SRIDEV SUMAN UTTARAKHAND UNIVERSITY

TEHRI GARHWAL

WEBSITE: www.sdsuv.ac.in

SYLLABUS FOR

M.SC (AGRICULTURE) BOTANY

Detailed agriculture Botany Syllabus

M.Sc. Agriculture Botany

Code	Course title	External + Internal	Total marks	Credit
	Semester I			
MSB/C -101	Statistical methods & Experimental Designs	(60+40)	100	03
MSB/C -102	Genetics	(60+40)	100	03
MSB/C -103	Plant Breeding	(60+40)	100	03
MSB/C -104	Plant Biotechnology	(60+40)	100	03
MSB/C -105	Practical I	(60+40)	100	03
MSB/C -106	Practical II	(60+40)	100	03
	Total		**600**	**18**
	Semester II			
MSB/C -201	Cytology and Cytogenetics	(60+40)	100	03
MSB/C -202	Advances in Plant Breeding	(60+40)	100	03
MSB/C -203	Crop Physiology-I	(60+40)	100	03
MSB/C -204	Genetic Engineering	(60+40)	100	03
MSB/C -205	Practical I	(60+40)	100	03
MSB/C -206	Practical II	(60+40)	100	03
	Total		**600**	**18**
	Semester III			
MSB/C-301	Population and biometrical Genetic	(60+40)	100	03
MSB/C-302	Seed Production Technology	(60+40)	100	03
MSB/C-303	Breeding Field Crops-I (Kharif)	(60+40)	100	03
MSB/E-304	Molecular Genetic } o r c select.	(60+40)	100	03
MSB/E-305	Crop Physiology-II }	(60+40)	100	03
MSB/C-306	**Practical I**	(60+40)	100	03
MSB/C-307	**Practical II**	(60+40)	100	03
	Total		**600**	**18**
	Semester IV			
MSB/E-401	Seed Science & technology	(60+40)	100	03
MSB/E-402	Breeding Field Crops-II (Rabi)	(60+40)	100	03
MSB/E-403	Plant Genetic Resources *	(60+40)	100	03
MSB/E-404	Stress Physiology of Field Crops*	(60+40)	100	03
MSB/E-405	Heterosis Breeding*	(60+40)	100	03
MSB/C-406	**Thesis Project Work**		200	06
MSB/C-407	**Seminar**		100	03
MSB/C-408	**Practical**	(60+40)	100	03
	Total		**600**	**18**

Detailed Syllabus

Agriculture Botany

M. Sc. (Ag.) I Semester

SOA/AB/C 501: Statistical Methods & Experimental Designs: 04 (03+01)

Theory :

1. Processing of Data: Classification and tabulation of data, Graphical and diagrammatic representation- Histogram, frequency polygon, frequency curve and cumulative frequency curves.
2. Measurement of Central tendencies and Dispersion: Mean, Median, Mode, Partition values, Range, Quartile deviation, Mean deviation, Standard deviation, Coefficient of variation, Moments and Kurtosis.
3. Probability and Distribution: Definition of probability, Random variable, Bernoulli trials, Binomial distribution, Poisson distribution, Normal distribution, properties of the above distributions, Fitting with available data, and test for their goodness of fit.
4. Correlation and Regression: Bivariate data, Bivariate frequency distribution, Correlation coefficients, Regression lines, Regression coefficients and their relation with correlation coefficient, Multiple regression, multiple and partial correlation coefficients.
5. Estimation: Concept of population and sample, Parameters and statistics, Criteria for a good estimator- unbiasedness, consistency and efficiency, Standard error of an estimator and Estimation of population mean.
6. Testing of Hypothesis: Null and alternative hypothesis, Two types of errors, Level of significance, Power of the test, One tailed and two tailed tests.
7. Test of Significance: Large sample tests, Chi square statistics and its use as a test for goodness of fit, Fisher's statistics and its use in testing the equality of two variances and homogeneity of means (analysis of variance).
8. Analysis of Variance and Covariance (ANOVA and ANCOVA): With one way and two way classification, Bartlestt's test for testing the homogeneity of variances
9. Experimental Designs: Principle of experimental designs, Replication, Randomization and Local control, CRD, RBD and Latin square designs and their analysis, Missing plot technique in RBD, Simple factorial experiments of the 2^2, 2^3, 2^4, 3^2 confounding in factorial experiment and Split-plot experiments.

