DAV UNIVERSITY, JALANDHAR

FACULTY OF AGRICULTURAL SCIENCES

COURSE CURRICULUM

FOR

M. Sc. Ag. (Genetics & Plant Breeding)

1st to 4th SEMESTER

Examinations 2020–2021 session

Syllabi applicable for admissions in 2020

DAV UNIVERSITY, JALANDHAR

Course Scheme for M. Sc. Ag. (Genetics and Plant Breeding)

Semester I

S. No	Paper Code	Course Title	Course Type	L	T	P	Cr
1	AGS 511	Principles of Genetics	Core	2	0	2	3
2	AGS 512	Principles of Plant Breeding	Core	2	0	2	3
3	AGS 513	Cell Biology and Molecular Genetics	Core	2	0	2	3
4		Departmental elective- I (Optional)		2	0	2	3
5	CSA 559	Computer fundamentals and programming	Compulsory foundation	2	0	2	3
6	Open elective or Interdisciplinary elective-I			2	0	2	3
				12		12	18

Departmental Elective- I (Choose any one course)

S. No	Paper Code	Course Title	Course Type	L	T	P	Cr
1	AGS 514	Population genetics	Elective	2	0	2	3
2	AGS 515	Breeding for biotic and abiotic stress resistance	Elective	2	0	2	3
3	AGS 516	Breeding cereals, millets, forages and sugarcane	Elective	2	0	2	3
4	AGS 517	Gene regulation and expression	Elective	3	0	0	3
5	AGS 518	Germplasm collection, exchange and quarantine	Elective	2	0	1	3

L: Lectures T: Tutorial P: Practical Cr: Credits

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Course Scheme for M. Sc. Ag. (Genetics and Plant Breeding)

Semester II

S. No	Paper Code	Course Title	Course Type	L	T	P	Cr
1	AGS 521	Principles of Cytogenetics	Core	2	0	2	3
2	AGS 522	Principles of Quantitative Genetics	Core	2	0	2	3
3	AGS 523	Biotechnology for Crop Improvement	Core	2	0	2	3
4	ENG 551	Technical Writing and Communication skills	Compulsory foundation	0	1	2	1
5	AGS 503	Intellectual Property and its management in Agriculture	Compulsory foundation	1	0	0	1
6	Departmental elective- II (Optional)			2	0	2	3
7	Open elective or Interdisciplinary elective-II			2	0	2	3
8	AGS500	Masters' Research	Core	0	1	8	4
				11	2	14	17+4

L: Lectures T: Tutorial P: Practical Cr: Credits

Departmental elective- II (Choose any one course)

S. No	Paper Code	Course Title	Course Type	L	T	P	Cr
1	AGS 524	Mutagenesis and mutation breeding	2+1	2	0	2	3
2	AGS 525	Breeding legumes, oilseeds and fibre crops	2+1	2	0	2	3
3	AGS 526	Breeding for quality traits	2+1	2	0	2	3
4	AGS 527	Heterosis breeding	2+1	2	0	2	3
5	AGS 528	Maintenance breeding and concepts of variety release and seed production	2+1	2	0	2	3
6	AGS 529	Data base management, evaluation & utilization of PGR	2+1	2	0	2	3

L: Lectures T: Tutorial P: Practical Cr: Credits

DAV UNIVERSITY, JALANDHAR

Course Scheme for M. Sc. Ag. (Genetics and Plant Breeding)

Semester III

S. No	Paper Code	Course Title	Course Type	L	T	P	Cr
1	MTH670	Statistical Methods for Applied Sciences	Compulsory foundation	3	0	2	4
2	AGS501	Library and Information services	Compulsory foundation	0	1	2	1
3	AGS504	Basic concepts of Laboratory Techniques	Compulsory foundation	0	1	2	1
4	AGS 505	Agricultural Research, ethics and rural developmental programmes	Compulsory foundation	1	0	0	1
5	EVS 658	Disaster Management	Compulsory foundation	1	0	0	1
6	AGS 550	Master's Seminar	Core	0	1	2	1
7	AGS500	Master's Research	Core	0	1	12	6
				5		8+12	9+6

L: Lectures T: Tutorial P: Practical Cr: Credits

Semester IV

S. No	Paper Code	Course Title	Course Type	L	T	P	Cr
1	AGS500B	Master's Research	Core	0	1	30	15

L: Lectures T: Tutorial P: Practical Cr: Credits

DAV UNIVERSITY, JALANDHAR

SYLLABUS

Paper Code	Course Title	L	T	P	Cr
AGS511	Principles of Genetics	2	0	2	3

Objective: To make students understand the basic concepts of genetics and cell biology, to develop analytical, quantitative and problem-solving skills from classical to molecular genetics.

Theory

UNIT I

Beginning of genetics, cell structure and cell division, 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

Population, Mendelian population, random mating population, frequencies of genes and genotypes, causes of change, Hardy-Weinberg equilibrium. Structural and numerical changes in chromosomes, 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, transposable genetic elements, overlapping genes, pseudogenes, oncogenes, gene families and clusters.

UNIT III

Regulation of gene activity in prokaryotes, molecular mechanisms of mutation, repair and suppression, bacterial plasmids, insertion (IS) and transposable (Tn) elements, molecular chaperones and gene expression, gene regulation in eukaryotes, RNA editing. 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 IV

Genomics, transcriptomics, structural and functional proteomics, pharmacogenomics, metagenomics. Methods of studying polymorphism at biochemical and DNA level, transgenic bacteria and bioethics, gene silencing, genetics of mitochondria and chloroplasts. Concepts of eugenics, epigenetics, behavioural genetics, and genetic disorders.

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; practical demonstrations, detection of transgenes in the exposed plant material; visit to transgenic glasshouse and learning the practical considerations.

