DEPARTMENT OF HIGHER EDUCATION

RAJA MAHENDRA PRATAP SINGH UNIVERSITY, ALIGARH

AS PER THE ICAR-Sixth Deans' Committee

Course Curriculum of M.Sc. (Ag.) Genetics & Plant Breeding

Course Curriculum of M.Sc. (Ag.) Genetics & Plant Breeding
(Based on Restructured and Revised Syllabi of PG Programme by ICAR)

1st Year (1st Semester)			Evaluation Marks			
Code No.	**Course Title**	**Credit Hours**	**Mid Term (Internal)**	**Practical (External)/ Assignment (Internal 2)**	**End term/Final (External)**	**Total**
GPB -501	Principles of Genetics	3(2+1)	20	30	50	100
GPB-502	Principles of Plant Breeding	3(2+1)	20	30	50	100
GPB-503	Fundamentals of Quantitative Genetics	3(2+1)	20	30	50	100
	Elective	3(2+1)	20	30	50	100
AST 501	Experimental Design	3(2+1)	20	30	50	100
PGS 501	Basic Concepts in Laboratory Technique	1(0+1)	40	10	-	50
PGS 502	Intellectual Property and Its Management in Agriculture	1(1+0)	-	-	50	50
	Total Credit	**17**				**600**
1st Year (2nd Semester)			**Evaluation Marks**			
GPB -504	Crop Breeding-I(Kharif Crops)	3(2+1)	20	30	50	100
GPB-505	Principles of Cytogenetics	3(2+1)	20	30	50	100
GPB-506	Molecular Breeding and Bioinformatics	2(1+1)	20	30	50	100
	Elective	3(2+1)	20	30	50	100
AST 502	Date Analysis Using Statistical Packages	3(2+1)	20	30	50	100
PGS 503	Agriculture Research, Research Ethic and Rural Development Programmes	1(1+0)	-	-	50	50
PGS 504	Library and Information Services	1(0+1)	40	10	-	50
	Total Credit	**16**				**600**
2nd Year (3rd Semester)			**Evaluation Marks**			
GPB-507	Seed Production and Certification	3(2+1)	20	30	50	100
GPB-508	Crop Breeding-II (Rabi Crops)	3(2+1)	20	30	50	100
GPB-509	Varietal Development and Maintenance Breeding	2(1+1)	20	30	50	100

	Elective	2(1+1)	20	30	50	100
PGS-505	Technical Writing and Communications Skills	1(0+1)	-	100	-	100
	Total Credit	**11**				**500**
2nd Year (4th Semester)			**Evaluation Marks**			
GPB-510	Master Seminar	1(0+1)	-	100	-	100
GPB- 511 A	Master Research (Thesis)	30	Satisfactory/Unsatisfactory			
OR						
GPB- 511 B	IDEA (Internship for Development of Entrepreneurship In Agriculture)	30	Satisfactory/Unsatisfactory			
	Total Credit	**1+30**				**100**
	Grand total credit hours	**45 +30 = 75**				**1800**

M.Sc. (Ag.) Genetics & Plant Breeding
The following nomenclature and Credit Hrs. are following while structuring Syllabus:

A. Course Work	Course Code	Allotted Credit Hours
1. Major Course	GPB- 501 To GPB- 509	25
2. Minor Course	Elective	08
3. Supporting Course	AST-501 & AST-502	06
4. Common Course	PGS-501 To PGS-505	05
5. Seminar	GPB- 510	01
B. 1.Thesis Research/ IDEA	Master Research or IDEA	30
Total		**75**

List of Minor Papers for Other Departments

Sr. No.	**Course Code**	**Course Name**	**Allotted Credit Hours**	**Sem.**
1	GPB -501	Principles of Genetics	3(2+1)	1st
2	GPB -504	Principles of Plant Breeding	3(2+1)	2nd
3	GPB-507	Seed Production and Certification	2(1+1)	3rd

Note: - 1. The student has to opt. Minor Courses of Minimum 8 credit hours offer by other department
2. The first course of every semester from the respective department is treated as a Minor for other department.

Detailed Syllabus
M.Sc. (Ag) in Genetics and Plant Breeding (GPB)

1st Semester

Course Contents

I. Course Title : Principles of Genetics
II. Course Code: GPB 501
III. Credit Hours: 3 (2+1)

Theory:

Unit I

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

Unit II

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

Unit III

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

Unit IV

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

Unit V

Genomics and proteomics; meta-genomics; Transgenic bacteria and bioethics; Gene silencing; genetics of mitochondria and chloroplasts. Concepts of Eugenics, Epigenetics, Genetic disorders. Restructured and Revised Syllabi of Post-graduate Programmes

Practical:

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

Suggested reading:

- Daniel LH and Maryellen R. 2011. Genetics: "Analysis of Genes and Genomes".