Practical:

Presentation of data-tabulation, histograms and frequency polygons, Calculations of Mean, Median, Mode, Standard deviation, Skewness and Kurtosis, Calculation of expected frequencies in Binomial, Poisson and Normal distributions, Testing the observed results against expected frequencies, Test of significance, Regression and Correlation coefficients and their significance, Analysis of variance for RBD and LSD.

04 (03+01)

SOA/AB/C 502: Genetics:

Theory:

1. Mendel's laws and modifications of F2 ratios, Lethality, Balanced lethal systems, Segregation distortion, Modifiers and suppressors, Pleiotropic genes, Forward vs. Reverse genetics.
2. Chromosomal theory of inheritance: Qualitative differences between chromosomes, formulation of chromosome theory.
3. Linkage and chromosome maps: Linkage groups, Incomplete linkage and recombination, Four strand crossing over, Factors affecting recombination frequencies, Detection of linkage and linkage maps, Three point test cross, Interference and coincidence, Cytological basis of crossing over (Experiments of Stern in *Drosophila* and Mc Cliintock in Corn).
4. Multiple alleles: Concept, Self incompatibility, Alleles in Nicotiana, Coat colour in rodents, Blood groups in humans, Antigen-antibody interaction in inheritance of A, B, AB and O blood groups, MNS systems, Rh factor.
5. Quantitative inheritance: Multiple factor hypothesis, Concept of gene effects (Additive, dominance, over dominance and epistasis), Polygenes and discontinuous variation.
6. Sex linked inheritance: Non disjunction of chromosomes (primary and secondary), Sex linked, Sex limited and Sex influenced traits in *Drosophila* and human beings.
7. Sex determination and differentiation: Theories, Sex determination in dibecious plants (*Melandrium, Coccinia and Rumex*) and in man, Single gene control of sex, Hormonal control of sex, Sex reversal and gynandromorphs, Human sex anomalies (Klinefelter's syndrome and Tuner's syndrome), Brief idea of dosage compensation and Lyon's hypothesis, Genetic basis of sex differentiation.
8. Extra chromosomal inheritance: Criterion, Plastid inheritance in *Mirabilis*, Iojap in corn, Kappa particles in *Paramecium*, Coiling of shell in snails, Male sterility in plants.
9. Organellar genetics: DNA in mitochondria and chloroplasts, Petite character in yeast, Resistance to antibiotics in *Chlamydomonas*.
10. Mutations and mutagenic agents: Brief history, Physical and chemical mutagenesis, Detection of mutations in *Drosophila* (CIB methods, Muller-5 method, attached X chromosome method), Detection of mutations in plants and its practical application.
11. Mechanism of gene mutations: Target theory, Peroxide formation, UV and thiamine dimmers, Incorporation of base analogues and chemical alterations in maleic acids, Radiation damage and repair of DNA.
12. Concept of Gene: Classical and modern concepts, Pseudoallelism, Position effect, Intragenic crossing over and complementation (cistron, recon and muton), Benzer's work on II locus in T4 phage.

Practical:

Analyses of Chi-square in grouped data and for detection of linkage, Calculation of recombination frequencies from three point test cross data and F_2 data, Estimation of linkage from F_2 data, Study of male sterility in Onion, Bajra, and Wheat.