Suggested Readings:

1. Gardner EJ &Snustad DP. 1991. Principles of Genetics. John Wiley & Sons.
2. Klug WS & Cummings MR. 2003. Concepts of Genetics. Peterson Edu.
3. Lewin B. 2008. Genes IX. Jones & Bartlett Publ.
4. Russell PJ. 1998. Genetics. The Benzamin/Cummings Publ. Co.
5. Snustad DP & Simmons MJ. 2006. Genetics. 4th Ed. John Wiley & Sons.
6. Strickberger MW. 2005. Genetics. 3rd Ed. Prentice Hall.
7. Tamarin RH. 1999. Principles of Genetics. Wm. C. Brown Publs.

8. Uppal S, Yadav R, Subhadra & Saharan RP. 2005. Practical Manual on Basic andApplied Genetics. Dept. of Genetics, CCS HAU, Hisar.

Paper Code	Course Title	L	T	P	Cr
AGS512	Principles of Plant Breeding	2	0	2	3

Objective: This course is intended to impart theoretical knowledge and practical skills about plant breeding objectives, modes of reproduction and genetic consequences, breeding methods for crop improvement.

Theory

UNIT I

History of plant breeding (Pre and post-Mendelian era), objectives of plant breeding, characteristics improved by plant breeding, patterns of evolution in crop plants, centres of origin, biodiversity and its significance. 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, plant introduction and role of plant genetic resources in plant breeding,

UNIT II

Self-incompatibility, male sterility and apomixis in crop plants and their commercial exploitation, Pure line theory, pure line selection and mass selection methods, line breeding, pedigree, bulk, backcross, single seed descent and multiline method, population breeding in self-pollinated crops (diallel selective mating approach). Breeding methods in cross pollinated crops, population breeding-mass selection and ear-to-row methods, S1 and S2 progeny testing,

UNIT III

Progeny selection schemes, recurrent selection schemes for intra and interpopulation improvement and development of synthetics and composites, hybrid breeding, genetical and physiological basis of heterosis and inbreeding, production of inbreds, breeding approaches for improvement of inbreds, predicting hybrid performance, seed production of hybrid and their parent varieties/inbreds. Breeding methods in asexually/clonally propagated crops, clonal selection apomixis, clonal selection.

UNIT IV

Concept of plant ideotype and its role in crop improvement, transgressive breeding, polyploidy wide hybridization and their significance in crop improvement, double haploidy breeding following androgenesis, gynogenesis and chromosome elimination-mediated approaches. Special breeding techniques- mutation breeding, breeding for abiotic and biotic stresses. 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.

Suggested Readings

1. Allard RW. 1981. Principles of Plant Breeding. John Wiley & Sons.
2. Chopra VL. 2001. Breeding Field Crops. Oxford & IBH.
3. Chopra VL. 2004. Plant Breeding. Oxford & IBH.
4. Gupta SK. 2005. Practical Plant Breeding. AGSibios.
5. Pohlman JM &Bothakur DN. 1972. Breeding Asian Field Crops. Oxford & IBH.

6. Roy D. 2003. Plant Breeding, Analysis and Exploitation of Variation. Narosa Publ. House.
7. Sharma JR. 2001. Principles and Practice of Plant Breeding. Tata McGraw-Hill.
8. Simmonds NW. 1990. Principles of Crop Improvement. English Language Book Society.
9. Singh BD. 2006. Plant Breeding. Kalyani.
10. Singh P. 2002. Objective Genetics and Plant Breeding. Kalyani.
11. Singh P. 2006. Essentials of Plant Breeding. Kalyani.
12. Singh S & Pawar IS. 2006. Genetic Bases and Methods of Plant Breeding. CBS.

Paper Code	Course Title	L	T	P	Cr
AGS513	Cell biology and molecular genetics	2	0	2	3

Objective: To impart knowledge about structure and function of major macromolecules of the cell and genetic material at cellular and molecular level.

Theory

UNIT I

Ultrastructure of the cell, differences between eukaryotic and prokaryotic cells, macromolecules, Structure and function of cell wall, nuclear membrane and plasma membrane, cellular organelles, nucleus, plastids chloro/ chromoplast, mitochondria endoplasmic reticulum, Golgi complex, lysosomes, peroxisomes.

UNIT II

Bioenergetics, ultrastructure and function of mitochondria and biological membranes, chloroplast and other photosynthetic organelles, Interphase nucleus- structure and chemical composition, cell division and physiology of cell division.

UNIT III

Historical background of molecular genetics, genetic material in organisms, structure and properties of nucleic acid, DNA transcription and its regulation, transcription factors and their role, genetic code, regulation of protein synthesis in prokaryotes and eukaryotes, ribosomes, t-RNAs and translational factors.

UNIT IV

Transposable elements, mechanisms of recombination in prokaryote, DNA organization in eukaryotic chromosomes, DNA content variation, types of DNA sequencing, unique and repetitive sequences, organelle genomes, gene amplification and its significance, proteomics and protein-protein interaction, signal transduction, genes in development, cancer and cell aging.

Practical: Morphological and gram staining of natural bacteria; cultivation of bacteria in synthetic medium; determination of growth rate and doubling time of bacterial cells in culture; demonstration of bacteriophage by plaque assay method; determination of soluble protein content in a bacterial culture. Isolation, purification and raising clonal population of a bacterium; biological assay of bacteriophage and determination of phage population in lysate; study of lytic cycle of bacteriophage by one step growth experiment; determination of latent period and burst size of phages per cell; quantitative estimation of DNA, RNA and protein in an organism; numericals: problems and assignments.

Suggested Readings:

1. Bruce A.2004. Essential Cell Biology. Garland.
2. Darell J, Harvey L& Baltimore D. 2004. Molecular Cell Biology. WH Freeman.
3. Karp G.2004. Cell and Molecular Biology: Concepts and Experiments. John Wiley.
4. Klug WS & Cummings MR 2003. Concepts of Genetics. Scot, Foreman & Co.
5. Lewin B. 2008. Genes IX. Jones & Bartlett Publ.

