M. Sc. Ag. (Genetics & Plant Breeding)
PROGRAM SYLLABUS (EMBEDDED WITH COs)

School of Agriculture,

ITM University, Gwalior, Madhya Pradesh 474001

SYLLABUS

WITH

EMBEDDED

COURSE OUTCOMES (COs)

Semester I

Course Code: GPB-501 **Course Name: Principles of Genetics** **Semester: I**

Credits	L	T	P	Contact Hours (per week)	Independent Study Hrs (per week)	Section (Group)
03	2	0	1	04		M.Sc. (Ag), GPB
Curriculum level				• Information based • Critical thinking based • Research based	Student specific course outcome	• Placement • Research • Higher education

Objective: This course aimed at understanding the basic concepts of genetics, helping students to develop their analytical, quantitative and problem-solving skills from classical to molecular genetics.

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

CO-1	Define the fundamental concepts and theories of genetics.
CO-2	Describe the nature and structure of genetic material.
CO-3	Conceptualize molecular genetics and hands on lab tools and techniques
CO-4	Apply the concepts of biochemistry and biotechnology for development of transgenic.
CO-5	Demonstrate various method to transfer the genetic material

Teaching Pedagogy	
T1	Activity based learning through lab experimentation Power Point Presentations
T2	ABL activities Assignments Flip Class/ Seminars Quiz

Assessment tools	
AT1-1	Mid term Exams and end term exam
AT1-2	Seminar Presentation
AT1-3	Quiz

AT1-4	Poster
AT1-5	Activity Based Learning
AT1-6	Flip Class
AT1-7	Viva voce examination
AT1-8	Report writing
AT1-9	Field trial
AT1-10	Spot Identification

Prerequisites	Module wise details	Assessment tools
Course Contents	**Unit – 1** 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.	Power Point Presentations Poster Presentation Assignments
	Unit – 2 Mendelian population, Random mating population, Frequencies of genes and genotypes, Causes of change: Hardy-Weinberg equilibrium.	ABL activities Assignments Flip Class/ Seminars Quiz Mid Term examination
	Unit – 3 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.	Power Point Presentations Quiz Field Trial
	Unit – 4 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).	Assignments Flip Class/ Seminars Quiz
	Unit- 5 Genomics and proteomics; metagenomics; Transgenic bacteria and bioethics; Gene silencing; genetics of mitochondria and chloroplasts. Concepts of Eugenics, Epigenetics, Genetic disorders.	Assignments Flip Class/ Seminars Quiz

Practical Exercise*	Course Modules	Assessment tools
	1. Laboratory exercises in probability and chi-square. 2. Demonstration of genetic principles using laboratory organisms. 3. Chromosome mapping using three point test cross; Tetrad analysis.	Practical Activity Practical Record Viva voce Spot Identification

	4. Induction and detection of mutations through genetic tests. 5. DNA extraction and PCR amplification -Electrophoresis – basic principles and running of amplified DNA. 6. Extraction of proteins and isozymes – use of *Agrobacterium* mediated method and Biolistic gun. 7. Practical demonstrations - Detection of transgenes in the exposed plant material. 8. Visit to transgenic glasshouse and learning the practical considerations.	
References	1. Gardner EJ &Snustad DP. 1991. *Principles of Genetics*. John Wiley &Sons. 2. Klug WS & Cummings MR. 2003. *Concepts of Genetics*. Peterson Edu. 3. Lewin B. 2008. *Genes IX*. Jones & Bartlett Publ. 4. Russell PJ. 1998. *Genetics*. The Benzamin/Cummings Publ. Co. 5. Snustad DP & Simmons MJ. 2006. *Genetics*. 4th Ed. John Wiley & Sons. 6. Strickberger MW. 2005. *Genetics (III Ed)*. Prentice Hall, New Delhi, India 7. Tamarin RH. 1999. *Principles of Genetics*. Wm. C. Brown Publs. 8. Uppal S, Yadav R, Subhadra & Saharan RP. 2005. *Practical Manual onBasic and Applied Genetics*. Dept. of Genetics, CCS HAU Hisar.	
Resources:	LCD, OHP, Black Board, Molecular Biology Laboratory.	
Assignment/ Tutorial:	Students are required to submit one assignment and deliver one power point presentation as a part of their continuous evaluation system.	
List of Assignments	1. Cell structure and cell division 2. Sex determination, differentiation and sex-linkage, sex-influenced and sex-limited traits 3. Hardy-Weinberg equilibrium 4. Structural and numerical changes in chromosomes	

	5. Genetic fine structure analysis 6. Regulation of gene activity in prokaryotes 7. Gene isolation, synthesis and cloning, genomic and cDNA libraries 8. Genomics and proteomics	

Course Code: GPB-502 **Course Name: Principles of Plant Breeding** **Semester: I**

Credit	L	T	P	Contact Hours (per week)	Independent Study Hos (per week)	Section (Group)
03	2	0	1	04		**M.Sc. (Ag.), GPB**
Curriculum level				• Information based • Critical thinking based • Research based	**Student specific course outcome**	• Placement • Research • Higher education

Objective:

To impart theoretical knowledge and practical skills about plant breeding objectives, modes of reproduction and genetic consequences, breeding methods for crop improvement.

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

CO-1	Define the basic concept of crop improvement and genetic variation.
CO-2	Describe the various breeding methods, their drawbacks and significance.
CO-3	Demonstrate the skill on emasculation, pollination and hybridization.
CO-4	Differentiate the inbred lines and hybrids, composite and synthetic varieties.
CO-5	Problems based on heritability, genetic advances and genetic variations and the role of heterosis, inbreeding depression, heritability and genetic advances in plant breeding.

T1	Activity based learning through field experiments on modelling of SPC's and CPC's Power Point Presentations
T2	ABL activities

	Assignments Flip Class/ Seminars Quiz Field trial

Assessment tools	
AT1-1	Midterm Exams and End term examination
AT1-2	Seminar Presentation
AT1-3	Industrial Visit Report
AT1-4	Quiz
AT1-5	Poster
AT1-6	Activity Based Learning
AT1-7	Flip Class
AT1-8	Spot Identification
AT1-9	Report writing
AT1-10	Field trial
AT1-11	Herbarium
AT1-12	Viva voce

Prerequisites	**Module wise details**	**Assessment tools**
Course Contents	**Unit – 1** 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.	Field trial ABL Quiz
	Unit – 2 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.	Field Trial Report Writing Poster Presentation Mid Term Examination
	Unit – 3 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.	Quiz Flip Class Herbarium
	Unit – 4 Breeding methods in cross pollinated crops; Population breeding: mass selection and ear-to-row methods; S_1 and S_2 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.	Seminar Presentation Industrial Visit Report Quiz
	Unit-5 Breeding methods in asexually/ clonally propagated crops, clonal selection.	Seminar Presentation Review writing Report writing

	Unit-6 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.	Seminar Presentation Industrial Visit Report Quiz
	Unit-7 Cultivar development: testing, release and notification, maintenance breeding, Participatory Plant Breeding, Plant breeders' rights and regulations for plant variety protection and farmers rights.	Field trial ABL Quiz End term examination

Practical Exercise*	**Course Modules**	**Assessment tools**
	1. Floral biology in self and cross pollinated species, selfing and crossing techniques. 2. Selection methods in segregating populations and evaluation of breeding material 3. Analysis of variance (ANOVA) 4. Estimation of heritability and genetic advance 5. Maintenance of experimental records; 6. Learning techniques in hybrid seed production using male-sterility in field crops.	Practical Activity Practical Record Viva voce Spot Identification Herbarium File
References	1. Allard RW. 1981. *Principles of Plant Breeding*. John Wiley & Sons. 2. Chopra VL. 2001. *Breeding Field Crops*. Oxford & IBH. 3. Chopra VL. 2004. *Plant Breeding*. Oxford & IBH. 4. Gupta SK. 2005. *Practical Plant Breeding*. Agribios. 5. Pohlman JM &Bothakur DN. 1972. *Breeding Asian Field Crops*. Oxford& IBH. 6. Roy D. 2003. *Plant Breeding, Analysis and Exploitation of Variation*.Narosa Publ. House. 7. Sharma JR. 2001. *Principles and Practice of Plant Breeding*. TataMcGraw-Hill. 8. Simmonds NW. 1990. *Principles of Crop Improvement*. English LanguageBook Society. 9. Singh BD. 2006. *Plant Breeding*. Kalyani. 10. Singh P. 2002. *Objective Genetics and Plant Breeding*. Kalyani. 11. Singh P. 2006. *Essentials of Plant Breeding*. Kalyani. 12. Singh S & Pawar IS. 2006. *Genetic Bases and Methods of Plant Breeding*.CBS.	
Resources:	LCD, OHP, Black Board, Laboratory.	

Assignment/ Tutorial:	Students are required to submit one assignment and deliver one power point presentation as a part of their continuous evaluation system.	
List of Assignments	1. Patterns of Evolution in Crop Plants 2. Mating systems and response to selection 3. Self-incompatibility and male sterility in crop plants. 4. Population breeding in self-pollinated 5. Breeding approaches for improvement of inbreds 6. Special breeding techniques- Mutation breeding 7. Plant breeders' rights and regulations for plant variety protection and farmers rights	
Projects based learning	Attachment to seed production industry	
Suggested e-resources (Websites/e-books)	1. "Biomes of the World"- Missouri Botanical Garden 2. Dragonfly Web Pages 3. Eco-Sensor Web - live data from the National Botanic Garden, Ireland with online tours and elementary-level activities 4. Flora Delaterre, The Plant Detective - learn about medicinal plants and listen to radio audio clips 5. Fun Facts about Fungi 6. Junior Master Gardener 7. Kid's Valley Webgarden - K-5 page on growing plants, understanding flowers, veggies, herbs, shrubs and more 8. Photosynthesis, Energy and Life - an elementary school science site 9. Plant Watch - part of Canada's Nature Watch citizen science programs 10. The Great Plant Escape - a clever chapter for 4th and 5th graders, 6 activities and a teacher's guide 11. The Science of Gardening - from the Exploratorium 12. Young Naturalist's Page - a focus on plants of Florida 13. Fact Monster - includes science(!) 14. The WWW Virtual Library: Science Fairs - search science fair projects 15. Try Science - a gateway to science centers and online activities 16. Gardening With Children - Resources to Encourage Kids to Plant	

Course Code: GPB- 505 **Course Name: Principles of Cytogenetics** **Semester: I**

Credit	L	T	P	Contact Hours (per week)	Independent Study Hos (per week)	Section (Group)
03	2	0	1	04		**M.Sc. (Ag.), GPB**
Curriculum level				• Information based • Critical thinking based • Research based	**Student specific course outcome**	• Placement • Research • Higher education

Objective: To provide insight into structure and functions of chromosomes, chromosome mapping, polyploidy and cytogenetic aspects of crop evolution.