- Gardner EJ and Snustad DP. 1991. Principles of Genetics. John Wiley and Sons. 8th ed. 2006
- Klug WS and Cummings MR. 2003. Concepts of Genetics. Peterson Edu. Pearson Education India; Tenth edition
- Lewin B. 2008. Genes XII. Jones and Bartlett Publ. (International Edition) Paperback, 2018
- Russell PJ. 1998. Genetics. The Benzamin/ Cummings Publ. Co
- Singh BD. 2009. Genetics. Kalyani Publishers (2nd Revised Edition)
- Snustad DP and Simmons MJ. 2006. Genetics. 4th Ed. John Wiley and Sons. 6th Edition International Student Version edition Stans field WD.1991.
- Genetics. Schaum Outline Series Mc Graw Hill Strickberger MW. 2005. Genetics (III Ed). Prentice Hall, New Delhi, India; 3rd ed., 2015
- Tamarin RH. 1999. Principles of Genetics. Wm. C. Brown Publs., McGraw Hill Education; 7edition
- Uppal S, Yadav R, Singh S and Saharan RP. 2005. Practical Manual on Basic and Applied Genetics. Dept. of Genetics, CCS HAU Hisar.

Course Contents

I. Course Title : Principles of Plant Breeding
II. Course Code : GPB 502
III. Credit Hours: 3 (2+1)

Theory:

Unit I

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

Unit II

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

Unit III

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

Unit IV

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

Unit V

Breeding methods in asexually/ clonally propagated crops, clonal selection. Special breeding techniques: Mutation breeding, breeding for abiotic and biotic stresses; Concept of plant ideotype and its role in crop improvement, concept of MAS, concept of polyploidy and wide hybridization, doubled haploidy. Cultivar development: testing, release and notification, maintenance breeding,

Participatory Plant Breeding, Plant breeders' rights and regulations for plant variety Protection and farmers rights.

Practical:

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

Suggested Reading:

- Allard RW. 1981. Principles of Plant Breeding. John Wiley & Sons.
- Chahal GS and Gossal, SS. 2002. Principles and Procedures of Plant Breeding Biotechnological and Conventional approaches. Narosa Publishing House.
- Chopra VL. 2004. Plant Breeding. Oxford & IBH.
- George A. 2012. Principles of Plant Genetics and Breeding. John Wiley & Sons.
- Gupta SK. 2005. Practical Plant Breeding. Agribios.
- Jain HK and Kharakwal MC. 2004. Plant Breeding and–Mendelian to Molecular Approach, Narosa Publications, New Delhi
- Roy D. 2003. Plant Breeding, Analysis and Exploitation of Variation. Narosa Publ. House.
- Sharma JR. 2001. Principles and Practice of Plant Breeding. Tata McGraw-Hill.
- Sharma JP. 2010. Principles of Vegetable Breeding. Kalyani Publ, New Delhi.
- Simmonds NW.1990. Principles of Crop Improvement. English Language Book Societ ty.
- Singh BD. 2006. Plant Breeding. Kalyani Publishers, New Delhi.
- Singh S and Pawar IS. 2006. Genetic Bases and Methods of Plant Breeding. CBS

I. Course Title : Fundamentals of Quantitative Genetics

II. Course Code : GPB 503
III. Credit Hours : 3 (2+1)

Theory:

Unit I

Introduction and historical background of quantitative genetics, Multiple factor hypothesis, Qualitative and quantitative characters, Analysis of continuous variation mean, range, SD, CV; Components of variation- Phenotypic, Genotypic, Nature of gene action- additive, dominance and epistatic, linkage effect. Principles of analysis Plant Sciences–Genetics and Plant Breeding of variance and linear model, Expected variance components, Random and fixed effect model, Comparison of means and variances for significance.

Unit II

Designs for plant breeding experiments- principles and applications; Variability parameters, concept of selection, simultaneous selection modes and selection of parents, MANOVA.

Unit III

Association analysis- Genotypic and phenotypic correlation, Path analysis Discriminate function and principal component analysis, Genetic divergence analysis Metro glyph and D2, Generation mean analysis, Parent progeny regression analysis

Unit IV

Mating designs- classification, Diallel, partial diallel, L × T, NCDs, and TTC; Concept of combining ability and gene action, G × E interaction-Adaptability and Stability; Methods and models for stability analysis; Basic models- principles and Interpretation, Bi-plot analysis.