6. Lodish H, Berk A &Zipursky SL. 2004. Molecular Cell Biology. 5th Ed. WH Freeman.
7. Nelson DL & Cox MM. 2005. Lehninger's Principles of Biochemistry. WH Freeman.
8. Russell PJ. 1996. Essential Genetics. Blackwell Scientific Publ.
9. Schleif R.1986. Genetics and Molecular Biology. Addison-Wesley Publ. Co.

Paper Code	Course Title	L	T	P	Cr
AGS514	Population genetics	2	0	2	3

Objective: This course is intended to provide knowledge different mating systems and gene and genotype frequencies and their use.

Theory

UNIT I

History of population genetics, properties of population, Mendelian population, genetic constitution of a population through time, space, age structure etc. Mating systems, random mating population, frequencies of genes and genotypes, causes of change: population size, differences in fertility and viability, migration and mutation. Hardy-Weinberg equilibrium, Hardy-Weinberg law, proof, applications of the Hardy, Weinberg law, test of Hardy-Weinberg equilibrium,

UNIT II

Mating frequencies, non-dominance, codominance, snyder's ratio, importance and its effect over random mating in succeeding generations. Multiple alleles, more than one locus, sex linked genes, use of gene and genotypic frequencies evaluation in field population level, lnterpretations, changes of gene frequency, migration, mutation, recurrent and nonrecurrent, Selection, balance between selection and mutation, selection favouring heterozygotes, overdominance for fitness.

UNIT III

Non random mating: selfing, inbreeding coefficient, panmictic index, sibmating, assortative mating and disassortative mating, pedigree populations and close inbreeding, estimation of selection, estimation of disequilibrium, estimation of linkage - correlation between relatives and estimation of F, Effect of inbreeding and sibbing in cross pollinated crops.

UNIT IV

Gene substitution and average effects, breeding value, genetic drift, genetic slippage, co-adapted gene complexes, homoeostasis, adapative organization of gene pools, polymorphism, balanced and nonbalanced polymorphism, heterozygous advantage, survival of recessive and deleterious alleles in populations.

Practical: Genetic exercise on probability; estimation of gene frequencies; exercises on factors affecting gene frequencies; estimation of average affect of gene substitution and breeding value; exercises on inbreeding and linkage disequilibrium, cavalli's joint scaling test; exercises of different mating designs; estimation of different population parameters from experimental data; measurement of genotype environment interaction; genetic divergence.

Suggested Readings:

1. Chawla V & Yadava RK. 2006. Principles of Population Genetics–A Practical Manual.
2. Dept. of Genetics, CCS HAU, Hisar.
3. Falconer DS & Mackay J. 1996. Introduction to Quantitative Genetics. Longman.
4. Jain JP & Parbhakaran,VT. 1992. Genetics of Populations. South Asian Publications.
5. Li CC. 1955. Population Genetics. The Univ. of Chicago Press.

6. Mather K & Jinks JL. 1982. Biometrical Genetics. Chapman & Hall.
7. Sorrens D & Doniel G. 2007. Methods in Quantitative Genetics. Series: Statistics for Biology and Health.

Paper Code	Course Title	L	T	P	Cr
AGS515	Breeding for biotic and abiotic stress resistance	2	0	2	3

Objective: The course envisages at understanding of various biotic and abiotic stresses and methodologies to be used to develop resilient varieties.

Theory

UNIT I

Importance of plant breeding with special reference to biotic and abiotic stress resistance, classification of biotic stresses, major pests and diseases of economically important crops, concepts in insect and pathogen resistance, analysis and inheritance of resistance variation, host defence responses to pathogen invasions, biochemical and molecular mechanisms, acquired and induced immunity and systemic acquired resistance (SAR), host-pathogen interaction, gene-for-gene hypothesis, molecular evidence for its operation and exceptions, concept of signal transduction and other host-defense mechanisms against viruses and bacteria.

UNIT II

Types and genetic mechanisms of resistance to biotic stresses, horizontal and vertical resistance in crop plants. Quantitative resistance/Adult plant resistance and slow rusting resistance, classical and molecular breeding methods, measuring plant resistance using plant fitness, behavioural, physiological and insect gain studies. Phenotypic screening methods for major pests and diseases, recording of observations, correlating the observations using marker data, gene pyramiding methods and their implications.

UNIT III

Classification of abiotic stresses, stress inducing factors, moisture stress/drought and water logging & submergence, acidity, salinity/alkalinity/sodicity, high/low temperature, wind, etc. Stress due to soil factors and mineral toxicity, physiological and phenological responses, emphasis of abiotic stresses in developing breeding methodologies. Genetics of abiotic stress resistance, genes and genomics in breeding cultivars suitable to low water regimes and water logging & submergence, high and low/freezing temperatures,

UNIT IV

Utilizing MAS procedures for identifying resistant types in important crops like rice, sorghum, wheat, cotton etc, breeding for resistance to stresses caused by toxicity, deficiency and pollutants/contaminants in soil, water and environment. Exploitation of wild relatives as a source of resistance to biotic and abiotic factors in major field crops. Transgenics in management of biotic and abiotic stresses, use of toxins, protease inhibitors, lectins, chitnases and Bt for diseases and insect pest management-achievements.

