-3	Apply genomic tools to analyse and interpret plant genetic data
CO-4	Compare and contrast different genomic approach for plant breeding
CO-5	Assess the effectiveness of genomic selection in implanting plant traits
CO-6	Design a genomic assisted breedingstrategies for crop improvement

Teaching Pedagogy:

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

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

Prerequisites	Unit wise contents details	Assessment tools
Course Content	**UNIT-I:** Introduction to the plant genomes: nuclear, chloroplast and mitochondrial genomes; Concept of genome size and complexity: C-value paradox, repetitive and unique DNA.	Assignment
	UNITII: Genome sequencing: Principles and techniques of conventional approaches and next generation sequencing including sequencing-by-synthesis/ ligation and single molecule real time (SMRT) technologies; Applications of sequence information: structural, functional and comparative genomics; Plant genome projects: Strategies for genome sequencing including shot gun and clone-by-clone method.	ABL

	UNITIII: Molecular maps: Use of molecular markers/ SNPs for development of genetic and physical maps; Linkage and LD-based gene mapping approaches including gene/ QTL mapping, genome wide association studies (GWAS) and association analysis; Integration of genetic and physical map for map-based cloning of economically important genes. Concept of allele mining; Diversity array technology: concepts and applications.	Presentation
	UNIT IV: Functional genomics: concept of reverse and forward genetics; Use of activation tagging, transposon tagging, insertional mutagenesis, TILLING and ECO-TILLING for crop improvement; Genome-wide and gene-specific transcriptomics approaches: serial analysis of gene expression, massively parallel signature sequencing, next generation sequencing, microarray, northern hybridization, RT-PCR, qRT-PCR and molecular beacon.	Midterm
	UNIT- V: Development and management of database; Applications of bioinformatics tools/ software in genomics for crop improvement. Basic concepts of high-throughput proteomics, metabolomics and phenomics.	Assignments
	UNIT-VI: Recent transgene free genome editing tools such as CRISPR-Cas9 system, TALENS and ZFNs for crop improvement. Cisgenesis and Intragenesis tools as twin sisters for Crop Improvement; Genomics-based plant breeding: Genome-Wide Genetic Diversity Studies, Identification of molecular markers linked to single Genes and QTL, Marker Assisted Selection (Marker Assisted Backcross Selection, Association mapping, Breeding by Design, Genome selection).	End term

Resources:	LCD, Black/White Board, Computer
Assignment/Tutorial:	Students are required to submit the given assignments and deliver one power point presentation as a part of their continuous evaluation system.
ListofAssignments	1. Applications of bioinformatics tools/ software in genomics for crop improvement. 2. Next Generation Sequencing 3. Genome Wide Association Studies (GWAS)
ABL	1. Northern hybridization 2. Microarray 3. Use of bioinformatics tools for molecular docking
Suggested reading:	**A. Textbooks:** ➢ Alonso JM, Stepanova AN. 2015. Plant Functional Genomics: Methods and Protocols. Springer. Chopra VL, Sharma RP, Bhat SR and Prasanna BM. 2007. Search for New Genes. Academic Foundation, New Delhi. ➢ Hackett PB, Fuchs JA and Messing JW. 1988. An Introduction to Recombinant DNA Technology— Basic Experiments in Gene and Manipulation. 2nd Ed. Benjamin Publication Co. ➢ Primose SB and Twyman RM. 2006. Principles of Gene Manipulation and Genomics. 7th Ed. Wiley-Blackwell Publishing. **B. Reference Book:** ➢ Sambrook J and Russel D. 2001. Molecular Cloning - a Laboratory Manual. 3rd Ed. Cold Spring Harbor Laboratory Press. ➢ Singh BD. 2005. Biotechnology: Expanding Horizons. Kalyani Publishers, New Delhi. ➢ Somers DJ, Langridge P, Gustafson JP. 2009. Plant Genomics: Methods and Protocols. Springer.
Suggested e-resources(Websites/e-books)	1. http://gramene.org 2. https://www.arabidopsis.org 3. https://wheat.pw.usda.gov 4. http://ncbi.nlm.nih.gov 5. http://www.maizegenetics.net

Course Code: SST- 604	Course Name: Genetic Purity and DUS Testing	Semester: II

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

Objective: To impart knowledge on various methods of genetic purity assessment and DUS testing for protection of plant varieties

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

CO-1	To Describe the DUS Testing for genetic Purity analysis
CO-2	To Identify the suitable molecular method for genetic Purity analysis
CO-3	Utilize the morphological and molecular methods of DUS testing
CO-4	To Categorize the National and International regulations for plant variety protection
CO-5	Assessment of DUS characteristics of major crops
CO-6	Develop a system to increase crop production, increase farmers income and standard of living

Teaching Pedagogy:

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

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

Prerequisites	Unit wise contents details	Assessment tools
Course Cont	**UNIT-I:** Genetic purity – importance – factors influencing genetic purity; genetic/ cultivar purity test – objectives – principles – methods; laboratory tests – green house and field plot methods, grow – out test, seed and seedling growth tests; chemical and biochemical methods; anthocyanin pigmentation, secondary compounds, phenol, peroxidase and fluorescence tests – chromatography techniques.	Assignment Mid term
	UNITII: Electrophoretic analysis of proteins and isozymes; DNA finger printing methods – RAPD, AFLP, SSR, SNP and other markers; computer based machine vision technique and image analysis for varietal identification	ABL

	UNITIII: Genesis of Plant Variety Protection (PVP); International Union for Protection of New Varieties of Plants (UPOV) and its functions – GATT agreement in relation to plant variety protection; Protection of Plant Varieties and Farmer's Rights (PPV and FR) Act 2001 – objectives, salient features, farmer's rights, breeder's rights, researcher's rights – PPV and FRA Rules 2003.	Assignments
	UNIT IV: Criteria for protection of new varieties of plants; Distinctness, Uniformity and Stability (DUS) testing – principles and procedures, guidelines, sample size, test duration, testing option; varieties of common knowledge – extant variety – essentiallyderived variety, Plant Sciences–Seed Science and Technology– collection of reference samples – grouping of varieties – example varieties; types and categories of characters – recording observations on characteristics – colour characteristics	End term
	UNIT- V: Assessment of DUS characters of major crops based on morphological, biochemical and molecular markers – rice, maize, wheat, barley, black gram, green gram, red gram, cowpea, rajma, sunflower, groundnut, castor, mustard, tomato, brinjal, onion, potato, chilli, bhendi, cucurbits, cole crops, sugarcane, cotton, flower, fruit and tree species; statistical procedure – computer software for DUS testing; guidelines for registration of germplasm – impact of plant variety protection on seed industry growth.	End term

Resources:	LCD, Black/White Board, Computer, Statistical packages	
Practical Exercise	**Course Modules**	**Assessment tools**
Assignment/Tutorial:	Students are required to submit Field & Lab Report, Assignments and ABL activities as a part of their continuous evaluation system.	
List of Assignments:	1. Practical exercise on recording DUS characteristics, statistical analysis and interpretation in major agricultural crops. 2. Practical exercise on recording DUS characteristics, statistical analysis and interpretation in major horticultural crops.	
	• Genetic purity assessment based on seed characters; • Genetic purity assessment based on seedling growth tests, anthocyanin pigmentation; • Genetic purity assessment based on secondary compounds, phenol, peroxidase and fluorescence tests; • Chromatography analysis of secondary compounds; • Electrophoretic analysis of seed protein and isozymes; • DNA fingerprinting using PCR techniques; • DUS testing based on morphological descriptors of plant – rice and millets; • DUS testing based on morphological descriptors of plant – pulses and oil seeds; • DUS testing based on morphological descriptors of plant – vegetable crops; • DUS testing based on morphological descriptors of plant – flower, fruit and tree species;	Activity based learning can be given to implement application aspect

	• Recording observations and interpretation of data; • Tree method of classification of varieties/ cultivars; • Chemical and biochemical test applicable for DUS testing;	
Suggested reading:	**A. Textbooks:** ➢ Anon. 2016. Manual of Seed Certification Procedures. Directorate of Seed Certification, Coimbatore, Tamil Nadu. ➢ Chakrabarthi SK. 2010. Seed Production and Quality Control. Kalyani Publishers, New Delhi. ➢ Choudhary DR. 2009. Guidelines for Storage and Maintenance of Registered Plant Varieties in the National Gene Bank. Published by Protection of Plant Varieties and Farmer's Rights Authority. Ministry of Agriculture, GoI, New Delhi, India. **B. Reference Book:** ➢ ISTA. 2010. Handbook of Variety Testing. International Seed Testing Association, Switzerland. Joshi AK and Singh BD. 2004. Seed Science and Technology, Kalyani Publishers, New Delhi, India ➢ Maiti RK, Sarkar NC and Singh VP. 2006. Principles of Post Harvest Seed Physiology and Technology. Agrobios., Jodhpur, India. ➢ ISTA. 2010. Handbook of Variety Testing. International Seed Testing Association, Switzerland. Joshi AK and Singh BD. 2004. Seed Science and Technology, Kalyani Publishers, New Delhi, India ➢ Intellectual Property Rights : Key to new wealth generation,-Delhi NRDC and Aesthetic technologies, 2001 ➢ Mishra DK, Khare D, Bhale, MS and Koutu GK. 2011. Handbook of Seed Certification. Agrobios, Jodhpur, Rajasthan. Ramamoorthy K, Sivasubramaniam K and Kannan M. 2006. Seed Legislation in India. Agrobios, Jodhpur, Rajasthan.	
Suggested websites:	www.seedquest.com www.ucanr.edu www.sasa.gov.uk www.ppvfra.org https://www.upov.int/test_guidelines/en/ http://plantauthority.gov.in/crop-guidelines.htm https://www.upov.int/resource/en/dus_guidance.html https://www.upov.int/edocs/tgpdocs/en/tgp_6_section_2.pdf https://www.upov.int/publications/en/tg_rom/introduction.html	
Suggested e-books:	https://books.google.co.in/books?isbn=16118603932. https://books.google.co.in/books?isbn=81894220303. https://books.google.co.in/books?id=2FbwZwEACAAJ https://books.google.co.in/books?id=J5bQtgAACAAJ https:/books.google.co.in/books?isbn=0851997392 https://www.upov.int/edocs/tgdocs/en/tg023.pdf	

