Department of Seed Science & Technology
Chaudhary Charan Singh University, Meerut

Programme Syllabus
Master of Agriculture in Seed Science & Technology
(M.Sc.Ag. Seed Science & Technology)

(Effective from Academic Year 2002-03)

SUBJECT	COURSE CODE	INTERNAL	EXTERNAL	TOTAL
Semester I				
Statistical Methods in Agriculture	SST-1001	50	50	100
Principles & Practices in Plant Bree	SST-1002	50	50	100
Fundamentals of Genetics	SST-1003	50	50	100
Floral Biology, Seed Development and Maturation	SST-1004	50	50	100
Practical		100	100	200
				600
Lab I				
Semester II				
Computer Applications and Bioinformatics	SST-2001	50	50	100
Plant Genetic Resources: Conservation and Sustainable Use	SST-2002	50	50	100
Seed Production Technology – I	SST-2003	50	50	100
Principles of Hybrid Seed Production	SST-2004	50	50	100
Practical		100	100	200
				600
Lab I				
Semester III				
Seed Production Technology – II: Vegetable crops	SST-3001	50	50	100
Seed Physiology	SST-3002	50	50	100
Seed Testing and Quality Control	SST-3003	50	50	100
Seed Processing and Storage	SST-3004	50	50	100
Practical		100	100	200
				600
Lab I				

Semester IV				
Seed Pathology	SST-4001	50	50	100
Seed Biotechnology	SST-4002	50	50	100
Practical	8001	50	50	100
Dissertation Work	8002	100		100
				400

PROGRAMME OUTCOMES (POs)

M.Sc. (Ag.) is a two years (four semesters) full time course, including the thesis work. Each student has to undertake a thesis work on any aspect related to the course of study and submit the same at the end of fourth semester to the Department. The students of M.Sc. (Ag.) are required to have in depth knowledge about classical and latest developments in the agricultural sciences and practices. Due emphasis has been given on practical classes wherever it was felt necessary to provide opportunity to learn and do the exercises on topics covered in the theory classes. Upon completion of this programme, students will be able to explore new opportunities in agriculture sector. The students will understand crop-improvement methods for a better world and will sparkle up the qualities of passion and perseverance for agricultural sciences. The objective of the programme is widening the scope of agricultural research and development. The students will be encouraged to plan the research work, use time effectively, develop an intellectual curiosity and manage small projects.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO-1: Student will gain expertise in the field of seed science & technology.

PSO-2: Students will be trained for entrepreneurship programme in seed industry.

PSO-3: Students will be to initiate basic research related to genetic purity, seed health and seed storage.

PSO-4: Students will develop core competency in the subject & comparative evidence on development of seed.

PSO-5: Students will gain high analytical ability in understanding the application of scientific principles and students will acquire skills &

handling operations of different equipment's in seed science laboratory.

PSO-6: The students will gain proficiency in mapping population, molecular marker assisted selection and its application in crop improvement.

PSO-7: The students will understand the significance of germplasm, biodiversity conservation in relation to Plant Variety Protection and Intellectual Property Rights.

COURSE OUTCOMES (COs)

M.Sc. (Ag.) Seed Science and Technology			
Semester	Course Name	Course Code	Course Outcome
I	Statistical Methods Agriculture	SST-1001	CO-1: Students will acquire independent ability to carry out statistical analysis of data and interpretation of results. CO-2: Students will be able to statistically analyze the phenotypic data of plant traits. CO-3: The students will recognize and examine the relationships between inputs and outputs in their agricultural field to make effective and profitable decisions. CO-4: Students will demonstrate an ability to engage in critical thinking by analyzing situations and constructing and selecting viable solutions to solve problems. CO-5: Student will be able to demonstrate the ability to analyse data and draw appropriate statistical conclusions. CO-6: Students will be well equipped to handle field level data for analysis and modeling purposes. They will learn how to draw a good sample from a population in order to draw valid inference. CO-7: Students will be able to develop strategies for experimental designs.
	Principles & Practices Breeding	SST-1002	CO-1: Students will understand the significance of different plant breeding systems. CO-2: Students will understand the application of conventional breeding approaches and gene technology approaches in plant breeding programs. CO-3: Students will be well versed in practical emasculation and pollination methods of important crops. CO-4: Students will be able to describe the progression of stages within a modern breeding programme. CO-5: Students will be able to judge which plant breeding methods are appropriate for specific objectives and situations. CO-6: Students will be able to carry out specific plant breeding activities, such as