Practical: Phenotypic screening techniques for sucking pests and chewing pests; traits to be observed at plant and insect level; phenotypic screening techniques for nematodes and borers; ways of combating them; Breeding strategies, weeds, ecological, environmental impacts on the crops; breeding for herbicide resistance. Evaluating the available populations like RIL; NIL etc. for pest resistance; use of standard MAS procedures; phenotypic screening methods for diseases caused by fungi and bacteria; symptoms and data recording; use of MAS procedures. Screening forage crops for resistance to sewage water and tannery effluents; quality parameters evaluation, screening crops for drought and flood resistance; factors to be considered and breeding strategies. Screening varieties of major crops for

acidity and alkalinity, their effects and breeding strategies; understanding the climatological parameters and predisposal of biotic and abiotic stress factors- ways of combating them.

Suggested Readings:

1. Blumm A. 1988. Plant Breeding for Stress Environments. CRC Press.
2. Christiansen MN & Lewis CF. 1982. Breeding Plants for Less Favourable Environments. Wiley International.
3. Fritz RS & Simms EL. (Eds.). 1992. Plant Resistance to Herbivores and Pathogens:Ecology, Evolution and Genetics. The University of Chicago Press.
4. Li PH & Sakai A. 1987. Plant Cold Hardiness. Liss, New York
5. Luginpill P. 1969. Developing Resistant Plants - The Ideal Method of Controlling Insects. USDA, ARS, Washington DC.
6. Maxwell FG & Jennings PR. (Eds.). 1980. Breeding Plants Resistant to Insects. John Wiley & Sons.
7. Painter RH. 1951. Insect Resistance in Crop Plants. MacMillan, New York.
8. Russel GE. 1978. Plant Breeding for Pest and Disease Resistance. Butterworths.
9. Sakai A &Larcher W. 1987. Frost Survival in Plants. Springer-Verlag.
10. Turener NC & Kramer PJ. 1980. Adaptation of Plants to Water and High Temperature Stress. John Wiley & Sons.
11. van der Plank JE. 1982. Host-Pathogen Interactions in Plant Disease. Academic Press.

Paper Code	Course Title	L	T	P	Cr
AGS516	Breeding cereals, millets, forages and sugarcane	2	0	2	3

Objective: To impart knowledge about the evolution of different cereal, forages and sugarcane crops, their germplasm, cytogenetics, breeding objectives and methodologies.

Theory

UNIT I

Rice: Evolution and distribution of species and forms, wild relatives and germplasm, genetics, cytogenetics and genome relationship, breeding objectives, yield, quality characters, biotic and abiotic stress resistance etc., hybrid rice breeding, potential and outcome, aerobic rice, its implications and drought resistance breeding. Wheat: 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, exploitation of heterosis etc, Sorghum: 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

Maize: 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., QPM and Bt maize, strategies and implications, heterosis breeding attempts taken in sorghum, pearl millet and maize. Pearl millet: 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 III

Minor 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. 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 grasses: 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., synthetics, composites and apomixis.

UNIT IV

Forage grasses and legumes: 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., tree fodders: 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, palatability studies. Distinguishing features of popular released varieties in rice and sorghum, wheat, pearl millet, maize and other millets, sugarcane, forage grasses and legumes and their application to DUS testing, maintenance of seed purity, nucleus and breeder seed production.

Practical: Floral biology, emasculation, pollination techniques; study of range of variation for yield and yield components; Study of segregating populations and their evaluation, trait based screening for stress resistance in crops of importance; Use of descriptors for cataloguing germplasm maintenance; learning on the standard evaluation system (SES) and descriptors; Use of softwares for database management and retrieval; practical learning on the cultivation of fodder crop species on sewage water; analysing 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 and learning the animal experiments related with palatability and digestibility of fodder.

Suggested Readings:

1. Agarwal RL. 1996. Identifying Characteristics of Crop Varieties. Oxford & IBH.
2. Bahl PN & Salimath PM. 1996. Genetics, Cytogenetics and Breeding of Crop Plants. Vol. I. Pulses and Oilseeds. Oxford & IBH.
3. Chandraratna MF. 1964. Genetics and Breeding of Rice. Longmans.
4. Chopra VL & Prakash S. 2002. Evolution and Adaptation of Cereal Crops. Oxford & IBH.
5. Gill KS. 1991. Pearl Millet and its Improvement. ICAR.
6. I RRI. 1986. Rice Genetics. Proc. International Rice Genetics Symposium. IRRI, Los Banos, Manila, Philippines.
7. IRRI. 1991. Rice Genetics II. Proc. International Rice Genetics Symposium. IRRI, Los Banos, Manila, Philippines.
8. IRRI. 1996. Rice Genetics III. Proc. International Rice Genetics Symposium. IRRI, Los Banos, Manila, Philippines.
9. IRRI. 2000. Rice Genetics IV. Proc. International Rice Genetics Symposium. IRRI, Los Banos, Manila, Philippines.
10. Kannaiyan S, Uthamasamy S, Theodore RK &Palaniswamy S. 2002. New Dimensionsand Approaches for Sustainable Agriculture. Directorate of Extension Education,TNAU, Coimbatore.
11. Murty DS, Tabo R &Ajayi O. 1994. Sorghum Hybrid Seed Production and Management. ICRISAT, Patancheru, India.
12. Nanada JS. 1997. Manual on Rice Breeding. Kalyani.
13. Ram HH & Singh HG. 1993. Crop Breeding and Genetics. Kalyani.
14. Singh HG, Mishra SN, Singh TB, Ram HH & Singh DP. (Eds.). 1994. Crop Breeding in India. International Book Distributing Co.

15.Slafer GA. (Ed.). 1994. Genetic Improvement of Field Crops. Marcel Dekker.
16.Walden DB. 1978. Maize Breeding and Genetics. John Wiley& Sons.

Paper Code	Course Title	L	T	P	Cr
AGS517	Gene regulation and expression	3	0	0	3

Objective: The course is intended to provide theoretical knowledge about regulation and expression of genes with special reference to model plant systems.

Theory

UNIT I

Introduction: Gene regulation-purpose, Process and mechanisms in prokaryotes and eukaryotes, levels of gene controls. Coordinated genetic regulation-examples, anthocyanin and gene families and maize, genetic and molecular basis depending on tissue specificity.