SOA/AB/C 503: Plant Breeding: 04 (03+01)

Theory:

1. Meeting human needs through plant breeding: Past progress and future needs.
2. Methods of reproduction: Self pollination, Cross pollination and Asexual reproduction (vegetative reproduction & apomixes).
3. Mating systems: Self fertilization, Full sib mating, Half sib mating, Back crossing, Inbreeding and Heterosis.
4. Genetic basis of breeding of self-pollinated crops: Selection, Pure line theory and its genetic basis, Sources of genetic variation, Genetic consequences of hybridization (segregation and recombination of genes), Composition of populations derived from hybrids, Role of genotype and environment in continuous variation, Heritability, Genetic advance under selection.
5. Breeding methods for self pollinated crops: Pure line and mass selection, Pedigree method and its modification, Bulk population method and back cross method.
6. Genetic basis of breeding of cross-pollinated crops: Genetic basis of self incompatibility and Heterosis, Genetic basis of population improvement (random mating and its consequences, germplasm complexes, composites and synthetics).
7. Breeding methods for cross pollinated crops: Selection, Recurrent selection, Development of hybrids, Synthetics and Composites.
8. Breeding methods for vegetatively propagated crops.
9. National and International organizations for crop improvement, IPR related issues in plant breeding.
10. Organization of Agricultural Research System in India: ICAR setup, ICAR Institutes, S.A.Us.

Practical:

Study of flower structure of Wheat, Barley, Legumes and *Brassica*, Emasculation and pollination in Wheat, Barley, Legumes and *Brassica*, Study of male sterility in onion, bajra, and wheat and its use in hybrid seed production.

SOA/AB/C 504: Biotechnology: 04 (03+01)

Theory:

1. Biotechnology and its scope in agriculture.
2. Plant organ, tissue and cell culture: Preparation of culture medium; Somaclonal variation and its use in crop improvement; Embryo culture and its utility in hybridization programmes; Anther culture production; Utility of haploids in plant breeding; Cell and protoplast culture in monocots and dicots- achievements and limitations; Micro propagation and its uses; Artificial seeds.
3. Technique of protoplast culture, regeneration and somatic cell hybridization: Achievements and limitations; Utility in improvement of crop plants.
4. *In Vitro* conservation of germplasm.
5. Germplasm characterization (including isozyme variation and DNA finger printing).

6. Biofertilizers and Bioinsecticides.

Practical:

Preparation of media for organ and tissue culture; Practice of excision and inoculation of tissues in culture medium; Developing protocol for different types of plant tissues; Visit to advanced biotech and tissue culture laboratories.

SOA/AB/C 505: Comprehensive Seminar: **02 (00+02)**

M. Sc. (Ag.) II Semester

SOA/AB/C 506: Cytology and Cytogenetics: **04 (03+01)**

Theory:

1. An introduction to cell structure and functions.
2. Cell division: Mitosis and meiosis, Differences between mitosis and meiosis.
3. Duplications and deficiencies: Classification, Methods of production, Meiotic pairing, Phenotic effects and breeding behavior.
4. Translocations: Classification, Methods of production, Identification, Meiotic pairing (alternate and adjacent disjunction), Crossing over in interstitial region, Breeding behavior of translocation heterozygote, Role in evolution (balanced lethal-*Oenothera* cytogenetics).
5. Inversions: classification (paracentric & pericentric), Methods of production, Identification, Meiotic pairing and crossing over in different regions, Anaphase-I and anaphase-II configurations in paracentric inversions, Breeding behavior of inversion heterozygote, Role in evolution.
6. Haploidy: Classification (monoploids, polyhaploids and aneuhaploids), Methods of production, Identification, Androgenetic and parthenogenetic haploids, Meiotic pairing, Utility.
7. Polyploidy: Classification (autopolyploids, allopolyploids and segmental allopolyploids), Methods of production, Cytological and genetic methods for identification, Polyploid genetics (chromosome and chromatid segregation, double reduction), Meiotic pairing (autosyndesis and allosyndesis), Role in evolution, Utility in crop improvement.
8. Trisomy and tetrasomy: Classification (primary, secondary and tertiary trisomics), Methods of production, Identification, Meiotic pairing, Breeding behavior of trisomics, Trisomic and tetrasomic ratios, Utility in chromosome mapping.
9. Monosomy and nullisomy: Methods of production (particularly in wheat), Identification, Meiotic behavior, Breeding behavior of monosomics, Monosomic analysis (monogenic characters only).
10. Apomixis: Cytogenetic basis of apomixes, Meiotic behavior in apomicts, Autogamy and pseudogamy, Agamospermy (apospory, diplospory) and other modes of apomixes.