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

CO-1	Describe the morphological and biochemical architecture of eukaryotes & prokaryotes along with the molecular mechanism of cell cycle and cell division.
CO-2	Understand the evolutionary significance of chromosome aberrations and illustrate karyotype, ideogram and banding pattern
CO-3	Utilization of polyploids, aneuploids and apomixes in various aspects of crop breeding, their maintenance and utilization in gene mapping and gene blocks transfer.
CO-4	Analyse fertilization barriers at pre-and post-fertilization levels, chromosome manipulations in wide hybridization and *In-vitro* techniques to overcome.
CO-5	Evaluate the synthesis of new crops (wheat, triticale and brassica) and gene transfer using bridge species.

T1	Activity based learning through lab experimentation Power Point Presentations
T2	ABL activities Assignments Flip Class/ Seminars Quiz

Assessment tools	
AT1-1	Mid term Exams and end term exam
AT1-2	Seminar Presentation
AT1-3	Assignment
AT1-4	Activity Based Learning
AT1-5	Quiz and Viva voce examination

Prerequisites	Module wise details	Assessment tools
Course Contents	**Unit – 1** Architecture of chromosome in prokaryotes and eukaryotes; Chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere; Artificial chromosome construction and its uses; Special types of chromosomes.	Assignment Mid Term exam
	Unit – 2 Chromosomal theory of inheritance – Cell Cycle and cell division – mitosis and meiosis; Differences, significance and deviations – Synapsis, structure and function of synaptonemal complex and spindle apparatus, anaphase movement of chromosomes and crossing over-mechanisms and theories of crossing over- recombination models, cytological basis, - Variation in chromosome structure: Evolutionary significance - Introduction to techniques for karyotyping; Chromosome banding and painting - *in situ* hybridization and various applications.	ABL activities Mid Term exam
	Unit – 3 Structural and Numerical variations of chromosomes and their implications- Symbols and terminologies for chromosome numbers - euploidy -haploids, diploids and polyploids; Utilization of aneuploids in gene location - Variation in chromosome behaviour - somatic segregation and chimeras – endomitosis and somatic reduction; Evolutionary significance of chromosomal aberrations - balanced lethals and chromosome complexes.	Assignments ABL activities
	Unit – 4 Inter-varietal chromosome substitutions; Polyploidy and role of polyploids in crop breeding; Evolutionary advantages of autopolyploids and allopolyploids - Role of	

	aneuploids in basic and applied aspects of crop breeding, their maintenance and utilization in gene mapping and gene blocks transfer – Alien addition and substitution lines – creation and utilization; Apomixis - Evolutionary and genetic problems in crops with apomixes.	Quiz Presentations/Seminars
	Unit-5 Reversion of autopolyploids to diploids; Genome mapping in polyploids - Interspecific hybridization and allopolyploids; Synthesis of new crops (wheat, triticale and brassica) – Hybrids between species with same chromosome number, alien translocations, Hybrids between species with different chromosome number; Gene transfer using amphidiploids – Bridge species. Fertilization barriers in crop plants at pre-and post-fertilization levels- *In-vitro* techniques to overcome the fertilization barriers in crops; Chromosome manipulations in wide hybridization; case studies Production and use of haploids, dihaploids and doubled haploids in genetics and breeding.	ABL activities Viva Voce

Practical Exercise* (Min-8)	**Course Modules**	**Assessment tools**
	1. Learning the cytogenetics laboratory, various chemicals to be used for fixation, dehydration, embedding, staining, cleaning etc. 2. Microscopy: various types of microscopes - Observing sections of specimen using Electron microscope. 3. Studies on the course of mitosis and meiosis in crops. 4. Using micrometers and studying the pollen grain size in various crops. 5. Various methods of staining and preparation of temporary and permanent slides - Pollen germination *in vivo* and *in vitro.* 6. Identification of polyploids in different crops - Induction and identification of haploids; Anther culture and Ovule culture. 7. Morphological observations on aneuploids- Cytogenetic analysis of interspecific and intergeneric crosses. 8. Fluorescent *in situ* hybridization (FISH)- Genome *in-situ* hybridization GISH.	Group presentation Assignment Practical record Viva voce
Resources:	LCD, OHP, Black Board, Laboratory and Research field.	
Assignment/ Tutorial:	Students are required to submit one assignment and deliver one power point presentation as a part of their continuous evaluation system.	
List of Assignments	1. Fertilization barriers in crop plants at pre-and post-fertilization levels and techniques to overcome them. 2. Artificial chromosome construction and its application. 3. Polyploidy and its evolutionary significance in crop breeding. 4. Creation and utilization of alien addition and substitution lines.	
Suggested reading:	1. Becker K & Hardin. 2004. *The World of Cell*. 5th Ed. Pearson Edu.	

	2. Carroll M. 1989. *Organelles*. The Guilford Press. 3. Charles B. 1993. *Discussions in Cytogenetics*. Prentice Hall. 4. Darlington CD & La Cour LF. 1969. *The Handling of Chromosomes*. Georger Allen & Unwin Ltd. 5. Elgin SCR. 1995. *Chromatin Structure and Gene Expression*. IRL Press. 6. Gray P. 1954. *The Mirotomist'sFormulatory Guide*. The Blakiston Co. 7. Gupta PK & Tsuchiya T. 1991. *Chromosome Engineering in Plants:Genetics, Breeding and Evolution*. Part A. Elsevier. 8. Gupta PK. 2000. *Cytogenetics*. Rastogi Publ. 9. Johannson DA. 1975. *Plant Microtechnique*. McGraw Hill. 10. Karp G. 1996. *Cell and Molecular Biology: Concepts and Experiments*.John Wiley & Sons. 11. Khush GS. 1973. *Cytogenetics of Aneuploids*. Academic Press. 12. Sharma AK & Sharma A. 1988. *Chromosome Techniques: Theory and Practice*. Butterworth. 13. Sumner AT. 1982. *Chromosome Banding*. Unwin Hyman Publ. 14. Swanson CP. 1960. *Cytology and Cytogenetics*. Macmillan & Co.
Suggested e-resources (Websites/e-books)	1. The polyploidy and its key role in plant breeding - PubMed (nih.gov) 2. https://www.encyclopedia.com/.../artificial-chromosome 3. https://doi.org/10.3389/fpls.2022.970943 4. https://www.britannica.com/.../heredity-genetics/Chromosomal-aberrations 5. https://www.researchgate.net/publication/256199268_Polyploidy_and_its_implications_in_plant_breeding

Course Code: SST- 503 **Course Name: Seed Production Principles and Techniques in Field Crops** **Semester I**

Credits	L	T	P	Marks			Contact Hours (per week)	Independent Study Hour (per week)	Section (Group)
3	2	0	1				4		**M.Sc. (Ag), GPB**
Curriculum level							Basic Critical Research Based	**Student specific course outcome**	Higher Education Placement Entrepreneurship

Objective: To impart knowledge on seed Production in relation to seed certification and quality control systems

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

CO-1	Describe role of quality seed, basic principles and concepts of seed techniques in field crops
CO-2	Classify different principles and practices involved in quality seed production
CO-3	Demonstrate the role of quality seed among farmers to enhances the quality seed demand and seed trade
CO-4	Analyze the advance seed production techniques to meet the seed demand (production)
CO-5	Assess the role of seed village concept and community seed bank for future quality enhancement

Teaching Pedagogy:

T1	Class room Lectures/ Guest lectures Laboratory/ Field and lab Practicals Student Seminars/ Presentations
T2	ABL activities Lab and field Tours/ Demonstrations Assignments

Assessment tools	
AT1-1	One Midterm Exam
AT1-2	Seminar, Presentation and Report
AT1-3	Assignment
AT1-4	Activity Based Learning
AT1-5	Preparation of lab test reports (Seed Quality testing)

Prerequisites	Unit wise contents details	Assessment tools
Course Contents	**UNIT-I:** Importance of seed – seed quality concept – factors influencing seed production; generation system of seed multiplication – classes of seed, stages of seed multiplication in varieties and hybrids – seed multiplication ratio (SMR) – seed replacement rate (SRR) – seed renewal period (SRP) – varietal replacement rate (VRR).	Assignment Mid term
	UNIT II: Genetic and agronomic principles of variety and hybrid seed production; methods and techniques of seed production in varieties and hybrids of important cereals and millets – wheat, oat, rice, maize, sorghum and pearl millet; varietal seed production in small millets – finger millet, fox tail millet, little millet, kodo millet, proso millet and barnyard millet.	Assignment Mid term
	UNIT III: Methods and techniques of varietal seed production in major pulses – black gram, green gram, cowpea, chickpea, horse gram, soybean and lentil – varietal and hybrid seed production in red gram.	Research field base assignments
	UNIT IV: Methods and techniques of seed production in major oil seed crops – groundnut, sesame – varietal and hybrid seed production in sunflower, castor and mustard; varietal seed production in minor oilseed crops (safflower, linseed, niger)	ABL activities
	– varietal and hybrid seed production in cotton – varietal seed production in jute.	
	UNIT V: Seed marketing: Seed production planning for varieties and hybrids of major crops; participatory seed production – seed hubs, seed village concept and community seed bank.	Assignments Presentation/ Seminars

Practical Exercise* (Min-8)	List of practicals (field/lab exercises)	Assessment tools
	• Seed selection – quality of seed on field establishment; • Sowing and nursery management techniques; • Planting – age of seedling on crop establishment – rice and pearl millet; • Isolation distance and border rows in hybrid seed production field – space and barrier isolation; modifying isolation based on border rows in maize; • Planting design for hybrid seed production – rice, maize, pearl millet, cotton, red gram, sunflower; • Practicing breeding tools for hybrid seed production – detasseling – emasculation and dusting; • Study on methods of achieving synchronization – rice, bajra, sunflower; • Practicing supplementary pollination – rice and sunflower; • Study on foliar nutrition and influence on seed yield; • Practicing roguing operation – identification of off-types, pollen shedders, shedding tassels, partials, selfed bolls; • Pre and post harvest sanitation operations – cereals, millets and pulses; • Estimation of shattering and shattering loss; study on insitu germination and loss; • Visit to seed production fields; • Visit to seed industry; • Seed production planning and economics of seed production – varieties; • Seed production planning and economics of seed production – hybrids.	Activity based learning can be given to implement application aspect
Resources:	LCD, Black/White Board, Laboratory, Research field	