UNIT II

Gene expression, transposons in plant gene expression, cloning-transposon tagging, light regulated gene expression, model systems in arabidopsis and maize, paramutations and imprinting of genes and genomes.

UNIT III

Transgene expression and gene silencing mechanisms, regulatory genes horizontal and vertical homology, transformation, regulatory genes as visible markers, reporter systems to study gene expression, combinatorial gene control.

UNIT IV

Eukaryotic transcriptional control, translational and post-translational regulation, signal transduction, stress-induced gene expression, gene traps and enhancer traps.

Suggested Readings

1. Brooker RJ. 2004. Genetics Analysis and Principles. Addison-Wesley Longman.
2. Brown TA. 2002. Genomes. Bios Scientific.
3. Griffiths AJF. 2000. An Introduction to Genetic Analysis. WH Freeman.
4. Hartl DL & Jones EW. 1998. Genetics Principles and Analysis. Jones &Barlett.
5. Hexter W & Yost HT. 1976. The Science of Genetics. Prentice Hall.
6. Lewin B. 2008. Genes IX. John Wiley & Sons.
7. Micklos DA & Freyer G. 2003. DNA Science - A First Course. CPL Scientific.
8. Russell PJ. 1996. Essential Genetics. Blackwell Scientific.
9. Schleif R.1986. Genetics and Molecular Biology. Addison-Wesley.
10.Singer M & Berg P. 1991. Genes and Genomes. John Wiley & Sons.
11.Tamarin RH. 1999. Principles of Genetics. Wm C Brown.
12.Watson JD. 2004. Molecular Biology of the Gene. Pearson Edu.

Paper Code	Course Title	L	T	P	Cr
AGS518	Germplasm collection, exchange and quarantine	2	0	2	3

Objective: The course aimed at an understanding of importance of germplasm, its conservation, maintenance and policies related to germplasm collection, exchange and IPR related issues.

Theory

UNIT I

History and importance of germplasm exploration, distribution and extent of prevalent genetic diversity, phyto-geographical regions/ecological zones and associated diversity, mapping eco-geographic distribution of diversity, threatened habitats, use of flora. Concept of population and gene pool, variations in population and their classification, gene frequencies in populations, rare and common alleles, gene pool sampling in self and cross pollinated and vegetatively propagated species,non-selective, random and selective sampling strategies, strategies and logistics of plant exploration and collection, coarse and fine grid surveys, practical problems in plant exploration, use of in vitro methods in germplasm collection.

UNIT II

Ethnobotanical aspects of PGR, crop botany, farming systems, collecting wild relatives of crop plants, collection and preservation of specimens, importance and use of herbaria and preparation of herbarium specimens. Post-exploration handling of germplasm collections, present status and future strategies in collection of major crops of Indian origin such as rice, maize, sorghum, sesame, brassica, okra, eggplant, cotton, mango etc, approaches for collection including indigenous knowledge.

UNIT III

History, principles, objectives and importance of plant introduction, prerequisites, conventions, national and international legislations and policies on germplasm collection , exchange and IPR issues, documentation and information management, plant quarantine- introduction, history, principles, objectives and relevance, regulations and plant quarantine set up in India, pest risk analysis, pest and pathogen information database, quarantine in relation to integrated pest management, economic significance of seed-borne pests (insects, mites, non-insect pests, nematodes, fungi, bacteria, viruses, phytoplasma etc.).

UNIT IV

Detection and identification of pests including use of recent techniques like ELISA, PCR etc., symptoms of pest damage, salvaging techniques for infested/infected germplasm, post-entry quarantine operation, seed treatment and other prophylactic treatments and facilities, domestic quarantine, seed certification, international linkages in plant quarantine, weaknesses and future thrust. Genetically modified organisms (GMOs) or genetically engineered plants (GEPs), concepts of biosafety, risk analysis and consequences of spread of GE crops on the environment, treaties and multilateral AGSeements governing trans-boundary movement of GEPs or GMOs, Indian regulatory system for biosafety.

Practical: Plant exploration and collection; techniques of coarse and fine grid surveys; identification of wild relatives of crop plants; example of collection; cataloguing and preservation of specimens; sampling techniques of plant materials; visiting ports, airports to study the quarantine regulations; techniques for the detection of insects; mites; nematodes; bacteria; weeds; pathogens and viruses on seed and planting materials and salvaging; use of visual; qualitative; quantitative; microscopic; molecular and plant growth related techniques(controlled green houses/growth chambers, etc); detection of GMOs and GEPs; study of post-entry quarantine operation; seed treatment and other prophylactic treatments.

Suggested Readings

1. Cronquist AJ. 1981. An Integrated System of Classification of Flowering Plants.
2. Columbia Univ. Press, New York.
3. David Briggs. 1997. Plant Variation and Evolution. Science Publ.
4. Dhillon BS, Varaprasad KS, Kalyani Srinivasan, Mahendra Singh, Sunil Arachak, Umesh Srivastava & Sharma GD. 2001. Germplasm Conservation A Compendium ofAchievements. NBPGR, New Delhi.

5. diCastri, F &Younes T. 1996. Biodiversity Science and Development: Towards NewPartnership. CABI, In association with International Union for BiologicalScience, France.
6. Gurcharan Singh. 2004. Plant Systematics: An Integrated Approach. Science Publ.
7. John H Wiersema. 1999. World Economic Plants: A Standard Reference. Blanca Leon.
8. Lawrence GMH. (Ed.) 1951. Taxonomy of Vascular Plants. London.
9. Lorentz C Pearson. 1995. The Diversity and Evolution of Plants. CRC Press.
10. Paroda RS & Arora RK. 1991. Plant Genetic Resources Conservation and Management Concepts and Approaches. IBPGR Regional office for south and south Asia New Delhi.
11. Singh BP. 1993. Principles and Procedures of Exchange of Plant Genetic Resources Conservation and Management. Indo-US PGR project management.
12. Sivarajan VV. 1991. Introduction of Principles of Plant Taxonomy. Science Publ. Takhrajan A. 1997. Diversity and Classification of Flowering Plants. Columbia University Press, New York.