Unit V

QTL mapping, Strategies for QTL mapping- Desired population and statistical Methods, QTL mapping in genetic analysis; Markers, Marker assisted selection and factors influencing the MAS, Simultaneous selection based on marker and phenotype.

Practical

- Analysis and interpretation of variability parameters;
- Analysis and interpretation of Index score and Metro glyph;
- Clustering and interpretation of D2 analysis;
- Genotypic and phenotypic correlation analysis and interpretation;
- Path coefficient analysis and interpretation,
- Estimation of different types of heterosis, inbreeding depression and interpretation;
- A, B and C Scaling test;
- L × T analysis and interpretation, QTL analysis;
- Use of computer packages;
- Diallel analysis;
- G × E interaction and stability analysis.

Suggested Reading:

- Bos I and Caligari P. 1995. Selection Methods in Plant Breeding. Chapman & Hall. Restructured and Revised Syllabi of Post-graduate Programmes Vol. 1
- Falconer DS and Mackay J. 1998. Introduction to Quantitative Genetics (3rd Ed.).ELBS/ Longman, London.
- Mather K and Jinks JL.1985. Biometrical Genetics (3rd Ed.). Chapman and Hall, London.
- Nandarajan N and Gunasekaran M. 2008. Quantitative Genetics and Biometrical Techniques in Plant Breeding. Kalyani Publishers, New Delhi.
- Naryanan SS and Singh P. 2007. Biometrical Techniques in Plant Breeding. Kalyani Publishers, New Delhi.
- Roy D. 2000. Plant Breeding: Analysis and Exploitation of Variation. Narosa Publishing House,New Delhi.
- Sharma JR. 2006. Statistical and Biometrical Techniques in Plant Breeding. New Age International Pvt. Ltd.
- Singh P and Narayanan SS. 1993. Biometrical Techniques in Plant Breeding. Kalyani Publishers, New Delhi.
- Singh RK and Chaudhary BD. 1987. Biometrical Methods in Quantitative Genetic analysis. Kalyani Publishers, New Delhi.
- Weir DS. 1990. Genetic Data Analysis. Methods for Discrete Population Genetic Data. Sinauer Associates.
- Wricke G and Weber WE. 1986. Quantitative Genetics and Selection in Plant Breeding. Walter de Gruyter.

e-Suggested Reading

www.iasri.icar.gov.in

I. Course Title : Experimental Designs
II. Course Code : (AST 501)
III. Credit Hours: 3 (2+1)

Theory:
Unit I
Need for designing of experiments, characteristics of a good design. Basic principles of designs-randomization, replication and local control.
Unit II
Uniformity trials, size and shape of plots and blocks, Analysis of Variance, Completely randomized design, randomized block design and Latin square design.
Unit III
Factorial experiments, (symmetrical as well as asymmetrical). Orthogonally and partitioning of degrees of freedom. Concept of confounding.
Unit IV
Split plot and strip plot designs, analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, Balanced Incomplete Block Design, resolvable designs and their applications,
Unit V
Lattice design, alpha design - concepts, randomization procedure, analysis and interpretation of results. Response surfaces. Combined analysis.

Practical
- Uniformity trial data analysis, formation of plots and blocks, Fairfield Smith Law, Analysis of Data obtained from CRD, RBD, LSD, Analysis of factorial experiments,
- Analysis with missing data,
- Split plot and strip plot designs.

Suggested Reading:

- Cochran WG and Cox GM. 1957. Experimental Designs. 2nd Ed. John Wiley.
- Dean AM and Voss D. 1999. Design and Analysis of Experiments. Springer.
- Montgomery DC. 2012. Design and Analysis of Experiments, 8th Ed. John Wiley.
- Federer WT. 1985. Experimental Designs. MacMillan.
- Fisher RA. 1953. Design and Analysis of Experiments. Oliver & Boyd.
- Nigam AK and Gupta VK. 1979. Handbook on Analysis of Agricultural Experiments. IASRI Publ.
- Pearce SC. 1983. The Agricultural Field Experiment: A Statistical Examination of Theory and Practice. John Wiley.
- www.drs.icar.gov.in.