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. Seed quality concept. 2. Community seed bank. 3. Seed village concept.
ABL	1. Visit to seed industry. 2. Practicing roguing operation – identification of off-types, pollen shedders, shedding tassels, partials, selfed bolls;
Suggested reading:	• Agrawal RL. 2019. Seed Technology. Oxford & IBH Publishing Company Pvt. Ltd., New Delhi . • Hebblethwaite PD. 1980. Seed Production. Butterworth Heinemann Ltd., London, UK. • Joshi AK and Singh BD. 2004. Seed Science and Technology. Kalyani Publishers, New Delhi. • 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, Rajasthan. • McDonald MB and Copeland L. 1998. Seed Production Principles and Practices. CBS Publishers, New Delhi • Mondal SS, Saha M and Sengupta K. 2009. Seed Production of Field Crops. New India Publishing Agency, New Delhi • Singhal NC. 2003. Hybrid Seed Production in Field Crops. Kalyani Publications, New Delhi • Sen S and Ghosh N. 2010. Seed Science and Technology. Kalyani Publishers, New Delhi
	• Singhal NC. 2010. Seed Science and Technology. Kalyani Publishers, New Delhi
Suggested e-resources (e-books)	• https://www.springer.com/in/book/9780792373223 • https://www.springer.com/in/book/9780412075513 • https://www.nipabooks.com/info/9788190723763/seed-production-of-field-crops • https://www.amazon.in/Production-Field-Crops-Brajesh-Tiwari/dp/9380179405 • https://www.cambridge.org/core/journals/journal-of-agricultural-science/article/seed-productionof-agricultural-crops-by-kelly-a-f-227-pages-harlow-longman-1988-price-2500-hard-coversisbn-0-582-40410-x/8BE3C99DFDC0F02D48E CB53418504D1
Suggested e-resources (Websites)	• https://agriinfo.in/botany/18/ • http://www.fao.org/3/a-e8935e.pdf • http://www.agriquest.info/seed_production.php • http://agritech.tnau.ac.in/seed_certification/seedtech_index.html • http://coin.fao.org/coinstatic/cms/media/16/13666518481740/seed_enterprises_enhacement_and_development_project_in_sierra_leone_mission_1_report_.pdf

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

Credits	L	T	P	Contact Hours(per week)	Independent Study Hour (per week)	Section (Group)
4	3	0	1	5		**M.Sc. Agri. & Horti.**
Curriculum level				Information based Critical thinking-basedResearch based	**Student specific course outcome**	Placement Research Higher education

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

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

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

T1	Classroom Lectures Activity based learning Power Point Presentations
T2	ABL activities Assignments Unannounced Test Quiz

Assessment tools	
AT1-1	Mid term Exams and end term exam
AT1-2	Quiz
AT1-3	Activity Based Learning
AT1-4	Assignments
AT1-5	Viva voce examination
AT1-6	Unannounced Test

Prerequisites	Module wise details	Assessment tools
Course Contents	**Unit – 1** Classification, tabulation and graphical representation of data. Descriptive statistics (including Box-plot and Scatter grams). Probability Theory, Statistics and exploratory Data Analysis. Random variable and mathematical expectation.	Quiz Assignment
	Unit – 2 Discrete and continuous probability distributions: Binomial, Poisson, Normal distribution, Beta and Gamma distributions and their applications. Concept of sampling distribution: chi-square, t and F distributions. Tests ofsignificance based on t and F distributions.	Assignment Unannounced test Mid Term examination
	Unit – 3 Introduction to theory of estimation and confidence-intervals. Correlation and regression. Simple and multiple linear regression model, estimation of parameters, predicted values and residuals, correlation, partial correlation coefficient, multiple correlation coefficient, rank correlation, test of significance of correlation coefficient and regression coefficients.	Quiz Assignment
	Unit – 4 Non-parametric tests - sign, Wilcoxon, Mann-Whitney U-test, Wald Wolfowitz run test, Run test for the randomness of a sequence. Median test, Kruskal- Wallis test, Friedman two-way ANOVA by ranks. Kendall's coefficient of concordance.	ABL Assignment
	Unit-5 Introduction to multivariate analytical tools- Hotelling's T2 Tests of hypothesis about the mean vector of a multinormal population. Cluster analysis, principal component analysis and Factor analysis.	End term examinationABL Viva Voce

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

Course Code: PGS-501 **Course Name: Library and Information Services** **Semester: I**

Credits	L	T	P	Contact Hours (per week)	Independent Study Hour (per week)	Section (Group)
1	0	0	1	2		Common to all PG Programs
Curriculum level				• Information based • Skill development based • Research based	**Student specific course outcome**	• Skill enhancement • Research • Higher education

Objective: To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines, etc.) of information search.

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

CO-1	Describe about the information and knowledge resources
CO-2	Carry out literature survey
CO-3	Apply the modern tools (Internet, OPAC, search engines, etc.) of information search
CO-4	Equip the students/scholars with skills to trace information from libraries efficiently
CO-5	Formulate information search strategies

Teaching Pedagogy:

T1	Classroom Lectures Web-based Practicals Student Seminars/ Presentations/Workshop
T2	ABL activities Library based study Web surfing for collection of information

Assessment tools	
AT1-1	Cataloguing
AT1-2	Student Seminars/ Presentations/Workshop Report
AT1-3	Drafting a technical program for scientific search of information
AT1-4	Indexing of journal/Literature Survey
AT1-5	Database information

Practical Exercise* (Min-8)	**List of practicals (field/lab exercises)**	**Assessment tools**
	1. Introduction to library and its services; 2. Role of libraries in education, research and technology transfer; Classification systems and organization of library; 3. Sources of information- Primary Sources, 4. Secondary Sources and Tertiary Sources; 5. Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.);	Cataloguing Drafting a technical program Student Seminars/ Presentations/Workshop Report/ Indexing of journal/

	Tracing information from reference sources; 6. Literature survey; Citation techniques/ Preparation of bibliography; 7. Use of CD-ROM Databases, 8. Online Public Access Catalogue and other computerized library services; 9. Use of Internet including search engines and its resources; 10. eResources access methods.	Literature Survey
Resources:	LCD, Black/White Board, Library	
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. Application of SCOPUS for scientific profile and scientific writing 2. Application of WoS for scientific profile and scientific writing 3. Application of reference management tools like Mendeley, EndNote, Paperpile *etc*. for scientific writing	
Suggested reading:	**A. Text and Reference books:** 1. James HS. 1994. Handbook for Technical Writing. NTC Business Books. 2. Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press. 3. Sethi J & Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India. 4. Wren PC & Martin H. 2006. High School English Grammar and Composition. S. Chand & Co.	
Suggested e-resources (Websites/e-books)	1. https://www.scopus.com/sources.uri?zone=TopNavBar&origin=searchbasic 2. https://mjl.clarivate.com/home	

Course Code: PGS-502 **Course Name: Technical Writing and Communications Skill** **Semester: I**

Credits	L	T	P	Contact Hours (per week)	Independent Study Hour (per week)	Section (Group)
1	0	0	1	2		Common to all PG Programs
Curriculum level				• Information based • Skill development based • Research based	**Student specific course outcome**	• Skill enhancement • Research • Higher education

Objective: To equip the students/ scholars with skills to write dissertations, research papers, etc. To equip the students/ scholars with skills to communicate and articulate in English (verbal as well as writing).

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

CO-1	Define various aspects of technical writing and communication skills.
CO-2	Translate scientific literatures for effective draft of technical writings.
CO-3	Apply the writing and communication skills at scientific platform.
CO-4	Relate the various scientific works on the given research ideas.
CO-5	Equip the students/scholars with skills to write dissertations, research papers, etc.

Teaching Pedagogy:

T1	Classroom Lectures Web-based Practicals Student Seminars/ Presentations/Workshop
T2	ABL activities Research paper and review paper reading Review writing

Assessment tools	
AT1-1	Review writing
AT1-2	Student Seminars/ Presentations/Workshop Report
AT1-3	Drafting a technical program for scientific research
AT1-4	Scientific profile evaluation
AT1-5	Paper publication

Practical Exercise* (Min-8)	**List of practicals (field/lab exercises)**	**Assessment tools**
	• 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	
Resources:	LCD, Black/White Board, Computer Laboratory	
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. Abstracts writing, 2. Citations writing, 3. Review article writing,	
Suggested reading:	**A. Text and Reference books:** 1. Barnes and Noble. Robert C. (Ed.). 2005. Spoken English: Flourish Your Language. 2. Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India. 3. Collins' Cobuild English Dictionary. 1995. 4. Harper Collins. Gordon HM and Walter JA. 1970. Technical Writing. 3rd Ed. 5. Holt, Rinehart and Winston. Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press. 6. James HS. 1994. Handbook for Technical Writing. NTC Business Books. 7. Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press. 8. Mohan K. 2005. Speaking English Effectively. MacMillan India. 9. Richard WS. 1969. Technical Writing. 10. Sethi J and Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India. 11. Wren PC and Martin H. 2006. High School English Grammar and Composition. S. Chand & Co.	
Suggested e-resources (Websites/e-books)	1. https://link.springer.com/chapter/10.1007/978-981-16-5248-6_15 2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3136027/	

Semester II

Course Code: GPB-503 **Course Name: Fundamentals of Quantitative Genetics** **Semester: II**

Credit	L	T	P	Contact Hours (per week)	Independent Study Hos (per week)	Section (Group)
3	2	0	1	04		**M.Sc. (Ag), GPB**
Curriculum level				• Information based • Critical thinking based • Research based	**Student specific course outcome**	• Placement • Research • Higher education

Objective: To impart theoretical knowledge and computation skills regarding component of variation and variances, scales, mating designs and gene effects.