Paper Code	Course Title	L	T	P	Cr
AGS521	Principles of cytogenetics	2	0	2	3

Objective: The course is intended to provide insight into structure and functions of chromosomes, chromosome mapping, structural and numerical chromosomal variations and cytogenetic aspects of crop evolution.

Theory

UNIT I

History of cytogenetics, 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. Chromosomal theory of inheritance, cell cycle and cell division, mitosis and meiosis, differences, significance and deviations, synapsis, structure and function of synaptonemal complex and spindle apparatus,

UNIT II

Anaphase movement of chromosomes and crossing over-mechanisms and theories of crossing over-recombination models, cytological basis, variation in chromosome structure, evolutionary significance, introduction to techniques for karyotyping, chromosome banding and painting, in situ hybridization and various applications. Structural and numerical variations of chromosomes and their implications, symbols and terminologies for chromosome numbers, euploidy, haploids, diploids and polyploids, utilization of aneuploids in gene location, variation in chromosome behaviour, somatic segregation and chimeras, endomitosis and somatic reduction, evolutionary significance of chromosomal aberrations, balanced lethals and chromosome complexes.

UNIT III

Inter-varietal chromosome substitutions, polyploidy and role of polyploids in crop breeding, evolutionary advantages of autopolyploids vs allopolyploids, role of aneuploids in basic and applied aspects of crop breeding, their maintenance and utilization in gene mapping and gene blocks transfer, alien addition and substitution lines, creation and utilization, apomixis, evolutionary and genetic problems in crops with apomixis. Production and use of haploids, dihaploids and doubled haploids in genetics and breeding.

UNIT IV

Reversion of autopolyploids to diploids, genome mapping in polyploids, interspecific hybridization and allopolyploids, synthesis of new crops (wheat, triticale and brassica), hybrids between species with same chromosome number, alien translocations, hybrids between species with different chromosome number, gene transfer using amphidiploids, bridge species. Fertilization barriers in crop plants at pre-

and post-fertilization levels, In vitro techniques to overcome the fertilization barriers in crops, Chromosome manipulations in wide hybridization, case studies.

Practical: Learning the cytogenetics laboratory, various chemicals to be used for fixation, dehydration, embedding, staining, cleaning etc., microscopy: various types of microscopes, observing sections of specimen using electron microscope; preparing specimen for observation, fixative preparation and fixing specimen for light microscopy studies in cereals, studies on the course of mitosis in wheat, pearl millet, studies on the course of mitosis in onion and Aloe vera , studies on the course of meiosis in cereals, millets and pulses, studies on the course of meiosis in oilseeds and forage crops, using micrometers and studying the pollen grain size in various crops, various methods of staining and preparation of temporary and permanent slides, pollen germination in vivo and in vitro; microtomy and steps in microtomy; agents employed for the induction of various ploidy levels; solution preparation and application at seed, seedling level, identification of polyploids in different crops, induction and identification of haploids; anther culture and ovule culture, morphological observations on synthesized autopolyploids, observations on cmitosis, learning on the dynamics of spindle fibre assembly, morphological observations on alloployploids - morphological observations on aneuploids, cytogenetic analysis of interspecific and intergeneric crosses, maintenance of Cytogenetic stocks and their importance in crop breeding, Various ploidy levels due to somaclonal variation ; polyploidy in ornamental crops. Fluorescent in situ hybridization (FISH), genomic in situ hybridization (GISH).

Suggested Readings

1. Becker K & Hardin. 2004. The World of Cell. 5th Ed. Pearson Edu.
2. Carroll M. 1989. Organelles. The Guilford Press.
3. Charles B. 1993. Discussions in Cytogenetics. Prentice Hall.
4. Darlington CD & La Cour LF. 1969. The Handling of Chromosomes. Georger Allen & Unwin Ltd.
5. Elgin SCR. 1995. Chromatin Structure and Gene Expression. IRL Press.
6. Gray P. 1954. The Mirotomist's Formulatory Guide. The Blakiston Co.
7. Gupta PK & Tsuchiya T. 1991. Chromosome Engineering in Plants: Genetics, Breeding and Evolution. Part A. Elsevier.
8. Gupta PK. 2000. Cytogenetics. Rastogi Publ.
9. Johannson DA. 1975. Plant Microtechnique. McGraw Hill.
10. Karp G. 1996. Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons.
11. Khush GS, 1973 Cytogenetics of Aneuploids. Academic Press.
12. Sharma AK & Sharma A. 1988. Chromosome Techniques: Theory and Practice. Butterworth.
13. Sumner AT. 1982. Chromosome Banding. Unwin Hyman Publ.
14. Swanson CP. 1960. Cytology and Cytogenetics. Macmillan & Co.

Paper Code	Course Title	L	T	P	Cr
AGS522	Principles of quantitative genetics	2	0	2	3

Objective: To impart knowledge in theoretical and practical aspects of quantitative genetics

Theory

UNIT I

Mendelian traits vs polygenic traits, nature of quantitative traits and its inheritance, multiple factor hypothesis, analysis of continuous variation, variations associated with polygenic traits, phenotypic, genotypic and 16 environmental, non-allelic interactions, nature of gene action, additive, dominance, epistatic and linkage effects. Principles of analysis of variance (ANOVA), expected variance

components, random and fixed models, MANOVA, biplot analysis, comparison of means and variances for significance.