			selection of parental germplasm, observation and recording of phenotypic variation and selection among progeny.
	Fundamentals of Genetics	SST-1003	CO-1: The students will be able to understand the classical and modern concepts of genetics. CO-2: Students are able to understand the basic principles of inheritance biology. CO-3: Students will be able to understand the sex linked inherited characters and diseases. CO-4: They will get in-depth knowledge about gene interaction, penetrance and expressivity. CO-5: The student will demonstrate proficiency in understanding the basic structure of atom and interpret the inheritance of characters by using linkage and crossing over.
	Floral Biology, Seed Development and Maturation	SST-1004	CO-1: Students gain knowledge about meaning of seed and its structure. CO-2: Students will get knowledge on seed development and maturation of various crop plants. CO3: Students will get knowledge on pollination behaviour and food reserves accumulation pattern of crop plant. CO4: Cultivate skill in emasculation and pollination of various crop plants.
II	Computer Applications and Bioinformatics	SST-2001	CO-1: Students will understand computational basis of genetic analysis that use genome data sets in system biology. CO-2: Students will be able to explain about the methods to characterize and manage the different types of biological data. CO-3: Student will know about various biological databases that provides information about nucleic acids and protein. CO-4: Student will understand the basics of sequence alignment and analysis. CO-5: Students will be able to design and execute the programmes related to structural and functional aspects of genes

			and proteins.
	Plant Genetic Resources: Conservation and Sustainable Use	SST-2002	CO-1: Students will have knowledge on the conservation of biodiversity. CO-2: They will acquire knowledge on various organizations involved in conservation and their policies. CO-3: The students will have knowledge on plant quarantine regulations. CO-4: The students will be able to promote human capacity to appreciate, maintain, and promote utilization of plant genetic resources. CO-5: Students will understand different forms of IPRs and legislations related with IPRs. They will be well aware of Farmers' and Plant Breeders' rights.
	Seed Production Technology – I	SST-2003	CO-1: Students will be able to believe the role of good quality seed in agriculture. CO-2: Students will be able to grasp the significance of basic principles of seed production in crop plants. CO-3: Students will be able to build private seed farms. CO-4: Students will be able to impart knowledge about various tools involved in hybrid seed production of crop plants.
	Principles of Hybrid Seed Production	SST-2004	CO-1: Students will be able to impart knowledge about various tools involved in hybrid seed production of crop plants. CO-2: To really understand the basic principles of seed production in varieties and hybrids. CO-3: Student will acquire knowledge on conventional and molecular breeding methods to obtain yield improved crop varieties. CO-4: Students will be able to understand pre-Mendelian and post-Mendelian aspects of heterosis
III	Seed Production Technology – II: Vegetable crops	SST-3001	CO-1: Students will be able to know the seed production technology of different vegetable crops. CO-2: To really understand the factors influencing seed production. CO-3: Students will be able to know about the methods to reduce vegetable spoilage.

			CO-4: Students will be able to know about the vegetable seed industry in India.
	Seed Physiology	SST-3002	CO-1: Students will be able to understand the physiological processes involved in seed. CO-2: Students will be able to understand the physiological mechanism involved in dormancy and germination. CO-3: Students will be able to compare the role of growth regulators in seed germination. CO-4: Students will be able to understand concept of dormancy and its regulation.
	Seed Testing and Quality Control	SST-3003	CO-1: To have a faith in seed certification procedure. CO-2: To sort out the rogues and off types from the seed production area and to understand the importance of seed testing. CO-3: Students will be in a position to emphasis on Seed Legislation, certification, labelling of different seed classes and truthfully labelled seeds. CO-4: To afford knowledge on various organizations involved in seed testing. CO-5: To provide knowledge about various seed testing procedure with tolerance.
	Seed Processing and Storage	SST-3004	CO-1: To impart knowledge on processing sequence for various crop plants. CO-2: Students will get knowledge principles and mode of action of various seed processing equipments. CO-3: Students will get knowledge on seed storage methods and seed treatment procedures. CO-4: Students will understand the importance of priming and treating seeds.
IV	Seed Pathology	SST-4001	CO-1: Students will understand the different methods of seed health testing. CO-2: Students will understand the techniques to avoid the seed-borne diseases. CO-3: Students will grasp the techniques to avoid deterioration of grains by storage &field fungi. CO-4: Students will understand the