Course outcomes: After successful completion of the course, the students are expected to

CO-1	Develop foundational understanding of quantitative genetics and basis of complex traits.
CO-2	Explore breeding strategies and selection methods
CO-3	Apply statistical methods for analyzing quantitative traits.
CO-4	Aanlyze different variable of a population and advanced biometric model with the help of statistical packages
CO-5	Develop a statistical model to assess the divergence of mapping population

T1	Class room Lectures/ Guest lectures Laboratory/ Field and lab Practical Student Seminars/ Presentations
T2	ABL activities Lab and field Tours/ Demonstrations Assignments

Assessment tools	
AT1-1	One Midterm Exam

AT1-2	Seminar, Presentation and Report
AT1-3	Assignment
AT1-4	Activity Based Learning
AT1-5	QTL mapping

Course Contents	**Module wise details**	**Assessment tools**
	UNIT-1: Mendelian traits *vs* polygenic traits - nature of quantitative traits and its inheritance - Multiple factor hypothesis - analysis of continuous variation; Variations associated with polygenic traits - phenotypic, genotypic and environmental - non-allelic interactions; Nature of gene action - additive, dominance, epistatic and linkage effects.	Assignment Mid term
	UNIT-2: Principles of Analysis of Variance (ANOVA) - Expected variance components, random and fixed models; MANOVA, biplot analysis; Comparison of means and variances for significance.	ABL activities Mid term
	UNIT-3: Designs for plant breeding experiments – principles and applications; Genetic diversity analysis – metroglyph, cluster and D2 analyses -Association analysis - phenotypic and genotypic correlations; Path analysis and Parent - progeny regression analysis; discriminant function and principle component analyses; Selection indices - selection of parents; Simultaneous selection models- concepts of selection - heritability and genetic advance.	Research field base assignments
	UNIT-4: Generation mean analysis; Mating designs- Diallel, partial diallel, line x tester analysis, NCDs and TTC; Concepts of combining ability and gene action; Analysis of genotype x environment interaction - adaptability and stability; Models for GxE analysis and stability parameters; AMMI analysis– principles and interpretation.	ABL activities

	UNIT-5: QTL mapping; Strategies for QTL mapping - desired populations for QTL mapping - statistical methods in QTL mapping - QTL mapping in Genetic analysis; Marker assisted selection (MAS) - Approaches to apply MAS in Plant breeding - selection based on marker - simultaneous selection based on marker and phenotype - factors influencing MAS.	Assignments Presentation/ Seminars

Practical Exercise	**Course Modules**	**Assessment tools**
	Demonstration & Report Preparation 1. Experimental design in field 2. Diallel mating design **Lab Analysis & Report Preparation :** 1. Divergence analysis- construction of cluster diagrams and dendrograms –interpretation. 2. Variability analyses –interpretation 3. Estimation of heterosis –interpretation 4. Stability analysis–interpretation 5. Selection methods in different populations and interpretation	Activity based learning can be given to implement application aspect
Text Books	1. Bos I & Caligari P. 1995. *Selection Methods in Plant Breeding*. Chapman& Hall. 2. Falconer DS & Mackay J. 1998. *Introduction to Quantitative Genetics*.Longman. 3. Mather K & Jinks JL. 1971. *Biometrical Genetics*. Chapman & Hall. 4. Mather K & Jinks JL. 1983. *Introduction to Biometrical Genetics*.Chapman & Hall. 5. Nadarajan N & Gunasekaran M. 2005. *Quantitative Genetics andBiometrical Techniques in Plant Breeding*. Kalyani.	
Reference Book	1. Naryanan SS & Singh P. 2007. *Biometrical Techniques in Plant Breeding.Kalyani.* 2. Singh P & Narayanan SS. 1993. *Biometrical Techniques in Plant*	

	Breeding.Kalyani. 3. Singh RK & Choudhary BD. 1987. *Biometrical Methods in QuantitativeGenetics*. Kalyani. 4. Weir DS. 1990. *Genetic Data Analysis. Methods for Discrete PopulationGenetic Data*. Sinauer Associates. 5. Wricke G & Weber WE. 1986. *Quantitative Genetics and Selection in Plant Breeding*. Walter de Gruyter.	
Resources:	LCD, Black/White Board, Computer laboratory, Statistical packages, Research field	
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. Marker Assisted Selection in Plant Breeding for Salinity Tolerance in Rice. 2. A comparative study on segregating analysis and QTL mapping of quantitative traits in Soybean. 3. The use of AMMI model for interpreting g×e interaction in bread wheat. 4. Yield response to water deficit in an upland rice mapping population associations among traits and genetic markers. 5. Construction of integrated genetic linkage maps by means of a new computer package: JOINMAP	
ABL	1. Know the statistical software for selection of genotype 2. MAPMAKER to construct a linkage map in maize 3. Rapid mapping of quantitative trait loci in rice	
Suggested websites:	https://app.pivotinteractives.com/activities https://qgg.au.dk/en/1 https://www.frontiersin.org/articles/10.3389/fpls.2011.00077/full https://www.otago.ac.nz/courses/papers/?papercode=QGEN401 https://www.r-project.org/ https://www.ibm.com/products/spss-statistics https://darwin.cirad.fr/	
Suggested e-books:	www.cabidigitallibrary.org/doi/book/10.1079/9781789240214.0000 staffold.najah.edu/sites/default/files/Introduction%20to%20quantitative%20genetics.pdf https://www.cell.com/trends/genetics/pdf/S0168-9525(98)01657-6.pdf https://vulms.vu.edu.pk/Courses/GEN733/Downloads/Introduction%20to%20Quantitative%20Genetic-DS%20Falconer.pdf.	

Course Code: GPB-504 **Course Name: Varietal Development and Maintenance Breeding** **Semester: II**

Credit	L	T	P	Contact Hours (per week)	Independent Study Hos (per week)	Section (Group)
2	1	0	1	03		**M.Sc. (Ag), GPB**
Curriculum level				• Information based • Critical thinking based • Research based	**Student specific course outcome**	• Placement • Research • Higher education

Objective: To make students well acquainted with the techniques and procedures of varietal development

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

CO-1	Identification of suitable locations for seed production
CO-2	Acquaintance to IPR, PPV and FV act. 2001
CO-3	Determination of generation system of seed multiplication
CO-4	Analysis for production of nucleus seed, breeder seed and foundation seed
CO-5	DUS evaluation and characterization technique

T1	Class room teaching(chalk-board) Power Point Presentations
T2	ABL activities Assignments Flip Class/ Seminars

	Quiz Field practices based

Assessment tools	
AT-1	Mid Term Exam and End Term Exam
AT-2	Seminar Presentation
AT-3	Class Test/Quiz
AT-4	Poster Presentation
AT-5	Activity Based Learning
AT-6	Viva voce Examination
AT-7	Spot Identification

Prerequisites	**Module wise details**	**Assessment tools**
Course Contents	**Unit – 1** Variety development system and maintenance; Definition- variety, cultivar, extant variety, essentially derived variety, independently derived variety, reference variety, farmer's variety, hybrid and population; Variety testing, release and notification systems in India and abroad.	Presentation Quiz
	Unit – 2 DUS Testing- DUS Descriptors for major crops; Genetic purity concept and maintenance breeding. Factors responsible for genetic deterioration of varieties-safeguards during seed production.	ABL Assignment Mid Term Examination
	Unit – 3 Maintenance of varieties in self and cross-pollinated crops- isolation distance; Principles of seed production; Methods of nucleus and breeder seed production. Generation system of seed multiplication -nucleus, breeders, foundation, certified.	Assignment
	Unit – 4 Quality seed production technology of self and cross-pollinated crop varieties viz. cereals & Millet (wheat, barley, paddy, pearl millet, sorghum, maize, ragi etc.); Pulses (green gram, black gram, pigeon pea, chickpea, field pea, lentil); Oilseeds (groundnut, soybean, sesame, castor, sunflower, safflower, linseed, rapeseed and mustard); fibres (cotton and jute) and forages (guar, forage sorghum, teosinte, oats, berseem, lucerne).	ABL Spotting Quiz
	Unit- 5 Seed certification procedures, Seed laws and plant variety protection, regulations in India and international systems.	ABL Assignment Viva Voce End Term Examination

Practical Exercise*	Course Modules	Assessment tools
	1. Identification of suitable areas/locations for seed production. 2. Ear-to-row method and nucleus seed production. 3. Main characteristics of released and notified varieties, hybrids and parental lines. 4. Identification of important weeds/objectionable weeds. 5. Determination of isolation distance and planting ratios in different crops. 6. Seed production techniques of varieties in different crops. 7. Hybrid seed production technology of important crops. 8. DUS Testing and descriptors in major crops. 9. Variety release proposal formats in different crops.	Practical Activity Practical Record Viva voce Spot Identification
References	A. **Textbooks:** 1. Agarwal RL. 1997. *Seed Technology*. 2nd Ed. Oxford & IBH. 2. Chhabra AK. 2006. *Practical Manual of Floral Biology of Crop Plants*. Department of Plant Breeding.CCS HAU Hisar. 3. Musil AF. 1967. *Identification of Crop and Weed Seeds*. Handbook No.219, USDA, Washington, DC. 4. Poehlman JM &Borthakur D. 1969.*Breeding Asian Field Crops*.Oxford & IBH. 5. Singh BD. 2005. *Plant Breeding: Principles and Methods*. Kalyani. 6. Tunwar NS & Singh SV. 1985. *Handbook of Cultivars*. ICAR. **A. Reference books:** 1. Kelly AF. 1988. *Seed Production of Agricultural Crops*. Longman. 2. McDonald MB Jr& Copeland LO. 1997. *Seed Production: Principles and Practices*. Chapman & Hall. 3. Thompson JR. 1979. *An Introduction to Seed Technology*. Leonard Hill.	
Resources	**Teaching methods:** • Power point presentation • Chalk and board • Smart board • Lectures • Assignments • Quiz • Group task • Students Presentations	
Assignment/ Tutorial	Students are required to submit one assignment and deliver one power point presentation as a part of their continuous evaluation system.	
List of Assignments	1. Factors responsible for genetic deterioration of varieties-safeguards during seed production. 2. Methods of nucleus and breeder seed production. 3. Seed certification procedures.	
PBL	Hands on training in Seed production techniques	

Course Code: GPB- 512 **Course Name: Crop Breeding- II (Rabi Crops)** **Semester: II**

Credit	L	T	P	Contact Hours (per week)	Independent Study Hours (per week)	Section (Group)
3	2	0	1	04		**M.Sc. (Ag), GPB**
Curriculum level				• Research based • Information based • Critical thinking based	**Student specific course outcome**	• Research • Higher education • Placement

Objective: To impart knowledge on the botanical description, origin, distribution and various breeding approaches used for the development of varieties/hybrids in various rabi crops.