UNIT II

Application of CRD, CRBD alpha designs, LSD , spilit plot, strip plot, progeny row, compact family block, simple and balance lattice, augumented and honey comb designs for plant breeding experiments, principles and applications, genetic diversity analysis, metroglyph, cluster and D2 analyses , association analysis, phenotypic and genotypic correlations, path analysis and Parent, progeny regression analysis, discriminant function and principal component analyses, selection indices, selection of parents, simultaneous selection models, concepts of selection - heritability and genetic advance.

UNIT III

Scaling tests and generation mean analysis, mating designs, diallel, partial diallel, line x tester analysis, NCDs and TTC, concepts of combining ability and gene action, analysis of genotype x environment interaction - adaptability and stability, models for G x E analysis and stability parameters, AMMI analysis, principles and interpretation.

UNIT IV

QTL mapping, strategies for QTL mapping - desired populations for QTL mapping - statistical methods in QTL mapping - QTL mapping in genetic analysis, marker assisted selection (MAS) - approaches to apply MAS in plant breeding - selection based on marker - simultaneous selection based on marker and phenotype - factors influencing MAS.

Practical: Problems on multiple factors inheritance, partitioning of variance, estimation of heritability and genetic advance, covariance analysis, metroglyph analysis, D2 analysis, grouping of clusters and interpretation, cluster analysis, construction of cluster diagrams and dendrograms, interpretation, correlation analysis, path analysis, parent-progeny regression analysis, diallel analysis: griffing's methods I and II, diallel analysis: hayman's graphical approach, diallel analysis: interpretation of results, NCD and their interpretations, line x tester analysis and interpretation of results, estimation of heterosis : standard, mid-parental and better-parental heterosis, estimation of inbreeding depression , generation mean analysis: Analytical part and Interpretation, estimation of different types of gene actions. Partitioning of phenotypic variance and co-variance into components due to genotypes, environment and genotype x environment interactions. Construction of saturated linkage maps and QTL mapping. Strategies for QTL mapping; statistical methods in QTL mapping; phenotype and marker linkage studies. Working out efficiency of selection methods in different populations and interpretation, biparental mating, triallel analysis, quadriallel analysis and triple Test Cross (TTC). Use of softwares in analysis and result interpretation, advanced biometrical models for combining ability analysis, models in stability analysis additive Main Effect and Multiplicative Interaction (AMMI) model. Principal, component analysis model. Additive and multiplicative model shifted 17 multiplicative model, analysis and selection of genotypes. Methods and steps to select the best model and selection systems, biplots and mapping genotypes.

Suggested Readings:

1. Bos I & Caligari P. 1995. Selection Methods in Plant Breeding. Chapman & Hall.
2. Falconer DS. 1983. Problems on Quantitative Genetics. Longman.
3. Falconer DS. 1998. Introduction to Quantitative Genetics. Longman.
4. Mather K &Jinks JL. 1971. Biometrical Genetics. Chapman & Hall.
5. Mather K &Jinks J L. 1983. Introduction to Biometrical Genetics. Chapman & Hall.
6. Nadarajan N & Gunasekaran M. 2005. Quantitative Genetics and Biometrical Techniques in Plant Breeding. Kalyani.
7. Naryanan SS and Singh P. 2007. Biometrical Techniques in Plant Breeding. Kalyani.
8. Singh P & Narayanan SS. 1993. Biometrical Techniques in Plant Breeding. Kalyani.

9. Singh RK &Choudhary BD. 1987. Biometrical Methods in Quantitative Genetics. Kalyani.
10. Weir DS. 1990. Genetic Data Analysis. Methods for Discrete Population Genetic Data. Sinauer Associates.

Paper Code	Course Title	L	T	P	Cr
AGS523	Biotechnology for crop improvement	2	0	2	3

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

Theory

UNIT I

Biotechnology and its relevance in Agriculture, definitions, terminologies and scope in plant breeding. Tissue culture history, callus, suspension cultures, cloning, regeneration, somatic embryogenesis, anther-culture, somatic hybridization techniques, meristem, ovary and embryo culture, cryopreservation. Techniques of DNA isolation, quantification and analysis, genotyping, sequencing techniques, vectors, vector preparation and cloning,

UNIT II

Biochemical and molecular markers, morphological, biochemical and DNA based markers (RFLP, RAPD, AFLP, SSR, SNPs, ESTs etc.), mapping populations (F_2s, back crosses, RILs, NILs and DH). Molecular mapping and tagging of Agronomically important traits, statistical tools in marker analysis, robotics, marker-assisted selection for qualitative and quantitative traits, QTLs analysis in crop plants, gene pyramiding. Marker assisted selection and molecular breeding, genomics and geoinformatics for crop improvement, genomic selection (GS), Genome Wide Association Studies (GWAS), genome editing

UNIT III

Integrating functional genomics information on Agronomically /economically important traits in plant breeding, marker-assisted backcross breeding for rapid introgression, generation of EDVs. 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 their commercial releases.

UNIT IV

Biotechnology applications in male sterility/hybrid breeding, molecular farming. 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 Bioinformatics & bioinformatics tools. Nanotechnology and its applications in crop improvement programmes.

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 hardening of regenerated plants; establishing a greenhouse and hardening procedures. Visit to commercial micropropagation; 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.

Suggested Readings

1. Chopra VL & Nasim A. 1990. Genetic Engineering and Biotechnology: Concepts, Methods and Applications. Oxford & IBH.
2. Gupta PK. 1997. Elements of Biotechnology. Rastogi Publ.
3. Hackett PB, Fuchs JA & Messing JW. 1988. An Introduction to Recombinant DNA Technology - Basic Experiments in Gene Manipulation. 2nd Ed. Benjamin Publ. Co.
4. Sambrook J and Russel D. 2001. Molecular Cloning-a Laboratory Manual (III Ed) Cold Spring Harbor Lab. Press, USA.
5. Singh BD. 2005. Biotechnology, Expanding Horizons. Kalyani.