			method of transmission of pathogens and disease in crop plants.
	Seed Biotechnology	SST-4002	CO-1: Ability to apply the concepts and principles of plant tissue culture techniques on research problems pertinent to crop improvement. CO-2: Dissemination of skills on usage of the acquired knowledge on practical biotechnology tools to augment agricultural research. CO-3: The knowledge required to execute, analyze and apply molecular marker systems for crop improvement. CO-4: Students will know about different mapping populations.
	Thesis Work		CO-1: The purpose of this course is to help students organize ideas, material and objectives for their dissertation and to begin development of communication skills and to prepare the students to present their topic of research and explain its importance to their fellow classmates and teachers. CO-2: Students should be able to formulate a scientific question. CO-3: Students should be able to present scientific approach to solve the problem. CO-4: Students should be able to interpret, discuss and communicate scientific results in written form. CO-5: Students should be able to gain experience in writing a scientific proposal. CO-6: Students should be able to learn how to present and explain their research findings to the audience effectively.

Course-I; Code- **SST-1001**

Statistical Methods in Agriculture

Teaching hours: 50

1. **Presentation of Data**: Frequency distributions; graphical presentation of data by histogram, frequency polygon, frequency curve and cumulative frequency curves. 6

2. **Measures of Locations and Dispersion**: Mean, median, mode and their simple properties (with-out derivation) and calculation of median by graphs; range, mean deviation, standard deviation, standard error, coefficient of variation. 6

3. **Probability and Distributions**: Random distributions; events exhaustive, mutually exclusive and equally likely; definition of probability (with simple exercises); definitions of binomial, Poisson and normal distributions; and simple properties of the above distributions (without derivation). 4

4. **Correlation and Regression**: Bivariate data-simple correlation and regression coefficients and their relation; Spearman rank correlation; limits of correlation coefficient; effect of change of origin and scale on correlation coefficient; linear regression and equations of line of regression; association and independence of attributes.
8

5. **Sampling**: Concept of population and sample; random samples; methods of taking a simple random sample. 4

6. **Tests of significance**: Sampling distribution of mean and standard error; z and t-test (Equality of means; paired and unpaired t-test); t-test for comparison of means when variances of two populations differ; Chi- square test for goodness of fit; independence of attributes, and homogeneity of samples; interrelation between t-test and F-Test
12

7. **Experimental Designs:** Principles of experimental designs; completely randomized, randomized complete block design (missing plot value in RBD); latin square designs; augmented block design; simple factorial experiments (mathematical derivations not required); analysis of variance (ANOVA) and its use including estimation of LSD (CD)

Course – II; Code-SST-1002
Principles & Practices in Plant Breeding

Teaching hours: 50

1. **Historical perspectives**: Past progress and future needs, green revolution, evergreen revolution, a brief introduction to Participatory plant breeding **(PPB)** **2**
2. **Mating Systems**: Self-fertilization, full sib mating, half sib mating, back crossing; inbreeding and backcrossing; random mating, assortative and disassortative matings, sister line crosses, convergent crosses, complex crosses, diallel selective mating, mating designs for components of variation. 6
3. **Genetic basis of breeding 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. 8
4. **Breeding methods for self-pollinated crops:** A brief outline of the following: pure line and mass selection; pedigree method and its modification, bulk population method and its modifications. Backcross method; and evaluation of pure lines, hybrid breeding. 8
5. **Genetic basis of breeding cross pollinated crops:** Genetic basis of self incompatibility and male sterility and their use in hybrid seed production; genetic basis of inbreeding depression and heterosis; exploitation and fixation of heterosis; genetic basic of population improvement. 8
6. **Breeding methods for cross-pollinated crops:** selection, recurrent selection; development of hybrids, synthetics and composites. 4
7. **Mutations and polyploidy breeding:** Mutation breeding, distant hybridization and polyploidy breeding including analytical breeding, mutant variety data (MVD)-IAEA. 4
8. **Breeding methods for vegetative propagated crops**: Somatic mutations, examples of sugarcane and potato crops. 2
9. **Pre-breeding and genetic enhancement**: Wide hybridization and alien gene transfer. 2
10. **Crop varieties**: Identification, release and notification of crop varieties, institutions involved in release of varieties. 6.