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

CO-1	Describe the crop diversity, its utilization and conservation
CO-2	Explain the procedure of emasculation and crossing techniques in various rabi crops
CO-3	Demonstrate major breeding tools for the development t of high yielding and climate resilient varieties
CO-4	Examine innovative approaches of crop improvement for rabi crops.
CO-5	Estimate the ideotype concept for its utilization in future

T1	Class room teaching (chalk-board) Power Point Presentations
T2	ABL activities Assignments Flip Class/ Seminars Animation/videos Field visit Case study Quiz

Assessment tools	
AT1-1	One Mid term Exam
AT1-2	Seminar Presentation and Report
AT1-3	ICAR- Research station Visit & report
AT1-4	Quiz
AT1-5	Hands on training
AT1-6	Activity Based Learning
AT1-7	Flip Class
AT1-8	Review writing
AT-9	Spot Identification

Prerequisites	**Module wise details**	**Assessment tools**
Course Contents	**Unit – 1** Plant genetic resources, its utilization and conservation; centres of origin; distribution of species, wild relatives in different rabi crops	Power Point Presentations Poster Presentation GD
	Unit – 2 Major breeding objectives and procedures including conventional and modern innovative approaches for development of hybrids and varieties for yield, adaptability, stability, abiotic and biotic stress tolerance and quality in wheat, chickpea, mustard, sunflower, sugarcane and lucerne	ABL activities Mid term Exam Assignments Quiz
	Unit – 3 Major breeding objectives and procedures including conventional and modern innovative approaches for development of hybrids and varieties in potato, tomato, brinjal, chillies, onion, garlic, cumin and coriander	Power Point Presentations Video lectures
	Unit – 4 Ideotype concept for wheat and mustard; climate resilient crop varieties for future.	Assignments Flip Class/ Seminars Quiz
	Unit-5 International, National and state level research station and varieties/hybrids released of wheat, chickpea, mustard, sunflower, sugarcane and lucerne, potato, tomato, brinjal, chillies, onion, garlic, cumin and coriander.	Assignments End term Exam ICAR- station Visit

Practical Exercise*	Course Modules	Assessment tools
	1. Floral biology, emasculation and hybridization techniques in wheat 2. Floral biology, emasculation and hybridization techniques in chickpea 3. Floral biology, emasculation and hybridization techniques in mustard 4. Floral biology, emasculation and hybridization techniques in sunflower 5. Floral biology, emasculation and hybridization techniques in potato 6. Floral biology, emasculation and hybridization techniques in sugarcane 7. Floral biology, emasculation and hybridization techniques in lucerne 8. Floral biology, emasculation and hybridization techniques in tomato, brinjal and chillies 9. Floral biology, emasculation and hybridization techniques in onion & garlic 10. Floral biology, emasculation and hybridization techniques in cumin & coriander. 11. Maintenance breeding and hybrid seed production in mustard, sunflower and onion. 12. Visit to Seed production plots and AICRP plots of different rabi crops.	Assignment Quiz Practical record Viva-voce
References	**Textbooks:** 1. D. G. Ingole, S. S. Vitnor and V. M. Bharade. 2020. Crop improvement II- Rabi crops 2. Lata J Raval, Janaki K Hadavani and D R Mehta. 2021. Crop Improvement-II (Rabi crops) **Reference books:** 1. Field Crops (Rabi), TNAU, Tamil Nadu	

Resources:	LCD, OHP, Black Board, Laboratory.	
Assignment/Tutorial:		

Course Code: SST-501 **Course Name: Seed Developmental Biology** **Semester: II**

Credits	**L**	**T**	**P**	**Contact Hours(per week)**	**Independent Study Hrs (per week)**	**Section (Group)**
02	1	0	1	03		**M.Sc. (Ag), GPB**
Curriculum level				• Information based • Critical thinking based • Research based	**Student specific course outcome**	• Placement • Research • Higher education

Objective:
Seed is the most complex and successful unit of reproduction in flowering plants. Seed contains genetic wisdom of the past and act as an agent of genetic transfer from generation to generation. Basic knowledge on seed developmental biology will enable the learners to understand the structure of seed to take up research in seed science and technology.

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

CO-1	Define the fundamental concepts of reproduction in flowering plants.
CO-2	Understanding on fundamental aspects of gametogenesis.
CO-3	Conceptualize the advanced research on seed developmental biology
CO-4	Examine the process of Seed maturity indices
CO-5	Application of plant hormones and novel signaling molecules to understand the process of germination and to determine signal transduction mechanisms in seeds.

Teaching Pedagogy	
T1	Class room teaching (chalk-board) Power Point Presentations, Field and laboratory experiments
T2	ABL, Assignments Flip Class/ Seminars Quiz, ICT Based tools, Group task.

Assessment tools	
AT1-1	Mid-term Exams and end term exam
AT1-2	Seminar Presentation
AT1-3	Quiz
AT1-4	Poster
AT1-5	Activity Based Learning
AT1-6	Flip Class
AT1-7	Viva voce examination
AT1-8	Report writing
AT1-9	Field trial
AT1-10	Spot Identification

Prerequisites	Module wise details	Assessment tools
Course Contents	**Unit – 1** Floral biology – types of pollination, mechanisms; sporogenesis – micro and mega sporogenesis; gametogenesis – development of male and female gametes and their structures; pollination and fertilization – mode of pollination, double fertilization, factors affecting pollination, fertilization; self-incompatibility and male sterility.	Power Point Presentations Poster Presentation Assignments
	Unit – 2 Embryogenesis – development of monocot and dicot embryos – embryo plane formation – development of endosperm, cotyledons and seed coat – hard seed; apomixis – identification, classification, significance and its utilization; polyembryony – types and significance; haplontic and diplontic sterility system, causes of embryo abortion, embryo rescue technique; somatic embryogenesis.	ABL activities Assignments Flip Class/ Seminars Quiz Mid Term examination
	Unit – 3 Seed development – source of assimilates – mechanism of translocation; chemical composition – synthesis and deposition of storage reserves – starch, protein, fat and secondary metabolites – hormonal regulation.	Power Point Presentations Quiz Field Trial
	Unit – 4 Maturation drying – orthodox and recalcitrant seeds – desiccation tolerance – mechanism – structural changes during desiccation – role of LEA protein.	Assignments Flip Class/ Seminars Quiz
	Unit-5 Seed maturity indices – physiological and harvestable maturity; biotic and abiotic factors influencing seed development – development of hard seeds.	Assignments Flip Class/ Seminars Quiz

Practical Exercise*	Course Modules	Assessment tools
	1. Study on floral biology of monocot. 2. Study on floral biology of dicot plants. 3. Study on pollen morphology of different crops. 4. Pollen germination and viability test in major crops. 5. Seed embryo and endosperm development in monocots. 6. Seed embryo and cotyledon development in dicots. 7. Anatomy and morphology of seed coat during development. 8. Hard seed coat development. 9. Study on external and internal structures 10. Seed development and maturation in agricultural crops – physical and physiological changes 11. Seed development and maturation in horticultural crops – physical and physiological changes. 12. Study of biochemical changes during seed development and maturation in agricultural crops. 13. Study of biochemical changes during seed development and maturation in horticultural crops 14. Study on physiological and harvestable maturity and maturity indices in different crops 15. Study on acquisition of seed dormancy and germination at different stages of maturity. 16. Preparation of seed album and identification of seeds	Practical Activity Practical Record Viva voce Spot Identification
References	1. Adkins SW, Ashmore SE and Navi SC. 2007. Seeds: Biology, Development and Ecology. CAB International, Oxfordshire, UK. 2. Bewley JD and Black M. 1994. Seeds: Physiology of Development and Germination. Springer, New York. 3. Bewley JD, Bradford KJ, Hilhorst HWM and Nanogaki H. 2013. Seeds: Physiology of Development, Germination and Dormancy. Springer, New York. 4. Black M, Bewley JD and Halmer P. 2006. The Encyclopedia of Seeds: Science, Technology and Uses. CAB International publications, UK. 5. Chhabra AK. 2006. Practical Manual of Floral Biology of Crop Plants. Department of Plant Breeding, CCSHAU, Hisar. 6. Copeland, LO and McDonald MB. 2001. Principles of Seed Science and Technology. 4th Ed. Kluwer Academic publishers, USA. 7. Frankel R and Galun E. 1977. Pollination Mechanisms, Reproduction and Plant Breeding. Springer Verlag, New York. 8. Hesse MH, Haidemarie R, Zettler M, Webber R, Buchner AR, Radivo and Ulrich S. 2009. Pollen Terminology. An illustrated hand book. Springer Verlag, New York 9. Kozlowski. TT. 2012. Seed Biology: Importance, Development and Germination. (Vol. I). Academic Press Inc., New York. 10. Maiti RK, Sarkar NC and Singh VP. 2006. Principles of Post Harvest Seed Physiology and Technology. Agrobios, Jodhpur, Rajasthan.	
Resources:	LCD, OHP, Black Board, Laboratory, Experimental research field	

Assignment/ Tutorial:	Students are required to submit assignments and deliver one power point presentation as a part of their continuous evaluation system.	
List of Assignments	1. Pollination, mechanism 2. Explain the formation of megasporogenesis. 3. Mode of pollination 4. Structural and numerical changes in chromosomes 5. Genetic fine structure analysis 6. Regulation of gene activity in prokaryotes 7. Gene isolation, synthesis and cloning, genomic and cDNA libraries 8. Genomics and proteomics	
Suggested e-books	https://www.springer.com/in/book/9783642810619 https://www.springer.com/in/book/9780792373223 https://www.springer.com/gp/book/9780792346456 https://www.cabi.org/bookshop/book/9780851997230 https://www.worldcat.org/title/seed-development-and-germination/oclc/44954614 https://books.google.co.in/books/about/Seeds.html?id=-Zbzr1F_z74C&redir_esc https://books.google.co.in/books/about/Seeds.html?id=6S75BwAAQBAJ&printsec=frontcover&source=kp_read_button&redir_esc=y#v=onepage&q&f=false	
Suggested websites	https://agriinfo.in/botany/18/ http://www.seedbiology.de/structure.asp http://www.fao.org/3/ad232e/AD232E02.htm sbc.ucdavis.edu/Research_pages/Seed_physiology_and_technology/ https://courses.lumenlearning.com/wmbiology2/chapter/development-seeds-fruit	

Course Code: STAT-512 **Course Name: Experimental Designs** **Semester: II**

Credits	L	T	P	Contact Hours(per week)	Independent Study Hour (per week)	Section (Group)
3	2	0	1	4		**M.Sc. Agri. & Hort**
Curriculum level				Information based Critical thinking basedResearch based	**Student specific course outcome**	Placement Research Higher education

Objective: To educate about concepts of Design of Experiments so as to enable them to understand the concepts involved inplanning, designing their experiments and analysis of experimental data.