I. Course Title : BASIC CONCEPTS IN LABORATORY TECHNIQUES
II. Course Code : (PGS 501)
III. Credit Hours: 1(0+1)

Practical
- Safety measures while in Lab;
- Handling of chemical substances;
- Use of burettes, pipettes, measuring cylinders, flasks, separators funnel, condensers, Micropipettes and vaccupets;
- Washing, drying and sterilization of glassware;

• Drying of solvents/ chemicals;
• Weighing and preparation of solutions of different strengths and their dilution;
• Handling techniques of solutions;
• Preparation of different agro-chemical doses in field and pot applications;
• Preparation of solutions of acids;
• Neutralization of acid and bases;
• Preparation of buffers of different strengths and pH values;
• Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, Magnetic stirrer, micro-ovens, incubators, sand bath, water bath, oil bath
• Electric wiring and earthing;
• Preparation of media and methods of sterilization;
• Seed viability testing, testing of pollen viability;
• Tissue culture of crop plants;
• Description of flowering plants in botanical terms in relation to taxonomy.

Suggested Readings

• Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press
• Gabb MH and Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.

I. Course Title : Intellectual Property and Its Management in Agriculture
II. Course Code : (PGS 502)
III. Credit Hours: 1(1+0)

Theory

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings:

• Erbisch FH and Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.
• Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.
• Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC and Aesthetic Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V.Technology Generation and IPR Issues. Academic Foundation.
• Rothschild M and Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.
• Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House.
• The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; The Biological Diversity Act, 2002.

2nd Semester

I. Course Title : Crop Breeding I (Kharif Crops)
II. Course Code: GPB 504
III. Credit Hours: 3(2+1)

Theory:
Unit I
Rice: Origin, evolution, mode of reproduction, chromosome number; Genetics Cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement, Aerobic rice, its implications and drought resistance breeding. Maize: Origin, evolution, mode of reproduction, chromosome number; Genetics Cytogenetics and genome relationship; breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement- QPM and Bt maize strategies and implications. Small millets: Evolution and distribution of species and forms - wild relatives and germplasm; Cytogenetics and genome relationship - breeding objectives yield, quality characters, biotic and abiotic stress resistance, etc.

Unit II
Pigeon pea: evolution, mode of reproduction, chromosome number; Genetics Cytogenetics and genome relationship; breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement - Hybrid technology; maintenance of male sterile, fertile and restorer lines, progress made at National And International institutes. Groundnut: Origin, evolution mode of reproduction, chromosome number; Genetics– Cytogenetics and genome relationship, breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, released varieties, examples of MAS used for improvement. Other pulses: Urdbean, mungbean, cowpea. Origin, evolution, mode of reproduction, chromosome number; Genetics – Cytogenetics and genome relationship, breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), released varieties, examples of MAS used for improvement. Interspecific crosses attempted and its implications, reasons for failure, ways of overcoming them.

Unit III
Soybean: Origin, evolution, mode of reproduction, chromosome number; Genetics– Cytogenetics and genome relationship; breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement. Castor and Sesame: Origin, evolution mode of reproduction, chromosome number; Genetics – Cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), released varieties, examples of MAS used for improvement; Hybrid breeding in castor – opportunities, constraints and achievements.

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

Development and maintenance of male sterile lines – Hybrid development and seed production Scenario of Bt cottons, evaluation procedures for Bt cotton. Jute: Origin, evolution, mode of reproduction, chromosome number; Genetics Cytogenetics and genome relationship; breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement.

Unit V

Sugarcane: Evolution and distribution of species and forms, wild relatives and Germplasm; Cytogenetics and genome relationship – Breeding objectives- yield, quality characters, biotic and abiotic stress resistance, etc. Forage crops: Evolution and distribution of species and forms – Wild relatives and Germplasm; Cytogenetics and genome relationship; Breeding objectives- yield, quality characters and palatability studies; Biotic and abiotic stress resistance, etc. Seed spices: Origin, evolution, mode of reproduction, chromosome number; Genetics– Cytogenetics and genome relationship; breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, Heterosis breeding, released varieties, examples of MAS used for improvement; Achievements of important spice crops.

Practical:

- Floral biology, emasculation, pollination techniques in rice, maize, pigeon pea, soybean, sesame, Cotton;
- Study of range of variation for yield and yield components;
- Study of segregating populations in cereal, pulses and oilseed crops;
- Learning on the crosses between different species; attempting crosses between black gram and green gram;
- Evaluating the germplasm of cotton for yield, quality and resistance parameters, learning the procedures on development of Bt cotton;
- Visit to Cotton Technology Laboratory and Spinning Mills;
- Learning on the Standard Evaluation System (SES) and descriptors; Use of software for database management and retrieval;
- Practical learning on the cultivation of fodder crop species on sewage water, analyzing them for Yield components and palatability;
- Laboratory analysis of forage crops for crude protein, digestibility percent and other quality Attributes;
- Visit to animal feed producing factories;
- Learning the practice of value addition; Visiting the animal husbandry unit and learning the Animal experiments related with palatability and digestibility of fodder.