Course-III; Code- SST-1003

Fundamentals of Genetics

Teaching hours: 50

1. **Introduction:** History of genetics, its scope and significance, brief idea of Mendel's laws and physical basis of heredity (chromosome theory of inheritance), forward vs. reverse genetics.
2. **Modification of F_2 ratios:** Epistasis (non-allelic intercations), segregation distortion and selfish genes; penetrance and expressivity; modifiers and suppressors; pleiotropic genes.
3. **Linkage and crossing over:** Coupling and repulsion hypothesis; theories of crossing over; three point test cross (interference and coincidence; calculation of recombination frequencies from F_2 data; brief idea about mapping function; cytological basis of crossing over (experiments of Stern in *Drosophila* and that of McClintock in corn).
4. **Multiple alleles:** Concept of multiple alleles; self incompatibili

ty alleles in *Nicotiana* and *Brassica;* coat colour in rodents; blood groups in humans, antigen-antibody interaction in inheritance of A, B, AB and O blood groups; H – antigens, MNS system, Rh factor. Epistasis and multiple allelism (e.g. Bombay blood groups). 4

5. **Quantitative inheritance**: Multiple factor hypothesis (a brief introduction); concept of gene effects (additive, dominance, over–dominance and epitasis); polygenes and quantitiave trait loci (QTL). 2
6. **Sex linked inheritance**: Sex linked**,** sex limited and sex influenced traits with suitable exmamples. 2
7. **Sex determination and differentiation**: Theories of sex determination -- chromosome theory and genic balance theory of sex determination, sex determination in dioecious plants {*Marchantia, Ceratopteris, Silene (Melandrium), Humulus, Coccinia, Rumex, Papaya*}, mouse and in man; genetic basis of sex differentiation (genes located on sex chromosomes and autosomes), single gene control of sex. Hormonal control of sex, sex reversal and gynandromorphs, human sex anomalies (Klinefelter's syndrome and Turner's syndrome); brief idea of dosage compensation and Lyon's hypothesis. 8
8. **Extrachromosomal inheritance**: Criteria for extra chromosomal inheritance; plastid inheritance in *Mirabilis,* iojap in corn, Kappa particles in *Paramecium,* coiling in snails, brief idea of mitochondrial (male sterility in plants) and .chloroplast genetics, paternal inheritance. 6
9. **Mutations and mutagenic agents**: Brief history of mutations; types of mutations; rate and frequencies of mutations; physical and chemical mutagens and deletogens; detection of mutations in *Drosophila* (ClB method, Muller–5 method, attached X method), detection of mutations in plants and their practical application in crop improvement. (molecular basis of mutations are included in another course). 8
10. **Biochemical genetics**: Inborn errors of metabolism in man; eye transplantation in *Drosophila;* biochemical mutations in *Neurospora;* biosynthetic pathways and biochemical mutations. 4
11. **Fine structure of gene**: Classical and modern gene concepts; pseudoallelism, positioneffect; intragenic crossing over and complementation (cistron, recon, muton), Benzer's work on r_{II} locus in T_4 phage .
12. **Epigenetics**: Paramutation; DNA methylation and histone modification; genome imprinting (IGF_2 in mammals) 'Solid gold' or Callipyge in sheep; epigenetics in *Arabidopsis* and *Linaria*; histone code..