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

CO-1	Describe the basic concept of designing of field experiment
CO-2	Compare the different experimental designs used in agriculture field experiments
CO-3	Demonstrate the analysis of covariance in basic designs and confounding in factorial experiments
CO-4	Analyse the result of various statistical designs along give scientific interpretation
CO-5	Assess the suitability of different Software for the statistical analysis of different designs for different sets of experimental conditions

Teaching Pedagogy:

T1	Class room Lectures Activity Based learning Power Point Presentations
T2	ABL activities Assignments Unannounced test Quiz

Assessment tools	
AT1-1	One Midterm Exam
AT1-2	Quiz
AT1-3	Activity Based Learning
AT1-4	Assignments
AT1-5	Viva voce examination
AT1-5	Unannounced test

Prerequisites	Unit wise contents details	Assessment tools
Course content	**Unit – 1** Need for designing of experiments, characteristics of a good design. Data Transformation, Basic principles of designs- randomization, replication and local control.	Classroomteaching ABL
	Unit – 2 Uniformity trials, size and shape of plots and blocks; Analysis of variance; completely randomized design, randomized block design and Latin square design.	Assignment Unannounced testMid Term examination
	Unit – 3 Factorial experiments, (symmetrical as well as asymmetrical). Orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment.	Quiz Assignment
	Unit – 4 Split plot and strip plot designs; Analysis of covariance and missing plot	ABL Assignment
	techniques in randomized block and Latin square designs; Transformations, crossover designs, balanced incomplete block design, resolvable designs andtheir applications ~ Lattice design, alpha design - concepts, randomization procedure, analysis and interpretation of results. Response surfaces. Experiments with mixtures.	Quiz
	Unit – 5 Bioassays- direct and indirect, indirect assays based on quantal doseresponse, parallel line and slope ratio assays potency estimation.	End term examination ABL Viva Voce

Practical Exercise*	List of practical	Assessment tools
	1. Analysis of data obtained from CRD 2. Analysis of data obtained from RBD 3. Analysis of data obtained from LSD 4. Analysis of factorial experiments without and with confounding 5. Analysis of Split plot Design 6. Analysis of Strip plot design 7. Transformation of data 8. Uniformity Trial data analysis	Practical ActivityPractical Record Viva voce

Resources:	LCD, Black/White Board, Computer Lab
Assignment/Tutorial:	Students are required to submit one assignment and attend quiz as a part of theircontinuous evaluation system.
List of Assignments	1. Examples of different designs
Suggested reading:	**A. Textbooks:** 1. Dean AM & Voss D. 1999. Design and Analysis of Experiments. Springer. 2. Federer WT. 1985. Experimental Designs. MacMillan. 3. Fisher RA. 1953. Design and Analysis of Experiments. Oliver & Boyd. 4. Pearce SC. 1983. The Agricultural Field Experiment: A Statistical Examinationof Theory and Practice. John Wiley. **B. Reference Book:** 1. Gupta, S. C. and Kapoor, V. K. 2007. Fundamentals of Applied Statistics.Sultan Chand and sons. New Delhi 2. Nigam AK & Gupta VK. 1979. Handbook on Analysis of AgriculturalExperiments. IASRI Publ. 3. Rangaswamy, R.1995. *A Text Book of Agricultural Statistics*. New AgeInternational Publishing Limited, Hyderabad.

Suggested e-reading:	1. http://apps.iasri.res.in/ebook/EBADAT/2-Basic%20Statistical%20Techniques/9-Fundamentals%20Of%20Designsf.pdf 2. http://apps.iasri.res.in/ebook/EBADAT/2-Basic%20Statistical%20Techniques/17- factoriallectf.pdf

Course Code: PGS-504 **Course Name: Basic Concepts in Laboratory Techniques** **Semester:** II

Credits	L	T	P Marks	Contact Hours (per week)	Independent Study Hour (per week)	Section (Group)
1	0	0	1	2		Common to all PG Programs
Curriculum level				• Information based • Research based • Skill Development based	**Student specific course outcome**	• Research • Higher education • Skill enhancement

Objective: To acquaint the students about the basics of commonly used techniques in laboratory.

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

CO-1	Describe the basic concepts and working principles of common laboratory instruments and techniques
CO-2	Explain the SOPs of various equipments and techniques used in different laboratories
CO-3	Demonstrate the analysis of physiochemical, molecular analysis using different equipments and techniques and solve problems with trouble shooting.
CO-4	Examine the results of various lab analysis with scientific explanation
CO-5	Assess the precision level of laboratory instruments and techniques and find the suitable methods for performing the different lab analyses

Teaching Pedagogy:

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

Assessment tools	
AT1-1	Mid-term Exams and end term exam
AT1-2	Assignment
AT1-3	Unannounced test
AT1-4	Activity Based Learning
AT1-5	Group discussions or debate
AT1-6	Skill test
AT1-7	Quiz
AT1-8	Extempore (student needs to explain the instant given topic as a teacher to all other students)
AT1-9	PPT Presentation

Practical Exercise* (Min-8)	**List of practicals (field/lab exercises)**	**Assessment tools**
	• 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;	Lab manuals Lab management skills Activity Based Learning (ABL) Experimental set up Oral Viva-voce examination Preparation of chemicals
	• Preparation of solutions of acids; • Neutralisation of acid and bases; • Preparation of buffers of different strengths and pH values; • Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; • Electric wiring and earthing; • Preparation of media and methods of sterilization; • Seed viability testing, testing of pollen viability; • Tissue culture of crop plants; • Description of flowering plants in botanical terms in relation to taxonomy.	
Resources:	Bio-chemistry Laboratory, Departmental laboratories	
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. Principle of working of different lab instruments 2. Sterilization techniques 3. Tissue culture Media composition and preparation	
Suggested reading:	**A. Text and Reference books:** 1. Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press. Gabb MH and Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.	

Suggested e-resources (Websites/e-books)	1. https://faculty.ksu.edu.sa/sites/default/files/1_identification_of_the_common_laboratory_glassware_pipettes_and_equipment_.pdf 2. https://ncert.nic.in/ncerts/l/kelm202.pdf 3. https://5.imimg.com/data5/BW/FG/MY-7710909/glass-reaction-cum-distillation-unit.pdf 4. https://www.borosil.com/site/assets/files/2618/labglassware_catalogue_2021.pdf

Course Code: PGS-503 **Course Name: Intellectual Property and Its Management in Agriculture** **Semester: II**

Credit	L	T	P	Marks	Contact Hours (per week)	Independent Study Hos (per week)	Section (Group)
1	0	0	1		02		**M.Sc. (Ag), GPB**
Curriculum level					• Research based • Information based • Critical thinking based	**Student specific course outcome**	• Research • Higher education • Placement

Objective: The main objective of this course is to equip students and stakeholders with knowledge of Intellectual Property Rights IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge based economy.

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

CO-1	Define various aspects of IPR.
CO-2	Elaborate scope of various types of IPRs in agriculture.
CO-3	Understand the significance of various national and international initiatives for biodiversity protection.
CO-4	Apply the approach of IPRs for protection.
CO-5	Equip the students/scholars with skills to apply for IPR.

Teaching Pedagogy:

T1	Classroom Lectures Web-based information Student Seminars/ Presentations/Workshop
T2	ABL activities IPR based activities Patent and copy right application

Assessment tools	
AT1-1	ABL
AT1-2	Student Seminars/ Presentations/Workshop Report
AT1-3	Drafting a technical program for IPR
AT1-4	Collection and conservation of biodiversity in campus
AT1-5	Applying for Copy right or patent

Prerequisites	**Unit wise** contents **details**	**Assessment tools**
Course Contents	**UNIT-I: History of IPR:** Historical perspectives and need for the introduction of Intellectual Property Right regime. TRIPs and various provisions in TRIPS Agreement.	ABL Drafting a technical program
	UNIT II: Introduction to IPR: Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs. Indian Legislations for the protection of various types of Intellectual Properties.	ABL Drafting a technical program
	UNIT III: Fundamentals of IPRs: Fundamentals of patents, copyrights. Geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection.	Collection and conservation of germplasm/ Applying for Copy right or patent
	UNIT IV: Protection of IPR: Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection.	Student Seminars/ Presentations/Workshop Report/ Applying for Copy right or patent
	UNIT V: National and International initiatives: National Biodiversity protection initiatives; Convention on Biological Diversity. International Treaty on Plant Genetic Resources for Food and Agriculture. Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.	Student Seminars/ Presentations/Workshop Report

Resources:	LCD, Black/White Board
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. The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000 2. PPV and FR Act 2001, and Rules 2003 3. The Biological Diversity Act, 2002
Suggested reading:	**A. Text and Reference books:** 1. Erbisch FH and Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI. 2. Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill. 3. Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC and Aesthetic Technologies. 4. Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation. 5. Rothschild M and Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI. 6. Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House.

Suggested e-resources (Websites/e-books)	1. https://www.meity.gov.in/writereaddata/files/National_IPR_Policy.pdf 2. https://icar.org.in/sites/default/files/ICAR%20Guidelines%20for%20IPM%20and%20Technology%20Transfer_2018-1.pdf

Semester III

Course Code: GPB-506 **Course Name: Molecular Breeding and Bioinformatics** **Semester: III**

Credit	L	T	P	Contact Hours (per week)	Independent Study Hos (per week)	Section (Group)
3	2	0	1	04		**M.Sc. (Ag), GPB**

Curriculum level	• Information based • Critical thinking based • Research based	**Student specific course outcome**	• Placement • Research • Higher education

Objective: To impart knowledge and practical skills to use biotechnological tools in crop improvement.

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

CO-1	Describe the role of basic understanding on Plant genetics and hereditary
CO-2	Classify functions of the cell, mendelian genetics, their principles and gene interaction
CO-3	Determine the function of genes and proteins, to establish evolutionary relationships
CO-4	Analyze integrate and manage data from different genomic and proteomic research
CO-5	Assess the role of evolutionary theory and related model to predict population change or stability.
CO-6	Formulate an advance breeding tools for climate resilience crop.