Course Code: BIOCHEM- 505	Course Name: Techniques in Biochemistry	Semester: II

Credits	L	T	P	Marks	Contact Hours (per week)	Independent Study Hour(per week)	Section(Group)
4	0	2	2		6		Ph.D. Ag. & Horti.
Curriculum level					Information based Critical thinking based Research based	Student specific course outcome	Higher Education Placement Research

Objective: To provide hands-on experience to different biochemical techniques commonly used in research along with knowledge on principles and the instrumentation.

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

CO-1	Describe basic methods and technologies used for biochemical procedure
CO-2	Explain the various methods involves in different biomolecular work
CO-3	Demonstrate use of various biochemical instrument for analyses of given sample
CO-4	Separation and estimation of differentmetabolomesfor the given sample
CO-5	Evaluate the disease affected samples to assess the level of different biomolecules
CO-6	Construct a strategies for detection of suitable metabolomesto study plant response at the time of antigen invasion.

Teaching Pedagogy:

T1	Classroom Lectures/Guest lectures Student Seminars/Presentations
T2	ABLactivities Assignments

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

Prerequisites	Unit wise contents details	Assessment tools
Course Contents	**UNIT-I:** Principles and applications of paper, thin layer, gel filtration, ion-exchange, affinity, column & HPTLC, GC, HPLC and FPLC. Principles and applications of UV-visible, Fluorescence, IR and FTIR, Raman, NMR and FTNMR, ESR and X-Ray spectroscopy. Tracer techniques in biology: concept of radioactivity, radioactivity counting methods with principles of different types of counters, concept of emitters, scintillation counters, -ray spectrometers, autoradiography, applications of radioactive tracers in biology.	Assignm ntMid term
	UNITII: General principles, paper and gel electrophoresis, native and SDS-PAGE, 2D-PAGE, capillary electrophoresis. MS/MS, LC-MS, GC-MS, MALDI-TOF, applications of mass spectrometry in biochemistry. Principles and applications of phosphor imager, MRI and CT scan.	ABL

	UNITIII: Hydrodynamic methods of separation of biomolecules such as viscosity and sedimentation velocity, - their principles. Principle, function and instrumentation of atomic absorption spectrophotometry. Production of antibodies, immunoprecipitation, immunoblotting, immunoassays, RIA and ELISA.	Assignments
	UNIT IV: Basic principles of sedimentation, type, care and safety aspects of centrifuge preparative and analytical centrifugation. Cryopreservation, polymerase chain reaction (PCR), FACS.	End term

Resources:	LCD, Black/White Board, Computer, Biochemical lab, All the basic instrument and chemicals for biochemical analyses	
Practical Exercise	**Course Modules**	**Assessment tools**
	Demonstration &Report Preparation 1. SDS PAGE 2. Centrifugation **Lab Analysis & Report Preparation** 1. Electrophoresis 2. Atomic Absorption Spectrophotometry	Activity based learning can be given to implement application aspect
Assignment/Tutorial:	Students are required to analysis any given biochemical compound using spectrophotometry.	
List of Assignments	1. Identification and validation of rice reference protein for western blotting 2. Electrophoretic separation of proteins and nucleic acids 3. ELISA technique 4. Principle, function and instrumentation of AAS	
ABL	1. pH measurement and buffer preparation 2. Estimation of biomolecules through spectrophotometry method 3. Separation and estimation of biomolecules through HPLC 4. Separation and analysis of fatty acids/lipids by GC	
Suggestedreading:	**A. Textbooks:** ➢ Boyer R. 2011. Biochemistry Laboratory: Modern Theory and Techniques 2nd Edition. Pearson. ➢ Hofman A and Clokie S. 2010. Wilson and Walker's Principles and Technique of Biochemistry and Molecular Biology. 7th edition. Cambridge University Press. ➢ Sawhney SK and Singh R. (2000). Introductory Practical Biochemistry. 2nd edition. Narosa. ➢ Katoch R. 2011. Analytical Technique in Biochemistry and Molecular Biology. Springer. **B. ReferenceBook:** ➢ Boyer R. 2009. Modern Experimental Biochemistry. Fifth impression. Pearson ➢ Lottspeich F and Engles JW. (Eds). 2018. Biochemistry: Analytical Methods and concept in Biochemstry and Molecular Biology, Wiley-VCH ➢ Wilson K and Walker J. 2010. Principles and Techniques of Biochemstry and Molecular Biology, 7th Edition. Cambridge University Press	