Practical:

Preparation of stains and fixatives, Study of various stages of mitosis in onion root tips, Study of various stages of meiosis particularly pachytene, diplotene, dikinesis, metaphase-I and anaphase-II in available materials like Bazara, Maize, Wheat, Onion and Beans, Preperation of permanent slides from squash preparations.

SOA/AB/C 507: Advanced Plant Breeding: 04 (03+01)

Theory:

1. Breeding for morphological and physiological traits: Concept of ideotype, Breeding for most efficient plant types (wheat and rice), Development of plant genotypes for multiple cropping system, Harvest index and energy conservation efficiency and its application to crop improvement,
2. Mutation breeding: Introduction and selection of desirable mutation in Autogamous, Allogamous and vegetatively propagated crops, Directed mutations, Achievements through mutation breeding in different crops.
3. Distant hybridization: Inter-specific, Inter-generic and somatic hybrids.
4. Breeding for quality parameters: Importance, Inheritance of quality characters and their relationship with other traits, Breeding methods for improvement of quality traits with particular reference to Wheat, Rice, Maize, Pulses, Oilseeds, Cotton and Forages.
5. Breeding for disease and insect resistance: Vertical and horizontal resistance, Genetics of resistance, host-pathogen relationship including Flor's hypothesis of gene-for-gene relationship, Dirty and clean crop approach in multiple breeding, Breeding methods.
6. Breeding for stress environments: Nature and characteristics of abiotic factors (soil & atmosphere), Crop response to different environmental stresses, Adaptations, Inheritance mechanism, Research needs and Breeding strategies.

Practical:

Study of Various types of plant canopy and leaf orientation, Study of flower structure of Various cereals, legumes and oilseed crops, Emasculation and pollination practices in various field crops, Study of male sterility in Onion, Bajra and Wheat and its use in hybrid seed production.

SOA/AB/C 508: Crop Physiology- I: 04 (03+01)

Theory:

1. Some basic aspects of biochemistry, Structure, classification and properties of carbohydrates, proteins, fat & lipids and nucleic acids.
2. Photosynthesis: Ultrastructure, composition and function of chloroplast, Chlorophylls and carotenoids, Electromagnetic radiations and their qualities, Light reaction and photophosphorylation, Dark reaction and C-3 & C-4 pathways, Photorespiration (C-2 pathway), CO_2 compensation point and its relationship with crop productivity, Factors affecting rate of photosynthesis.
3. Respiration: Ultra structure, Composition and function of mitochondria, Aerobic and anaerobic respiration, Glycolysis, Kreb's cycle, Hexose Monophosphate Shunt, Pentose Phosphate Pathways (PPP), Respiratory Quotient (RQ), Factors affecting respiration and its relationship with crop productivity
4. Mineral nutrition: Absorption, Translocation, Role of minerals in plant nutrition and their deficiency symptoms.

5. Nitrogen metabolism: Source of nitrogen and its assimilation, Role of nitrite and nitrate reductases, Physiology of nodulation and nitrogen fixation.
6. Water relations in plants and transpiration.

Practical:

Demonstration and measurements of photosynthesis, respiration and transpiration. Preparation of stock solutions of different molarity, molality and normality. Finding out isotonic points of the various plant materials. Demonstration of exo- & endo-osmosis. Analysis of carbohydrates, proteins and fats.