T1	Class room Lectures/ Guest lectures Laboratory/ Field and lab Practicals Student Seminars/ Presentations
T2	ABL activities Lab and field Tours/ Demonstrations Assignments

Assessment tools	
AT1-1	Two Midterm Exams and Viva voce
AT1-2	Seminar Presentation and Report
AT1-3	Industrial Visit Report
AT1-4	Quiz
AT1-5	Poster
AT1-6	Activity Based Learning
AT1-7	Flip Class
AT1-8	Review writing

Prerequisites	Module wise details	Assessment tools
Course Contents	**Unit – 1** Genotyping; Biochemical and Molecular markers; Morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR, SNPs, ESTs, etc.), Functional markers; Mapping populations (F_2s, back crosses, RILs, NILs and DH); Molecular mapping and tagging of agronomically important traits; Statistical tools in marker analysis.	Poster Presentations Assignment Quiz
	Unit – 2 Allele mining; Marker-assisted selection for qualitative and quantitative traits; QTLs analysis in crop plants; Marker-assisted backcross breeding for rapid introgression; Genomics- assisted breeding; Generation of EDVs; Gene pyramiding.	Assignments Quiz Tissue culture laboratory
	Unit – 3 Introduction to Comparative Genomics; Large scale genome sequencing strategies; Human genome project; Arabidopsis genome project; Rice genome project; Comparative genomics tools; Introduction to proteomics; 2D gel electrophoresis; chromatography and sequencing by Edman degradation and mass spectrometry; Endopeptidases; Nanotechnology and its applications in crop improvement.	Activity based Learning Molecular laboratory Mid Term Examination
	Unit – 4 Recombinant DNA technology, transgenes, method of transformation, selectable markers and clean transformation techniques, vector-mediated gene transfer, physical methods of gene transfer; Production of transgenic plants in various field crops: cotton, wheat, maize, rice, soybean, oilseeds, sugarcane, etc. and commercial releases; Biotechnology applications in male sterility/ hybrid breeding.	Assignments Flip Class/ Seminars Quiz
	Unit-5 Molecular farming; Application of Tissue culture in molecular	Flip Class/ Seminars

	breeding; MOs and related issues (risk and regulations); GMO; International regulations, biosafety issues of GMOs; Regulatory procedures in major countries including India, ethical, legal and social issues; Intellectual property rights; Introduction to bioinformatics: bioinformatics tools, biological data bases (primary and secondary), implications in crop improvement.	Assignments Experimental field visit

Practical Exercise*	**Course Modules**	**Assessment tools**
	• Requirements for plant tissue culture laboratory; • Techniques in plant tissue culture; • Media components and media preparation; • Aseptic manipulation of various eXplants, observations on the contaminantsoccurring in media, interpretations; • Inoculation of eXplants, callus induction and plant regeneration; Standardizingthe protocols for regeneration; • Hardening of regenerated plants; Establishing a greenhouse and hardeningprocedures; • Visit to commercial micropropagation unit; • Transformation using Agrobacterium strains; • GUS assay in transformed cells/ tissues; • DNA isolation, DNA purity and quantification tests; • Gel electrophoresis of proteins and isozymes, PCR-based DNA markers, gel scoring and data analysis for tagging and phylogenetic relationship; • Construction of genetic linkage maps using computer software; • NCBI Genomic Resources, GBFF, Swiss Prot, Blast n/ Blast p, Gene Prediction Tool, EXpasy Resources, PUBMED and PMC, OMIM and OMIA, ORF finder; • Comparative Genomic Resources: - Map Viewer (UCSC Browser and Ensembl); • Primer designing- Primer 3/ Primer BLAST.	Practical Activity Practical Record Viva voce Examination Specimen Identification

References	• Azuaje F and Dopazo J. 2005. *Data Analysis and Visualization in Genomics and Proteomics.* John Wiley and Sons. • Brown TA. 1991. *Essential Molecular Biology: a practical Approach*. OXford university press, 2002, 2nd edition • Chawala HS. 2000. *Introduction to Plant Biotechnology*. OXford & IBH Publishing Co.Pvt. Ltd. • Chopra VL and Nasim A. 1990. *Genetic Engineering and Biotechnology: Concepts, Methods and Applications*. OXford & IBH. • Gupta PK. 1997. *Elements of Biotechnology*. Rastogi Publ. • Hackett PB, Fuchs JA and Messing JW. 1988. *An Introduction to Recombinant DNA Technology Basic Experiments in Gene Manipulation*. 2nd Ed Benjamin Publ. Co. • Jollès P and Jörnvall H. 2000. *Proteomics in Functional Genomics: Protein Structure Analysis*. Birkhäuser. • Lewin B. 2017. *Genes XII*. Jones & Bartlett learning, 2017. • Robert NT and Dennis JG. 2010. *Plant Tissue Culture, Development, and Biotechnology.* CRC Press. • Sambrook J and Russel D. 2001. *Molecular Cloning - a Laboratory Manual*. 3rd Ed. Cold SpringHarbor Lab. Press. • Singh BD. 2005. *Biotechnology, Expanding Horizons*. Kalyani Publishers,	

	Delhi. Watson J. 2006. *Recombinant DNA*. Cold Spring harbor laboratory press.	
Resources	LCD, OHP, Black Board, Laboratory.	
Assignment /Tutorial	Students are required to submit one assignment and deliver one power point presentation as a part of their continuous evaluation system.	
ABL	3. Know the use of marker in crop improvement 4. Mapping and tagging of agronomically important trait. 5. Application of RDT	
List of Assignments	1. Comparative study of different molecular marker. 2. Structure of mapping population. 3. Application and benefits of MABB in plant breeding. 4. Section of parents for Gene pyramiding. 5. List of bioinformatics tool with application.	
Suggested e-resources (Websites)	https://www.ncbi.nlm.nih.gov/ https://www.genome.gov/genetics-glossary/Recombinant-DNA-Technology	

Course Code: GPB-516 **Course Name: Breeding for Stress Resistance and Climate Change** **Semester: III**

Credit	L	T	P	Marks	Contact Hours (per week)	Independent Study Hos (per week)	Section (Group)
3	2	0	1		04		**M.Sc. (Ag), GPB**
Curriculum level					• Research based • Information based • Critical thinking based	**Student specific course outcome**	• Research • Higher education • Placement

Objective: To apprise about various abiotic and biotic stresses influencing crop yield, mechanisms and genetics of resistance and methods to breed stress tolerant varieties.

Course outcomes: Through this course the students would be able to

CO-1	Describe the biotic and abiotic stress from molecular to phenotype
CO-2	Classify different stress of biotic and abiotic form
CO-3	Utilize molecular breeding approach to identify resistance type of the given crop
CO-4	Examine climate driven various stress appearance & changes in molecular to metabolomics level
CO-5	Develop a comprehensive breeding strategy to measure plant resistance against various stresses
CO-6	Construction of mapping population for the given stress resistance

T1	Class room Lectures/ Guest lectures Laboratory/ Field and lab Practical Student Seminars/ Presentations
T2	ABL activities Lab and field Tours/ Demonstrations Assignments

Assessment tools	
AT1-1	One Midterm Exam
AT1-2	Seminar, Presentation and Report
AT1-3	Assignment
AT1-4	Activity Based Learning
AT1-5	Marker Assisted Selection

Prerequisites	Module wise details	Assessment tools
Course Content	**Unit – 1** Concept and impact of climatic change; Importance of plant breeding with special reference to biotic and abiotic stress resistance; Classification of biotic stresses – major pests and diseases of economically important crops.	Assignment Mid term
	Unit – 2 Concepts of resistance to insect and pathogen resistance; Analysis and inheritance of resistance variation; Host defence responses to pathogen invasions- Biochemical and molecular mechanisms; Acquired and induced immunity and systemic acquired resistance (SAR); Host- pathogen interaction, gene-for-gene hypothesis, molecular evidence for its operation and exceptions; Concept of signal transduction and other host-defence mechanisms against viruses and bacteria.	ABL activities Mid term
	Unit – 3 Types and genetic mechanisms of resistance to biotic stresses – Horizontal and vertical resistance in crop plants; Quantitative resistance/ adult plant resistance and slow rusting resistance; Classical and molecular breeding methods - Measuring plant resistance using plant fitness; Behavioural, physiological and insect gain studies; Phenotypic screening methods for major pests and diseases; Recording of observations; Correlating the observations using marker data – Gene pyramiding methods and their implications. Classification of abiotic stresses - Stress inducing factors, moisture stress/ drought and water logging and submergence; Acidity, salinity/ alkalinity/ sodicity; High/ low temperature, wind, etc.; Stress due to soil factors and mineral toxicity; Physiological and Phenological responses; Emphasis of abiotic stresses in developing breeding methodologies.	Research field base assignments
	Unit – 4 Genetics of abiotic stress resistance; Genes and genomics in breeding cultivars suitable to low water regimes and water logging and submergence, high and low/ freezing temperatures; Utilizing MAS procedures for identifying resistant types in important crops like rice, sorghum, wheat, cotton, etc.; Breeding for resistance to stresses caused by toxicity, deficiency and pollutants/ contaminants in soil, water and environment.	ABL activities
	Unit- 5 Use of crop wild relatives as a source of resistance to biotic and abiotic factors in major field crops; Transgenics in management of biotic and abiotic stresses, use of toxins, protease inhibitors, lectins, chitinases and Bt for diseases and insect pest management.	Assignments Presentation/ Seminars

Practical Exercise*	Course Modules	Assessment tools
	Demonstration & Report Preparation 6. Measuring plant resistance with the help of molecular marker 7. Phenotypic screening against major diseases of a given crop **Lab/Field Analysis & Report Preparation :** 1. Symptoms and data recording followed by MAS procedure 2. Evaluation of NIL population for pest resistance 3. Screening of different treatment/genotype for major crops for alkalinity their effect and breeding strategies 4. Understandingtheclimatologicalparametersandpredisposalofbiotica ndabiotic stress factors- ways of combating them for diseases caused by fungi and bacteria	Activity based learning can be given to implement application aspect
References	1. Maxwell FG and Jennings PR. (Eds.). 1980. Breeding Plants Resistant to Insects. John Wiley & Sons. Wiley-Blackwell. 2. Roberto F. 2018. Plant Breeding for Biotic and Abiotic Stress Tolerance. Springer. Russel GE. 1978. Plant Breeding for Pest and Disease Resistance. Butterworths. Sakai A and Larcher W. 1987. Frost Survival in Plants. Springer-Verlag. 3. Singh BD. 2006. Plant Breeding. Kalyani Publishers, New Delhi. 4. Turener NC and Kramer PJ. 1980. Adaptation of Plants to Water and High Temperature Stress. John Wiley & Sons. 5. van der Plank JE. 1982. Host-Pathogen Interactions in Plant Disease. Academic Press.	
Resources:	LCD, OHP, Black Board, Microbiology laboratory.	
Assignment/ Tutorial:	Students are required to submit one assignment and deliver one power point presentation as a part of their continuous evaluation system.	
List of Assignment	1. Breeding for herbicide resistance 2. Transgenics in management of biotic and abiotic stresses 3. Gene pyramiding methods and their implications. 4. Emphasis of abiotic stresses in developing breeding methodologies.	