Course-IV; Code- SST-1004
Floral Biology, Seed Development and Maturation
Teaching Hours: 50

1. Flower type and floral structure in relation to Seed development.	2
2. Microsporogenesis and megasporogenesis.	2
3. Development and structure of megasporangium and microsporangium.	2
4. Gametogenesis: Male and female gametophyte development and structure.	4
5. Pollination mechanism and control of pollination.	6
6. Pollen physiology, preservation and sterility.	4
7. Fertilization: barriers to fertilization, incompatibility and male sterility.	6
8. Development of embryo, endosperm and seed coat. Different types of embryo, endosperm and cotyledons-development and structure in representative crop plants	8
9. Modification of food storage structures with reference to crop plants.	4
10. Seed structure: external and internal features of monocot and dicot seed. Structure of seed coat and pericarp; Seed coat permeability.	4
11. Seed sterility and its causes: Causes of embryo abortion.	2
12. Parthenocarpy and induced parthenogenesis; Polyembryony	2
13. Apomixis: classification, significance and its utilization in hybrid seed production	4

Course-V: Code- SST-2001

Computer Applications and Bioinformatics

Teaching hours: 50

Part I

1. **Introduction to computers:** Types, general characteristics, input/output units, memory, internal representation of data (binary, octal and hexa-decimal system, bits and bytes). 2

2. **Brief idea of operating systems:** Disc operating systems (DOS), UNIX and its versions (Linux), WINDOWS and its upgraded version 4
3. **Introduction to networking:** LAN (local area network), WAN (wide area network), MAN (metropolitan area network) including www (World Wide Web) 2

4. **Microsoft (MS) office and its applications:** Introduction to MS Excel and its applications for statistical analyses with particular reference to agricultural data (tabular and graphical representation of data, analyses of variance, regression and correlation); introduction to MS Word and its application for document preparation; Power Point and its application for preparing presentations. 6
5. **Introduction to statistical packages:** SAS (Statistical Analysis Software) packages for statistical analysis of agricultural data, handling software for data analyses, introductory knowledge of SPSS (Statistical Package for the Social Sciences). 6

Part II

BIOINFORMATICS

Unit – 1

1) **Introduction**: History, What is bioinformatics? Components of bioinformatics, Scope & Goal of bioinformatics, Role of internet in bioinformatics, Applications & Limitations.

Unit – 2

1) **Biological databases**: What is Databases? Types of Databases, Biological Databases, Information retrieval from biological databases, File formats: Primary databases, Secondary databases & Structure databases.

Unit – 3

2) **Sequence alignment**: Introduction to sequence alignment, Global alignment, Local alignment, multiple sequence alignment, Alignment algorithms: The dot plot, Dynamic programming method & Database similarity search: BLAST & FASTA, Scoring matrices: PAM and BLOSUM.

Unit – 4

3) **Molecular Phylogenetics**; Terminology, Types of phylogentics tree, Phylogenetics tree construction methods: Distance-based methods, Character based methods, Phylogenetics Programs.

Course-VI; Code- SST-2002

Plant Genetic Resources: Conservation and Sustainable Use

Teaching hours: 50

1. **Centers of diversity and centers of origin:** Brief account of domestication of important crop plants (wheat, maize, rice, potato, sorghum and brassica) and gene pools. 6

2. **A brief idea of modern system of classification** (angiosperm phylogeny groups). 2
3. **Biodiversity vs. genetic resources:** Definition and explanation, alpha vs. beta biodiversity and methods of their study; present levels of biodiversity and rate of loss of biodiversity; causes for the loss of biodiversity; uses of biodiversity; extent of biodiversity in plants; exploration and germplasm collection, introduction and exchange of PGR. 8

4. **Direct and indirect uses of plant genetic resources for human welfare**: In plant breeding and agriculture, pharmaceuticals and in maintenance of ecosystem; Red Data books and endangered plant species. 4

5. **Plant genetic resources**: Different kinds of PGR- basic, derived and molecular; core collections; principles of germplasm characterization, DNA fingerprinting and plant bar codes; germplasm evaluation, maintenance and regeneration; plant quarantine aspects- sanitary and phytosanitary systems (SPS). 6

6. **Techniques for conservation of plant germplasm**: *In situ* and *Ex-situ* methods of conservation; cryopreservation of genetic materials; gene banks and cryobanks. 4

7. **Biodiversity International (IPGRI) and NBPGR:** Their role in conservation of PGR. 2
8. **Future harvest centers** (formerly-IARCs)-a brief idea. 2
9. **CBD and sustainable use of biodiversity**. Genetreaty; Cartagena protocol; harmonization of international and national treaties. 2
10. **Role of FAO/CGIAR system for access to genetic resources**: ITPGRFA (International treaty on plant genetic resources for food and agriculture) and global system of PGR; FAO's commission on PGR (CPGR); International code of conduct for PGR collection and transfer; multilateral system for access to PGR. 6
11. **IPRs in plant breeding:** UPOV, plant breeders rights (PBRs); essentially derived varieties and farmers rights (FRs); protection of plant varieties and farmers rights act (PPV & FRA) 2001; intellectual property rights- patents, copyrights, trademarks; GATT and TRIPs, patents for higher plants; terminator and traitor techniques (v-GURT and t-GURT); Protection of plant varieties and farmers rights rules 2003 ; biodiversity act 2002; geographical indications act 1999; amendments to patent act 1970 .