Suggested Reading:

- Agarwal RL. 1996. Identifying Characteristics of Crop Varieties. Oxford & IBH.
- Bahl PN and Salimath PM. 1996. Genetics, Cytogenetics and Breeding of Crop Plants. Vol. I. Pulses and Oilseeds. Oxford & IBH.
- Chandraratna MF. 1964. Genetics and Breeding of Rice. Longmans.
- Chopra VL and Prakash S. 2002. Evolution and Adaptation of Cereal Crops. Oxford & IBH.
- Gill KS. 1991. Pearl Millet and its Improvement. ICAR.
- IRRI. 1964. Rice Genetics and Cytogenetics. Elsevier.
- IRRI. 1986. Rice Genetics. Proc. International Rice Genetics Symposium. IRRI, Los Banos, Manila, Philippines.
- IRRI. 1991. Rice Genetics II. Proc. International Rice Genetics Symposium. IRRI, Los Banos, Manila, Philippines.

- IRRI. 1996. Rice Genetics III. Proc. International Rice Genetics Symposium. IRRI, Los Banos, Manila, Philippines.
- IRRI. 2000. Rice Genetics IV. Proc. International Rice Genetics Symposium. IRRI, Los Banos, Manila, Philippines.
- Jennings PR, Coffman WR and Kauffman HE. 1979. Rice Improvement. IRRI, Los Banos, Manila, Philippines.
- Kannaiyan S, Uthamasamy S, Theodore RK and Palaniswamy S. 2002. New Dimensions and Approaches for Sustainable Agriculture. Directorate of Extension Education, TNAU, Coimbatore.
- Murty DS, Tabo R and Ajayi O. 1994. Sorghum Hybrid Seed Production and Management. ICRISAT, Patancheru, India.
- Nanda JS. 1997. Manual on Rice Breeding. Kalyani Publishers.
- Parthasarathy VA. 2017. Spices and Plantation Crops Vol.1 (Part A) Breeding of Horticultural Crops Vol.1 (Part-B), Today and Tomorrow Printers and Publishers
- Poehlman, JM. 1987. Breeding of Field Crops. AVI Publishing Co. Inc. East Post Connecticut, USA.
- Ram HH and Singh HG. 1993. Crop Breeding and Genetics. Kalyani.
- Sharma, AK. 2005. Breeding Technology of Crop Plant. Yesh Publishing House, Bikaner
- Slafer GA. (Ed.). 1994. Genetic Improvement of Field Crops. Marcel Dekker.
- Singh HG, Mishra SN, Singh TB, Ram HH and Singh DP. (Eds.). 1994. Crop Breeding in India. International Book Distributing Co.
- Walden DB. 1978. Maize Breeding and Genetics. John Wiley & Sons.

I. Course Title : Principles of Cytogenetics

II. Course Code : GPB 505

III. Credit Hours: 3 (2+1)

Theory

Unit I

Cell cycle and 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. Variation in chromosome structure: Evolutionary significance; Introduction to techniques for karyotyping; Chromosome banding and painting –In situ hybridization and various applications.

Unit II

Structural and numerical variations of chromosomes and their implications; Symbols and terminologies for chromosome numbers, euploidy, haploids, diploids and polyploids; Utilization of aneuploidy in gene location; Variation in chromosome behavior, somatic segregation and chimeras, end mitosis and somatic reduction; Evolutionary significance of chromosomal aberrations, balanced lethal and chromosome complexes; Inter-varietal chromosome substitutions.

Unit III

Fertilization barriers in crop plants at pre-and post-fertilization levels; In-vitro techniques to overcome the fertilization barriers in crops; Polyploidy. Genetic consequences of polyploidization and role of polyploidy in crop breeding; Evolutionary advantages of autopolyploid vs. allopolyploids; Role of aneuploidy 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; Apomixes, evolutionary and genetic problems in crops with apomixes.

Unit IV

Reversion of autopolyploid to diploids; Genome mapping in polyploids; Interspecific hybridization and allopolyploids; Synthesis of new crops (wheat, Triticale, Brassica, and cotton); Hybrids between species with same chromosome number, alien translocations; Hybrids between species with different chromosome number; Gene transfer using amphidiploids, bridge species.

Unit V

Chromosome manipulations in wide hybridization; case studies; Production and use of haploids, dihaploids and doubled haploids in genetics and breeding.

Practical

- Learning the cytogenetical laboratory techniques, various chemicals to be used for Fixation, dehydration, embedding, staining, cleaning, etc.;
- Microscopy: various types of microscopes;
- Preparing specimen for observation;
- Fixative preparation and fixing specimen for light microscopy studies in cereals;
- Studies on mitosis and meiosis in crop plants;
- Using micrometers and studying the pollen grain size in various crops. Pollen germination In vivo and in-vitro;
- Demonstration of polyploidy.