SOA/AB/C 509: Genetic Engineering: 04 (03+01)

Theory:

1. Cloning and expression vectors (including YAC vectors); Expression cassettes; Gene cloning and amplification (including PRC); Preparation and screening of genomic and cDNA libraries; Molecular probes and their uses.
2. Methods of gene transfer in plants: Agro bacterium mediated gene transfer; Direct DNA delivery methods (microinjection, particle gun method and electroporation).
3. Transgenic plants in dicots and monocots and their utility in basic studies and in crop improvement; resistance for herbicides, viruses, insects and abiotic stresses; *barnase* and *barstar* for hybrid seed production.
4. Preparation of RFLP, RAPD and STS maps (using F2s, DH and RI lines) and their uses in plant breeding; Gene tagging using near isogenic lines; Map base cloning.
5. Monoclonal antibodies: Discovery and uses; Genetic engineering of antibodies; Uses in basic and applied research.

Practical:

Preparation of RFLP, RAPD and STS maps (using F2s, DH and RI lines). Visit to advanced biotech and tissue culture laboratories.

SOA/AB/C 510: Comprehensive Seminar: 02 (00+02)

M. Sc. (Ag.) III Semester

SOA/AB/C 511: Population and Biometrical Genetics: 04 (03+01)

Theory:

Section-A

1. Genes in populations: Estimation of gene frequencies, Hardy-Weinberg law.
2. Forces changing gene frequencies: Migration, Mutation, Selection, Random drift and Inbreeding; Equilibrium in small populations.

3.X Inbreeding: Coefficient of inbreeding, Pedigreed populations (recurrent relation of F and hrterozygosity), Irregular systems of mating.

Section-B

1. Correlation studies: Genotypic, Phenotypic, Environmental Correlations and Path Coefficient Analysis in relation to crop improvement.
2. Heritability and selection response: Methods of estimation and their application in plant breeding.
3. Simultaneous selection models: Discriminant functions; Classical, Restricted and General Selection indices.
4. Combining ability and gene effects: General and specific combining abilities; Additive, Dominance and Epistatic gene effects; Line X Tester analysis, Diallel analysis (Hayman and Griffings approaches), Generation mean analysis (6, 5 and 3 parameters models).
5. Genotype X Environment interaction and stability analysis: Varietal evaluation in multi location / multi year trials; Estimation of G X E interactions and Stability parameters following the models of Finlay and Wilkinson, Eberhart and Russell, Perkins and Jinks, Freeman and Perkins.

Note: Question paper will be set in two sections (A & B) as above. Candidates will be required to attempt at least one question from Section-A and two question from Section-B.

Practical:

Numerical examples on Generation mean analysis; D H and I component analysis; Diallel analysis (i) Component analysis (ii) Combining ability analysis; Line X Tester analysis; Character association, Path analysis, Correlation and regressions.

SOA/AB/C 512: Seed Production Technology: 04 (03+01)

Theory:

1. History and role of seed industry, Importance of quality seed, Categories of seed (nucleus, breeder, foundation and certified), Causes for the deterioration of seed quality.
2. Seed production methods: For Self pollinated, Cross pollinated and Vegetatively propagated crops, Male sterility and its use in hybrid seed production, Isolation, Agronomic requirements for seed production and the techniques involved.
3. Production of high quality seeds of following crops: Maize, Bajra, Sorghum, Paddy, Wheat, Barley, Pea, Pigeon pea, Chickpea, Urdbean, Mungbean, Mustard, Groundnut, Cotton, Potato, Bhindi, Brinjal, Tomato, Cauliflower, Radish, Chilly, Cucurbits, Sunflower and Carrot.
4. Seed processing: Principles and practices, Seed drying and conditioning, Seed cleaning and grading, Methods of seed packing and storage, Factors affecting seed storage, Problems of stored grain pests and methods to overcome them.
5. Seed testing: Importance, History and developments, Seed testing laboratories, Sampling and its methods, Purity analysis, Germination tests and seedling evaluations, Moisture test, Seed dormancy, Viability tests, Reporting of results.