	5. Acquired and induced immunity and systemic acquired resistance	
ABL	• Germplasm collection and evaluation for resistance against disease and pest and study on salinity tolerance.	
Suggested websites:	http://www.nbpgr.ernet.in/ https://nph.onlinelibrary.wiley.com/doi/full/10.1111/nph.16610 https://www.ncbi.nlm.nih.gov/ https://niasm.icar.gov.in/ https://www.mdpi.com/journal/life/special_issues/KUKP98H8U7 https://link.springer.com/collections/fjbhcffehj https://nibsm.icar.gov.in/ http://niam.res.in/about-location https://www.indiascienceandtechnology.gov.in/organisations/ministry-and-departments/icar-national-institue-abiotic-stress-management	

Course Code: SST-508 **Course Name: Post Harvest Handling and Storage of Seeds** **Semester: III**

Credits	**L**	**T**	**P**	**Contact Hours(per week)**	**Independent Study Hrs (per week)**	**Section (Group)**
03	2	0	1	04		**M.Sc. (Ag), GPB**
Curriculum level				• Information based • Critical thinking based • Research based	**Student specific course outcome**	• Placement • Research • Higher education

Objective:
To impart knowledge on principles, techniques and methods of seed processing, treatment and storage.

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

CO-1	Define the basic mechanism involved in seed processing.
CO-2	Understanding on fundamental aspects of storage techniques and quality management practices.
CO-3	Conceptualize the advanced research on seed developmental biology.
CO-4	Examine the process of seed deterioration
CO-5	Acquire the skill on seed handling and storage methods on commercial basis.

Teaching Pedagogy	
T1	Class room teaching (chalk-board) Power Point Presentations, Processing experiments, Demonstration visits
T2	ABL, Assignments Flip Class/ Seminars Quiz, ICT Based tools, Group task, Hands on training, Exposure and field

Assessment tools

AT1-1	Mid-term Exams and end term exam
AT1-2	Seminar Presentation
AT1-3	Quiz
AT1-4	Poster
AT1-5	Activity Based Learning
AT1-6	Flip Class
AT1-7	Viva voce examination
AT1-8	Report writing
AT1-9	Field trial
AT1-10	Spot Identification

Prerequisites	Module wise details	Assessment tools
Course Contents	**Unit – 1** Seed processing – objectives and principles; processing sequence – threshing, shelling, ginning, extraction methods; drying – principles and methods; seed cleaning, grading, upgrading – methods – machineries and equipment – scalper, pre-cleaner, cleaner cum grader, specific gravity separator, indented cylinder, disc separator, spiral separator, velvet separator, magnetic separator, electronic colour sorter – working principles and functions.	Power Point Presentations Poster Presentation Assignments
	Unit – 2 Online seed processing – elevators and conveyers – processing plant – specifications, design and layout; mechanical injury – causes and detection – management.	ABL activities Assignments Flip Class/ Seminars Quiz Mid Term examination
	Unit – 3 Seed treatment – methods – pre and mid storage seed treatments, seed treating formulations and equipments; packaging materials – types – bagging and labeling; seed blending – principle and methods.	Power Point Presentations Quiz Field Trial
	Unit – 4 Seed storage – purpose and importance – factors affecting storage, optimum condition for storage of different seeds; storage principles – Harrington's thumb rule – concepts and significance of moisture equilibrium – maintenance of safe seed moisture – physical, physiological, biochemical and molecular changes during seed storage – storage behavior of orthodox and recalcitrant seeds – prediction of viability – viability nomograph.	Assignments Flip Class/ Seminars Quiz
	Unit-5 Methods of seed storage – modified atmospheric storage – ultra dry storage – vacuum storage – cryopreservation – germplasm storage – gene banks – NBPGR, IPGRI and National seed storage laboratory; seed storage godown – structure – maintenance – sanitation.	Assignments Flip Class/ Seminars Quiz

	17. • Seed extraction – wet and dry methods. 18. Seed processing sequence for different crops 19. Design of processing plant – equipments – estimation of processing efficiency 20. Seed drying methods – principle and methods 21. Practicing seed grading – upgrading techniques 22. Delinting methods – assessment of mechanical damage 23. Visit to seed processing unit 24. Seed packaging – effect of packaging materials on seed longevity 25. Prediction of viability during storage – viability nomograph and accelerated ageing test 26. Assessing physical changes during seed storage 27. Assessing physiological changes during seed storage 28. Assessing biochemical changes during seed storage 29. Storage behaviour of recalcitrant seeds 30. Pre-storage seed treatments – protectants – antioxidants – halogens 31. Practicing seed blending methods 32. Seed storage godown – sanitation, fumigation – visit to seed storage godown and cold storage unit	Practical Activity Practical Record Viva voce Spot Identification
References	11. Barton LV. 1961. Seed Preservation and Longevity, (Vol. 1). Leonard Hill, London. 12. Gregg BR, Law AG, Virdi SS and Balis JS. 1970. Seed Processing. Avion printers, New Delhi. 13. Gupta D. 2009. Seeds: their conservation principles and practices. Sathish serial publishing house. New Delhi. 14. Justice OL and Bass LN. 1978. Principles and Practices of Seed Storage. Agriculture Hand Book No. 506, Castle House Publication Ltd., Washington. 15. Kulkarni GN. 2011. Principles of Seed Technology. Kalyani Publishers, New Delhi. 16. Maiti RK, Sarkar NC and Singh VP. 2006. Principles of Post Harvest Seed Physiology and Technology. Agrobios, Jodhpur, Rajasthan. 17. Padmavathi S, Prakash M, Ezhil Kumar S, Sathiyanarayanan G and Kamaraj A. 2012. A Text book of Seed Science and Technology, New India Publishing Agency, New Delhi. 18. Sen S and Ghosh N. 2010. Seed Science and Technology. Kalyani Publishers, New Delhi. 19. Singhal NC. 2010. Seed Science and Technology. Kalyani Publishers, New Delhi.	
Resources:	LCD, OHP, Black Board, Laboratory, Experimental research field	
Assignment/ Tutorial:	Students are required to submit assignments and deliver one power point presentation as a part of their continuous evaluation system.	

List of Assignments	9. Pollination, mechanism 10. Explain the formation of megasporogenesis. 11. Mode of pollination 12. Structural and numerical changes in chromosomes 13. Genetic fine structure analysis 14. Regulation of gene activity in prokaryotes 15. Gene isolation, synthesis and cloning, genomic and cDNA libraries 16. Genomics and proteomics	
Suggested e-books	http://dfsc.dk/pdf/Handbook/chapter8_internet.pdf https://naldc.nal.usda.gov/download/CAT87208646/PDF https://www.springer.com/in/book/9780792373223 http://203.64.245.61/fulltext-pdf/EB/1900-2000/eb0021.pdf https://www.kopykitab.com/ebooks/2016/05/6997/sample/sample_6997.pdf https://trove.nla.gov.au/work/6862691?q&sort=holdings+desc&-=1541066209257 &versionId=45008917+251246346 http://www.worldseed.org/wp-content/uploads/2017/01/Seed-Production-Good-practice- 10.01.17- final.pdf	
Suggested websites	http://www.fao.org/3/a-ah803e.pdf agritech.tnau.ac.in/seed_certification/seedtech_index.html http://ecoursesonline.iasri.res.in/mod/page/view.php?id=17806 http://www.bcseeds.org/wp-content/uploads/2015/01/Seed-Processing-2015-update.pdf https://www.carolinafarmstewards.org/wpcontent/uploads/2012/05/Seed Processingand StorageVer_1pt3.pdf	

Course Code: PGS- 505 Course Name: Agricultural Research, Research Ethics and Rural Development Programmes Semester: III

Credits	L	T	P	Marks			Contact Hours (per week)	Independent Study Hour (per week)	Section (Group)
1	1	0	0				1		**M.Sc. Agronomy**
Curriculum level							Basic and applied	**Student specific course outcome**	Higher Education Placement Research

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

CO-1	Define various aspects of agricultural research.
CO-2	Understand the research ethics.
CO-3	Apply the skill for rural development programmes.
CO-4	Relate the functioning of agricultural research systems at national and international levels.
CO-5	Equip the students/scholars with skills to perform research.

Teaching Pedagogy:

T1	Classroom Lectures Web-based information Student Seminars/ Presentations/Workshop
T2	ABL activities Case studies Community development programs

Assessment tools	
AT1-1	Case studies
AT1-2	Student Seminars/ Presentations/Workshop Report
AT1-3	Drafting a technical program for scientific research
AT1-4	Participation in community development programs

Prerequisites	Unit wise contents details	Assessment tools
Course Contents	**UNIT-1** Agricultural Research: History of agriculture in brief. Global agricultural research system: need, scope, opportunities. Role in promoting food security, reducing poverty and protecting the environment.	Student Seminars/ Presentations/Workshop Report/ Drafting a technical program
	UNIT- 2 NARS and CGIAR: National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions. Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels. International fellowships for scientific mobility.	Student Seminars/ Presentations/Workshop Report/ Case studies
	UNIT- 3 Research Ethics: Research ethics: research integrity, research safety in laboratories. Welfare of animals used in research, computer ethics. Standards and problems in research ethics.	Student Seminars/ Presentations/Workshop Report
	UNIT- 4 RDP- Concept and policies: 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 Organisations.	Participation in Community Development Programme / Case studies
	UNIT- 5 RDP- Evaluation and implementation: Critical evaluation of rural development policies and programmes. Constraints in implementation Constraints in implementation of rural policies and programmes.	Participation in Community Development Programme / Case studies

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. Case studies on NARS 2. Case studies on RDP 3. Case studies on Research ethics
Suggested reading:	**A. Text and Reference books:** 1. Bhalla GS and Singh G. 2001. Indian Agriculture - Four Decades of Development. Sage Publ. 2. Punia MS. Manual on International Research and Research Ethics. CCS Haryana Agricultural University, Hisar. 3. Rao BSV. 2007. Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives. Mittal Publ. 4. Singh K. 1998. Rural Development - Principles, Policies and Management. Sage Publ.
Suggested e-resources (Websites/e-books)	1. https://www.fao.org/3/i1307e/i1307e.pdf 2. https://icar.org.in/files/reports/icar-dare-annual-reports/2013-14/NAIP-13-14.pdf 3. https://icar.org.in/files/advcn.pdf