Suggested Reading:

- Becker K and Hardin J. 2004. World of the Cell. 5th Ed. Pearson Edu. 9th edition.
- Carroll M. 1989. Organelles. The Guilford Press. harles
- B. 1993. Discussions in Cytogenetics. Prentice Hall Publications.
- Darlington CD and La Cour LF. 1969. The Handling of Chromosomes. George Allen & Unwin Ltd.
- Elgin SCR. 1995. Chromatin Structure and Gene Expression. IRLPress, Oxford.
- Gupta PK and Tsuchiya T. 1991. Chromosome Engineering in Plants: Genetics, Breeding and Evolution. Part A.
- Gupta PK. 2010. Cytogenetics. Rastogi Publishers.
- Johansson DA. 1975. Plant Micro technique. McGraw Hill.
- Karp G. 1996. Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons.
- Khush GS. 1973. Cytogenetics of aneuploids. Elsevier. 1 edition.
- Roy D.2009. Cytogenetics. Alpha Science Intl Ltd.
- Schulz SJ.1980. Cytogenetics- Plant, animals and Humans. Springer.
- Sharma AK and Sharma A. 1988. Chromosome Techniques: Theory and Practice. Butterworth Heinemann publisher 2014.3rd edition
- Singh RJ. 2016. Plant Cytogenetics 3rd Edition. CRC Press.
- Sumner AT. 1982. Chromosome Banding. Unwin Hyman Publ. 1 edition, Springer pub.
- Swanson CP. 1960. Cytology and Cytogenetics. Macmillan & Co

I. Course Title : Molecular Breeding and Bioinformatics

II. Course Code : GPB 506

III. Credit Hours : 2(1+1)

Unit I

Genotyping; Biochemical and Molecular markers; Morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR, SNPs, ESTs, etc.), Functional markers; Mapping populations

(F2s, back crosses, RILs, NILs and DH); Molecular mapping and tagging of agronomic ally important traits; Statistical tools in marker analysis.

Unit II

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.

Unit III

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; Endo peptidases; Nanotechnology and its applications in crop improvement.

Unit IV

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, molecular farming; Application of Tissue culture in molecular 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.

Practical

- Requirements for plant tissue culture laboratory;
- Techniques in plant tissue culture;
- Media components and media preparation;
- Aseptic manipulation of various explants, observations on the contaminants occurring in media, Interpretations;
- Inoculation of explants, callus induction and plant regeneration; standardizing the protocols for Regeneration;
- Hardening of regenerated plants; establishing a greenhouse and hardening procedures;
- Visit to commercial micro-propagation 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.

Suggested Reading

- 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 Spring Harbor Lab. Press.
- Singh BD. 2005. Biotechnology, Expanding Horizons. Kalyani Publishers, New Delhi.
- Watson J. 2006. Recombinant DNA. Cold Spring harbor laboratory press.

(AST 502) Data Analysis Using Statistical Packages 3(2+1)

Theory

Unit I

Introduction to various statistical packages: Excel, R, SAS, SPSS. Data Preparation; Descriptive statistics; Graphical representation of data, Exploratory data analysis.

Unit II

Test for normality; Testing of hypothesis using chi-square, t and F statistics and-Ztest.

Unit III

Data preparation for ANOVA and ANCOVA, Factorial Experiments, contrast analysis, multiple comparisons, Analyzing crossed and nested classified designs.

Unit IV

Analysis of mixed models; Estimation of variance components; Correlation and regression analysis, Probit, Logit and Tobit Models.

Unit V

Discriminant function; Factor analysis; Principal component analysis; Analysis of time series data, Fitting of non-linear models; Neural networks.

Practical

- Use of software packages for summarization and tabulation of data, obtaining descriptive statistics, graphical representation of data
- Testing the hypothesis for one sample t-test, two sample t-test, paired t-test, test for
- large samples - Chi-squares test, F test, one-way analysis of variance;
- Designs for Factorial Experiments, fixed effect models, random effect models, mixed
- effect models, estimation of variance components;
- Linear regression, Multiple regression, Regression plots
- Discriminant analysis - fitting of discriminant functions, identification of important
- variables
- Factor analysis. Principal component analysis - obtaining principal component.