6. Field inspection and seed certification: Purpose, necessity and procedures of field inspecti
Roguing, Field standard, Purpose and necessity of seed certification, Seed certification terms,
Seed legislation, Seed act and rules.

Practical:

Experiments for seed purity, germination ,viability and moisture tests, Seed sampling and preparation of samples for seed testing, Evaluation of seed tests and writing of seed testing report, Laboratory laycut and laboratory equipments for seed testing, Field inspection of seed production plots of wheat, rice and potato, Visit to seed processing plants to see equipments and machinery used in seed cleaning, grading, treating and packing, Visit to seed production plots of vegetable crops, Visit to different breeding station of crop plants.

SOA/AB/C 513: Breeding Field Crops-I (Kharif): 04 (03+01)

Theory:

1. Genetic basis of breeding for the self-pollinated Field Crops of Kharif Season: Selection, Pure line theory and its genetic basis, Sources of genetic variation, Genetic consequences of hybridization (segregation and recombination of genes), Composition of populations derived from hybrids, Role of genotype and environment in continuous variation, Heritability, Genetic advance under selection.
2. Breeding methods for self pollinated field crops of Kharif season: Pure line and mass selection, Pedigree method and its modification, Bulk population method and back cross method.
3. Genetic basis of breeding of cross-pollinated Field Crops of Kharif Season: Genetic basis of self incompatibility and Heterosis, Genetic basis of population improvement (random mating and its consequences, germplasm complexes, composites and synthetics).
4. Breeding methods for cross pollinated field crops of Kharif season: Selection, Recurrent selection, Development of hybrids, Synthetics and Composites.
5. Breeding methods for vegetatively propagated field crops of Kharif season.

Practical:

Study on flower structures of the various field crops of Kharif season. Emasculation and pollination exercise on the various field crops of Kharif season. Study on male sterility in the field crops of Kharif season.

SOA/AB/E 516: Molecular Genetics: 03 (02+01)

Theory:

1. Genetic material: DNA and RNA as genetic material; Structure of DNA and RNA; Nucleotides and polynucleotides; Watson and Crick's model; Single stranded DNA; Double stranded RNA; Types of RNAs; Differences between DNA and RNA.

DNA replication: Unwinding proteins; Role of RNA & DNA- polymerases; Semi-conservative, discontinuous and bidirectional replication; Experiments of Meselson and Stall, Cairns and Taylors.

3. Organization of genetic material: C-value paradox; Repetitive and unique sequences; Overlapping and split genes; Satellite DNA.
4. Genetic code: Properties of genetic code; Deciphering of code (experiments of Nirenberg and Khorana).
5. Protein synthesizing apparatus: Structure of t-RNAs and Ribosomes.
6. Protein synthesis: Co linearity between gene and protein; Central dogma; Transcription and reverse transcription; Prokaryotic & eukaryotic RNA polymerases; Promoters for transcription initiation (TATA and CAAT boxes etc.); Translation- activation of amino acids, initiation, elongation, modification and termination; Base substitution and frame shift mutation.
7. Regulation of protein synthesis: The operon concept and its recent modifications; Positive and negative control; Leaders sequences and attenuation; Feedback inhibition.
8. Synthesis of gene.
9. Chromosome ultra-structure and nucleosome concept: Techniques used for discovery of nucleosome; Structure and assembly of nucleosomes; Solenoid model; Phasing of nucleosomes.

Practical:

Experimental evidence of DNA and RNA as genetic material; Chromosome mapping in bacteria from given data; Problems on molecular genetics.