Course –VII; Code- SST-2003
Seed Production Technology – I
Cereals, pulses, Oilseeds, fiber and forage crops

4) General aspects of seeds production technology: Concept of seed technology; history and role of seed industry (relative role of public and private sector undertakings); importance of quality seed; categories of seeds (nucleus, breeder, foundation and certified); causes for the deterioration of seed quality. 8

2. Seed production methods: Seed production methods for self-pollinated, cross-pollinated and vegetative propagated crops; isolation and agronomic requirements for seed production and the techniques involved, causes of seed deterioration, maintenance of nucleus and breeder seeds, factors affecting seed production. 12

3. Seed production techniques of following field crops with special emphasis on land requirement, isolation requirement, cultural practices, male sterility, rouging, field inspection, insect and disease control, harvesting and threshing, pre-processing care, sealing and bagging; 30

a) Cereals ; Rice, wheat, maize, barley, sorghum and pearl millent
b) Pulses; Red gram, black gram, green gram, chickpea, pea lentil, and rajmash .
c) Oilseeds; Groundnut, castor, mustard, sunflower, sunflower, sesame, and soybean.
d) Fibres; Cotton and jute.
e) Forage crops; Berseem, senji, lucerne and napier grass

Course-VIII; Code- SST-2004
Principles of Hybrid Seed Production

Teaching hours: 50

1. **Definition and historical aspects of heterosis:** Definition, pre-Mendelian and post-Mendelian aspects of heterosis 2
2. **Genetic and molecular bases of heterosis:** Dominance and over-dominance theories, inbreeding and heterosis; possible role of epistasis in heterosis; estimation of genetic diversity and the expression of heterosis; physiological, biochemical, cytoplasmic, organellar and molecular basis for expression of heterosis; single gene/mutant heterosis. 8

3. **Exploitation of heterosis:**
   (a) Extent of heterosis and its exploitation. 2
   (b**)** Male sterility and self incompatibility for hybrid seed production: development and use of cytoplasmic, genetic, cytoplasmic genetic male sterility system, environmental sensitive genetic male sterility (EGMS) and chemical hybridizing agents (CHAs), self- incompatibility for hybrid seed production. 4
   (c) Pistillate plants and hybrid seed production 2
   (d) Development of inbred lines and hybrid cultivars: Development and evaluation of inbreds and heterotic grouping in maize, genetic improvement of inbred lines, double cross, double top cross and single cross hybrids 4

4. **Current status of exploitation of heterosis & hybrid technology:** Rice, wheat, maize, sorghum, pearlmillet, sunflower, cotton, tomato, Capsicum , pigeonpea, rapeseed mustard, Cole crops, potato and sugarcane. 20

6. **Biotechnological applications in heterosis breeding:** (a) *Barnase* and *barstar* genes in hybrid seed production; (b) marker-assisted heterosis breeding in maize, pearl millet and rice; (c) possible use of molecular markers in selection of diverse parents for hybrid breeding. 6
7. **Hybrid seed production and role of the hybrids in enhancing crop productivity in India**

Course –IX; Code- SST-3001
Seed Production Technology – II: Vegetable crops

Teaching Hours: 50

1. History and scope of vegetable seed industry in India. 4

2. Categories of seeds in vegetables 2

3. Factors influencing seed production in vegetable 2

4. Agro-techniques for seed production of vegetable crops

Seed production techniques of following vegetable crops with special emphasis on land and climate requirement, isolation requirement, cultural practices, rouging, field inspection, plant protection, harvesting and threshing pre-processing care, sealing and bagging:

1. Fruit vegetables: Tomato, brinjal, bhindi, chilli, cucurbits 12
2. Cole vegetables: cauliflower, cabbage, knol- khol 10
3. Leaf vegetables spinach, lettuce, amaranthus 8
4. Root vegetables : radish, turnip, carrot 6
5. Bulb crops: onion 2
6. Tubers potato and TPS 4

Course –X; Code- SST-3002

Seed Physiology

Teaching Hours: 50

1. Seed physiology and composition; chemical composition of seed and its significance in seed quality; Synthesis and accumulation of food reserves. 4

2. Physiology of seed maturation and Seed viability & longevity: Introduction, Life span of seeds; Pre- and post- harvest factors affecting seed viability; Causes for loss of seed viability – seed moisture, harvesting and post- harvest 8

3. Biochemistry of seed viability – ageing of seeds, biological oxidation of viable seeds, seed viability tests and other biochemical events related to seed viability; Depletion of food reserves. 8

4. Factors affecting seed vigour; Physiological and genetical basis of seed vigour; vigour tests, Seed vigour and crop performance and yield. 6

5. Seed dormancy: Introduction; Resting germination blocks and after-ripening;
Biochemical mechanisms of dormancy – coat imposed dormancy, embryo dormancy;
Endogenous and exogenous factors affecting dormancy; Involvement of hormones and growth regulators; Role of phytochrome; Methods of breaking and inducing dormancy; Biological significance of dormancy. 10

6. Seed germination: Introduction; Biochemistry and physiology of germination- water uptake, expression of germination, respiration, biosynthesis of proteins and nucleic acids; Mobilization of food reserves – carbohydrates lipids and proteins; Role of different organs of seed in germination, Involvement of hormones and growth regulators, Effect of age, size and position of seed on germination; Environmental stresses controlling seed germination – secondary dormancy, factors influencing seed germinability.

Course –XI; Code SST-3003
Seed Testing and Quality Control

Teaching Hours: 50

1**.** Seed Testing: Introduction, National and International history of seed testing. Seed testing network in India, National and international seed testing rules; Seed testing organization. 4

2. Seed Testing laboratory**:** layout, furnishing and management. 2

3. Seed sampling- types of samples, sampling methods; determination of heterogeneity, mixing and dividing techniques; sample receipt and registration ;physical purity analysis, determination of other species by number, determination of the other distinguishable variety. 6

4. Seed Moisture Determination, Testing for varietals verification, Grow out Test; germination test- equipment, media temperature conditions and other requirements for different corps; Seedling evaluation 6

5. Seed viability and seed vigour tests- Tetrazolium test- principle, procedure and evaluation; Testing for coated/ pelleted seeds 4

6. Seed health testing Insect damage, reporting of seed testing results. Variability in seed testing results, factors affecting variability, use of tolerance tables in seed testing. Weed seed identification. Preservation and storage of guard samples. 8

7. Seed Certification and Quality control: History of quality control Importance of quality seed. Seed quality standards – definition and concept 2

8. History of seed certification and objectives. Principles of seed certification, Seed certification scheme- Generation scheme of seed certification; Certification procedure. 4

9. Seed legislation and seed law enforcement; Indian seeds act; Seed rules; Seed control order;Seed policy. Seed fraud. Seed committees; central seed certification board ; List of certification agencies; Appellate authority and its composition. 6

10. Minimum seed certification standards; General certification standards; Specific crop standards- field and seed standards; Field and seed inspection.

4

11. labeling of breeder seed; Certified seed labels; Specification for certification tag.
Minimum seed lot size; procedure for construction of lot numbers 2

Course –XII; Code- SST-3004

Seed Processing and Storage

Teaching Hours: 50

1. Seed Processing –Concept, introduction and importance. 2

2. Plan for seed processing plant- layout and installation 2

3**. Seed drying- different methods of seed drying including dehumidification**.4

4. Preparing seed for processing; Seed cleaning and grading- scalper de-bearder, scarifier, Huller, seed cleaners and graders, screen cleaners, specific gravity separators, spiral separators, disc separators and other types of separators, and color sorters. 8