Suggested Reading

- Anderson C.W. and Loynes R.M. 1987. The Teaching of Practical Statistics. John Wiley.
- Atkinson A.C. 1985. Plots Transformations and Regression. Oxford University Press.
- Chambers J.M., Cleveland W.S., Kleiner B and Tukey P.A. 1983. Graphical Methods for Data Analysis. Wadsworth, Belmont, California.
- Chatfield C. 1983. Statistics for Technology. 3rd Ed. Chapman & Hall. Chatfield C. 1995. Problem Solving: A Statistician's Guide. Chapman & Hall.
- Cleveland W.S. 1985. The Elements of Graphing Data. Wadsworth, Belmont, California.
- Ehrenberg ASC. 1982. A Primer in Data Reduction. John Wiley.
- Erickson B.H. and Nosan Chuk T.A. 1992. Understanding Data. 2nd Ed. Open University Press, Milton Keynes.
- Snell E.J. and Simpson HR. 1991. Applied Statistics: A Handbook of GENSTAT Analyses. Chapman and Hall.
- Sprent P. 1993. Applied Non-parametric Statistical Methods. 2nd Ed. Chapman & Hall.
- Tufte ER. 1983. The Visual Display of Quantitative Information. Graphics Press, Cheshire, Conn.
- Velleman PF and Hoaglin DC. 1981. Application, Basics and Computing of Exploratory Data Analysis. Duxbury Press.
- Weisberg S. 1985. Applied Linear Regression. John Wiley.
- Wetherill GB. 1982. Elementary Statistical Methods. Chapman & Hall.

(PGS 503)- Agricultural Research, Research Ethics and Rural Development Programmes 1 (1+0)

Theory:

UNIT I

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions;

UNIT II

Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centers (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

UNIT III

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

UNIT IV

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

UNIT V

Critical evaluation of rural development policies and Programmes. Constraints in implementation of rural policies and Programmes.

Suggested Readings

- Bhalla GS and Singh G. 2001. Indian Agriculture - Four Decades of Development. Sage Publ.
- Punia MS. Manual on International Research and Research Ethics. CCS Haryana Agricultural University, Hisar.

- Rao BSV. 2007. Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives. Mittal Publ.
- Singh K. 1998. Rural Development - Principles, Policies and Management. Sage Publ

I. Course Title : Library and Information Services
II. Course Code : (PGS 504)
III. Credit Hours: 1(0+1)

Practical:
Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/ Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; e-resources access methods.

3rd Semester

Course Contents

I. Course Title : Seed Production and Certification
II. Course Code: GPB 507
III. Credit Hours: 3(2+1)

Theory:

Unit I

Importance of seed as basic input in agriculture; Seed quality concept and importance; Generation system of seed multiplication -Varietal replacement rate, Seed multiplication ratios, Seed replacement rate, Seed renewal period and seed demand and supply; Various factors influencing seed production –Physical and Genetic purity in seed production; Factors responsible for varietal and genetic deterioration.

Unit II

Nucleus seed production and its maintenance - Maintenance of parental lines of hybrids, Production of breeder, foundation and certified seed and their quality maintenance; Principles of seed production in self- and cross-pollinated crops; Hybrid seed production - system and techniques involved in Seed village concept; Organic seed production and certification.

Unit III

Principles of seed production in field crops; Floral structure, pollination mechanism and seed production techniques in self- and cross-pollinated cereals and millets. Floral structure, pollination mechanism and methods and techniques of seed production in major pulses and oilseed crops; Varietal and hybrid seed production techniques in Pigeon pea, Mustard, Castor and Sunflower.

Unit IV

Floral structure, pollination mechanism and methods and techniques of seed production in major commercial fibers. Hybrid-seed production techniques in major vegetative propagated crops.

Unit V

Seed certification - history, concept, objectives; Central seed certification board Seed certification agency/ organization and staff requirement; Legal status - Phases of seed certification, formulation, revision and publication of seed certification standards; Minimum Seed Certification Standards (MSCS) for different crops General and specific crop standards, Field and seed standards; Planning and management of seed certification programs; Eligibility of a variety for certification, area assessment, cropping history of the seed field.

Practical:

- Planting design for variety- hybrid seed production techniques, planting ratio of male and female Lines, synchronization of parental lines and methods to achieve synchrony;
- Identification of rogues and pollen shedders, supplementary pollination, detasseling, hand emasculation and pollination;
- Pollen collection and storage methods, pollen viability and stigma receptivity;
- Pre-harvest sanitation, maturity symptoms, harvesting techniques;
- Visits to seed production plots - visit to seed industries;
- Planning for seed production: cost benefit ratio, seed multiplication ratio and seed replacement rate;
- General procedure of seed certification, identification of weed and other crop seeds as per specific crops, field inspection at different stages of a crop and observations recorded on contaminants and reporting of results, inspection and sampling, harvesting/ threshing, processing and after

processing for seed law enforcement;
• Specifications for tags and labels to be used for certification purpose.