SOA/AB/E 517: Crop Physiology- II: **04 (03+01)**

Theory:

1. Growth and development: Concept; Biological & Economic yield, Harvest Index (HI), Leaf area index (LAI), Leaf area ratio (LAR), Net assimilation rate (NAR) and Relative growth rate (RGR); Applied aspects of growth and development in determining crop productivity potentials.
2. Source-Sink relationship: Importance in crops' yield potentials and efficiency of energy use; Sink potential and its utilization in different crops.
3. Photoperiodism and Varnalization: Concept and role in crop productivity.
4. Physiology of germination and dormancy.
5. Applied aspects of phytohormones with special reference to auxins, gibberellins, cytokinins and abscisic acids.
6. Economic importance of phytohormones and growth regulators in agriculture.

Practical:

Practical exercise on the measurement and analysis of Biological & Economic yield, Harvest Index (HI), Leaf area index (LAI), Leaf area ratio (LAR), Net assimilation rate (NAR) and Relative growth rate (RGR), Bioassay methods of auxins, gibbrellins cytokinins abd abscic acid.

SOA/AB/C 514: Comprehensive Seminar: **02 (00+02)**

M. Sc. (Ag.) IV Semester

SOA/AB/E 518: Seed Science & Technology: 04 (03+01)

1. General aspects of seed science: Floral types, structure and biology in relation to pollination mechanisms; sporogenesis: micro-sporogenesis and mega-sporogenesis; micro and mega gametogenesis; development of male and female gametes and their structures; effect of environmental factors on floral biology.
2. Fertilization – embryo sac structure, process, barriers to fertilization, incompatibility and male sterility, factors affecting fertilization.
3. Embryogenesis - development of typical monocot and dicot embryos; endosperm development, modification of food storage structures with reference to crop plants; different types of embryos, endosperm and cotyledons; development and their structure in representative crop plants with reference to food storage; external and internal features of monocot and dicot seed; seed coat structure and development in representative crop plants.
4. Apomixis – identification, classification, significance and its utilization in different crops for hybrid seed production; Polyembryony - types and significance; haplontic and diplontic sterility, causes of embryo abortion, embryo rescue and synthetic seeds.
5. Factors influencing loss of seed viability during storage, physiological and biochemical changes associated with seed ageing,, theories of seed ageing, seed viability and its evaluation, seed storage, protection from water, temperature and contaminants, desiccation tolerance and sensitivity in relation to seed longevity..
6. Seed vigour, concept, importance, measurement; seed invigoration, methods, physiological and molecular basis of seed invigoration, effect of vigour on field emergence and yield, seed hardening.
7. Modern techniques for identification of varieties and hybrids; principles and procedures of electrophoresis, machine vision technique, DNA fingerprinting and other molecular techniques and their utilization; techniques for improving seed quality; proteomic analysis; seed priming, coating, pelleting and synthetic seeds; GM seeds and their detection, terminator technology (GURT).
8. Detection and identification of seed borne fungi, bacteria, viruses, nematodes and insect pests through advanced techniques like ELISA, PCR based techniques etc.
9. Genesis of plant variety protection (PVP); International Union for Protection of New Varieties of Plants (UPOV) and its functions; General agreements on Tariff and Trades (GATT) agreement in relation to protection of plant varieties; Protection of Plant Varieties and Farmers' Rights (PPV &FR) Act, 2001; PPV&FR rules, 2003.
10. Criteria for protection of new varieties of plants; principles and procedures of Distinctness, Uniformity and Stability (DUS) testing; test guidelines, planting material, duration, testing options, varieties of common knowledge, reference collection, grouping of varieties, types and categories of characters; technical questionnaire.
11. Assessment of DUS characters based on morphological, biochemical and molecular markers; statistical procedures; computer software for use in DUS testing; impact of PVP on growth of seed industry.

Practical:

Study of floral biology of monocots and dicots; micro-sporogenesis and mega-sporogenesis; study of pollen grains - pollen morphology, pollen germination and pollen sterility; types monocot and dicot embryos; external and internal structures of monocot and dicot seeds; preparation of seed albums and identification. Practical exercise of DUS testing in rice, wheat, maize and cauliflower.