5. Seed treatment- methods of treatment, seed treatment compounds, seed disinfestations. 4

6. Seed packaging- principles, practices and materials 2

5. Economics of seed processing and Management of seed processing plants 4

6. Seed Storage: Introduction; need for seed storage; factors influencing seed storage; Physiological, biochemical and cytological changes in seed during storage; Causes of seed deterioration 6

7. Loss of seed vigour and viability and methods to minimize; Prediction of seed storability 4

8. Storage of certified, foundation, breeder seed and germplasm 4

9. Seed packing, construction and equipping seed storages. 4

10. Seed priming, biochemical and physiological basis of priming. 4

11. Storage losses due to pests; factors influencing storage losses; Storage pest methods of control.

Course –IV; Code- SST-4001

Seed Pathology

Teaching Hours: 50

1. Introduction; Terminology; historical development; seed heath testing; and significance. 2

2. Seed borne pathogens; fungi, bacteria, viruses, and nematodes. 4

3. Location of seed borne inoculum's: embryo, endosperm and perisperm, seed coat and pericarp, and glume; seed contamination or infestation. 2

4. Mechanism of seed infection: systemic infection through flower, fruit or seed stock; penetration through stigma, ovary wall and seed coat, natural openings and injuries. 4

5. Factors affecting seed infection: host genotype, environment; crop management; stages of plant infection; severity of mother plant infection; insect infestation; and antagonism and synergism. 4

6. Longevity of seed borne pathogens and the factors influencing longevity. 2

7. Seed transmission: systemic and non-systemic 2

8. Factors affecting seed transmission: crop species, environment, inoculum and its survival, cultural practices, seed abnormalities, seed germination, seed leachates, and presence of other microflora. 4

9. Epiphytology of seed borne diseases: monocyclic and polycyclic diseases, non-parasitic seed disorders: genetic effects, mechanical injuries, environmental effects, mineral deficiencies and insect damage. 6

10. Detection of seed borne pathogens: major objectives of seed health testing; testing methods for seed borne fungi, seed borne bacteria, seed borne viruses and seed borne nematodes. 8

11. Deterioration of grains by storage &field fungi: Invasion by storage fungi, losses, conditions favoring storage fungi development, detection of damage, and Control of seed borne pathogens: selection of seed production areas, crop management, seed treatment, certification, and plant quarantine and disease resistance, animal and human diseases caused by storage fungi. 12

Course-XIV; Code-SST-4002

Seed Biotechnology

Teaching hours: 50

1. **Plant organ, tissue and cell culture**: Totipotency; micro-propagation and its uses; somaclonal variation and its use in crop improvement; embryo culture; anther culture; somatic embryo; techniques of protoplast culture, regeneration and somatic cell hybridization, achievements and limitations, utility in improvement of crop plants; application in production of secondary metabolites and transformations. 12

2. **Artificial seed biotechnology**: Induction of somatic embryos; synchronization, development and maturation; drying and storage of somatic embryos- effects of stresses on desiccation tolerance; methods of drying; induction of quiescence/ dormancy; protective encapsulation; germination. 8

3. **Methods of gene transfer in plants:** *Agrobacterium* mediated gene transfer (dicots and monocots), direct DNA delivery methods (microinjection, particle gun method electroporation); gene targeting (including zinc finger nucleases). 6

4. **Transgenic plants in dicots and monocots:** Utility of transgenics in basic studies and in crop improvement (resistance for biotic and abiotic stresses; barnase and barstar for hybrid seed production); molecular farming for production of foreign proteins and edible vaccines; biosaftey issues including risks associated with transgenic crops; biosafety regulations (role of IBC, RCGM and GEAC or NBRA). 8

5. **A brief idea of DNA-based molecular markers for varietal identification:** Restriction Fragment Length Polymorphism (RFLP); Randomly Amplified polymorphic DNA (RAPD); Simple Sequence Repeats (SSRs); Sequence Tagged Sites (STSs); Amplified Fragment Length Polymorphism (AFLP) and its variations (such as SAMPL, etc.); Single Nucleotide Polymorphisms (SNP), DArT markers, etc. **8**

6. **A bried idea of application of molecular markers:** Construction of molecular maps (using F_2, DH, RILs); gene tagging using bulked segregant analysis (BSA) and near isogenic lines (NILs); QTL analysis; map-based cloning of genes; elementary idea of marker-assisted selection (MAS) in plant breeding. 8