Suggested Reading:

- Agrawal PK and Dadlani M. 1987. Techniques in Seed Science and Technology, South Asian Publishers, Delhi.
- Agrawal RL. 1997. Seed Technology, Oxford & IBH Publishing.
- Anon, 1965. Field Inspection Manual and Minimum Seed Certification Standards, NSC Publication, New Delhi.
- Anon. 1999. Manual of Seed Certification procedures. Directorate of Seed Certification, Coimbatore, Tamil Nadu.
- Joshi AK and Singh BD. 2004. Seed Science and Technology, Kalyani Publishers, New Delhi.
- Kelly AF. 1988. Seed Production of Agricultural Crops. John Wiley, New York.
- Mc Donald MB and Copeland LO. 1997. Seed Science and Technology, Scientific Publisher, Jodhpur.
- Ramamoorthy K, Sivasubramaniam K and Kannan M. 2006. Seed Legislation in India. Agrobios (India), Jodhpur, Rajasthan.
- Singhal NC. 2003. Hybrid Seed Production in Field Crops, Kalyani Publications, New Delhi
- Tunwar NS and Singh SV. 1988. Indian Minimum Seed Certification Standards. Central Seed Certification Board, Ministry of Agriculture, New Delhi.

I. Course Title : Crop Breeding II (Rabi Crops)
II. Course Code : GPB-508
III. Credit Hours : 3(2+1)

VI. Theory

Unit I

Wheat: Origin, evolution, mode of reproduction, chromosome number; Geneticscytogenetics and genome relationship; Breeding objectives: yield, quality characters,biotic and abiotic stress resistance, etc., breeding approaches, introgression of aliengene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, releasedvarieties, examples of MAS used for improvement.

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

Unit II

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

Unit III

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

Unit IV

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

Unit V

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

Practical

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

Suggested Reading

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

I. Course Title : Varietal Development and Maintenance Breeding
II. Course Code : GPB-509
III. Credit Hours : 2(1+1)

Theory:

Unit I

Variety Development systems and Maintenance; Definition- variety, cultivar, extant variety, essentially derived variety, independently derived variety, reference variety, farmers' variety, landraces, hybrid, and population; Variety testing, release and notification systems and norms in India and abroad.

Unit II

DUS testing- DUS Descriptors for major crops; Genetic purity concept and maintenance breeding. Factors responsible for genetic deterioration of varieties safeguards during seed production.

Unit III

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.

Unit IV

Quality seed production technology of self and cross-pollinated crop varieties, viz. cereals and millets (wheat, barley, paddy, pearl millet, sorghum, maize and ragi etc.); Pulses (green gram, black gram, cowpea, pigeon pea, chickpea, field pea, lentil); Oilseeds (groundnut, soybean, sesame, castor, sunflower, safflower, linseed, rapeseed and mustard); fibers (cotton/ jute) and forages (guar, forage sorghum, oats, berseem, Lucerne).

Unit V

Seed certification procedures; Seed laws and acts, plant variety protection regulations in India and international systems.

Practical

- Identification of suitable areas/ locations for seed production;
- Ear-to-row method and nucleus seed production;
- Main characteristics of released and notified varieties, hybrids and parental lines;
- PGMS and TGMS;
- Identification of important weeds/ objectionable weeds;
- Determination of isolation distance and planting ratios in different crops; Seed production techniques of varieties in different crops;
- Hybrid seed production technology of important crops;
- DUS testing and descriptors in major crops;
- Variety release proposal formats in different crops.

Suggested Reading:

- Agarwal RL. 1997. Seed Technology. 2nd Ed. Oxford & IBH.
- Kelly AF. 1988. Seed Production of Agricultural Crops. Longman.
- McDonald MB Jr and Copeland LO. 1997. Seed Production: Principles and Practices. Chapman & Hall.
- Poehlman JM and Borthakur D. 1969. Breeding Asian Field Crops. Oxford & IBH.
- Singh BD. 2005. Plant Breeding: Principles and Methods. Kalyani. 2015
- Thompson JR. 1979. An Introduction to Seed Technology. Leonard Hill

I. Course Name : Technical Writing and Communications Skills
II. Course Code : PGS-505
III. Credit Hours : 1(0+1)

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

Suggested Readings:

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

4th Semester

(GPB-510) Master Seminar 1(0+1)

(GPB- 511 A) Master Research (Thesis) 30

OR

(GPB- 511 B) IDEA (Internship for Development of Entrepreneurship in Agriculture) 30