SOA/AB/C 519: Breeding Field Crops-II (Rabi): 04 (03+01)

Theory:

1. Genetic basis of breeding for the self-pollinated Field Crops of Rabi Season: Selection, Pure line theory and its genetic basis, Sources of genetic variation, Genetic consequences of hybridization (segregation and recombination of genes), Composition of populations derived from hybrids, Role of genotype and environment in continuous variation, Heritability, Genetic advance under selection.
2. Breeding methods for self pollinated field crops of Rabi season: Pure line and mass selection, Pedigree method and its modification, Bulk population method and back cross method.
3. Genetic basis of breeding of cross-pollinated Field Crops of Rabi Season: Genetic basis of self incompatibility and Heterosis, Genetic basis of population improvement (random mating and its consequences, germplasm complexes, composites and synthetics).
4. Breeding methods for cross pollinated field crops of Rabi season: Selection, Recurrent selection, Development of hybrids, Synthetics and Composites.
5. Breeding methods for vegetatively propagated field crops of Rabi season.

Practical:

Study on flower structures of the various field crops of Rabi season. Emasculation and pollination exercise on the various field crops of Rabi season. Study on male-sterility in the field crops of Rabi season.

SOA/AB/E 520: Plant Genetic Resources: 04 (03+01)

Theory:

1. An introduction to Plant Genetic Resources.
2. Taxonomical classification of cultivated plants.
3. Gene Pool: Primary, Secondary and Tertiary.
4. Centre of origin and diversity.
5. Basic genetic resources, Derived genetic resources and Tran genes.
6. Principles, Strategies and Practices of Exploration, Collection, Characterization, Evaluation and Cataloging of PGR.
7. Plant quarantine and phytosanitary certification.
8. Germplasm introduction and exchange.
9. Principles of *in vitro* and cryopreservation.
10. Germplasm conservation: *in situ, ex situ* and on-farm.
11. Short, medium and long term conservation strategies for orthodox & non orthodox seeds and vegetatively propagated crops.
12. PGR database management: Registration, Description, National and International mechanism.
13. PGRs for food and agriculture (PGRFA), access and benefit sharing.
14. IPR, UPOV and CBD issues and consequences.
15. Farmers' rights and privilege.

Practical:

Visit to Gene Bank, National and Regional Research Stations/Centers. Practices of Exploration, Collection, Characterization, Evaluation and Cataloging of PGR. Germplasm conservation: *in situ, ex situ* and on-farm.

SOA/AB/E 521: Stress physiology of Field Crops: 04 (03+01)

Theory:

1. Basic Concepts of plants under stresses.
2. Types of stresses: Biotic & Abiotic.
3. Effects of biotic and abiotic stresses on the physiology of various field crops e.g. Cereals, Pulses, Oilseeds, Sugarcane and Vegetable crops.
4. Methods to overcome that. Concept of stress tolerance, resistance and avoidance.
5. Plant modeling for the effective stress management.

Practical:

Conducting experiment to study the effect of various biotic and abiotic stresses on the physiology and morphology of common field crops under *in vivo* and *in vitro* conditions. Measurements of various plant growth characters under normal and different stress conditions.

SOA/AB/E 522: Heterosis Breeding: 04 (03+01)

Theory:

1. An introduction to Heterosis breeding; Principles and practices of Heterosis breeding.
2. Physiological and genetical basis of Heterosis breeding.
3. Crop modeling and its application in Heterosis breeding.
4. Detailed study on Heterosis expression, exploitation and significant achievements with special reference to: Paddy, Maize, Sorghum, Wheat, Sugarcane, Cotton, Pigeon-pea, Chick-pea, Mustard, Okra (Ladies finger), Brinjal, Potato and Tomato.

Practical:

Practical exposure of students for conducting field trials on Heterosis breeding, Visit to different breeding stations of national importance.

SOA/AB/E 523: Thesis Project Work & Seminar: 16 (00+16)

SOA/AB/C 515: Comprehensive Seminar: 02 (00+02)