Paper Code	Course Title	L	T	P	Cr
AGS524	Mutagenesis and mutation breeding	2	0	2	3

Objective: To impart the knowledge about mutations, physical and chemical mutagens, their classification, effect on living cells and method of detections and exploitation in crop improvement

Theory

UNIT I

Mutation and its history, nature and classification of mutations: spontaneous and induced mutations, micro and macro mutations, pre and post adaptive mutations, detection of mutations in lower and higher organisms, paramutations. Mutagenic agents: physical, radiation types and sources, ionising and non-ionizing radiations viz., X rays, γ rays, α and β particles, protons, neutrons and UV rays, radiobiology: mechanism of action of various radiations, (photoelectric absorption, Compton scattering and pair production) and their biological effects, RBE and LET relationships.

UNIT II

Effect of mutations on DNA - repair mechanisms operating at DNA, chromosome, cell and organism level to counteract the mutation effects, dosimetry, objects and methods of treatment, factors influencing mutation: dose rate, acute vs chronic irradiation, recurrent irradiation, enhancement of thermal neutron effects, radiation sensitivity and modifying factors: external and internal sources-oxygen, water content, temperature and nuclear volume.

UNIT III

Chemical mutagens- classification, base analogues, antibiotics, alkylating agents, acridine dyes and other mutagens: their properties and mode of action, dose determination and factors influencing chemical mutagenesis, treatment methods using physical and chemical mutagens, combination treatments, other causes of mutation, direct and indirect action, comparative evaluation of physical and chemical mutagens. Observing mutagen effects in M_1 generation: plant injury, lethality, sterility, chimeras etc., Observing mutagen effects in M_2 generation, estimation of mutagenic efficiency and effectiveness, spectrum of chlorophyll and viable mutations. Mutations in traits with continuous variation.

UNIT IV

Factors influencing the mutant spectrum: genotype, type of mutagen and dose, pleiotropy and linkage etc. - individual plant based mutation analysis and working out effectiveness and efficiency in M_3 generation - comparative evaluation of physical and chemical mutagens for creation of variability in the same species – case studies. Use of mutagens in creating oligogenic and polygenic variations, case studies, in vitro mutagenesis, callus and pollen irradiation, handling of segregating generations and selection procedures, validation of mutants, mutation breeding for various traits (disease resistance, insect resistance, quality improvement etc.) in different crops- procedures for micro mutations breeding /polygenic mutations. Achievements of mutation breeding- varieties released across the world-problems associated with mutation breeding. Use of mutagens in genomics, allele mining, tilling.

Practical: Learning the precautions on handling of mutagens; dosimetry - studies of different mutagenic agents: physical mutagens; studies of different mutagenic agents: chemical mutagens; learning on radioactivity; production of source and isotopes at BRIT; Trombay; Learning about gamma chamber; radiation hazards; monitoring, safety regulations and safe transportation of radioisotopes; visit to radio isotope laboratory; learning on safe disposal of radioisotopes. Hazards due to chemical mutagens, treating the plant propagules at different doses of physical and chemical mutagens; Learning combined mutagenic treatments; raising the crop for observation. Mutagenic effectiveness and efficiency; calculating the same from earlier literature. Study of M_1 generation, parameters to be observed; study of M_2 generation, parameters to be observed; mutation breeding in cereals and pulses; Achievements made and an analysis, mutation breeding in oilseeds and cotton. Achievements and opportunities, mutation breeding in forage crops and vegetatively propagated crops; procedure for detection of mutations for polygenic traits in M_2 and M_3 generations.

Suggested Readings:

1. Alper T. 1979. Cellular Radiobiology. Cambridge Univ. Press, London.
2. Chadwick KH & Leenhouts HP. 1981. The Molecular Theory of Radiation Biology. Springer-Verlag.
3. Cotton RGH, Edkin E & Forrest S. 2000. Mutation Detection: A Practical Approach, Oxford Univ. Press, USA.
4. International Atomic Energey Agency. 1970. Manual on Mutation Breeding. International Atomic Energey Agency, Vienna, Italy.
5. Singh BD. 2003. Genetics. Kalyani.
6. Strickberger MW. 2005. Genetics (III Ed). Prentice Hall

Paper Code	Course Title	L	T	P	Cr
AGS525	Breeding legumes, oilseeds and fibre crops	2	0	2	3

Objective: To impart knowledge about the evolution of different legumes, oilseeds and fibre crops, their germplasm, cytogenetics, breeding objectives and methodologies.

Theory

UNIT I

Pigeonpea: Evolution and distribution of species and forms, wild relatives and germplasm, genetics, cytogenetics and genome relationship, morphological and molecular descriptors used for differentiating the accessions, breeding objectives, yield, quality characters, biotic and abiotic stress etc - hybrid technology, maintenance of male sterile, fertile and restorer lines, progress made at ICRISAT and other Institutes. Chickpea: Evolution and distribution of species and forms, wild relatives and germplasm, cytogenetics and genome relationship, breeding objectives, yield, quality characters, biotic and abiotic stress etc, protein quality improvement, conventional and modern plant breeding approaches, progress made, breeding for anti nutritional factors.

UNIT II

Other pulses: greengram, blackgram, fieldpea, lentil, lathyrus, cowpea, common bean (rajmash) lablab, mothbean: evolution, cytogenetics and genome relationship, learning the descriptors, breeding objectives, yield, quality characters, biotic and abiotic stress etc, interspecific crosses attempted and its implications, reasons for failure, ways of overcoming them. Groundnut: Evolution and distribution of species and forms, wild relatives and germplasm, cytogenetics and genome relationship, pod and kernel characters, breeding objectives- yield, quality characters, biotic and abiotic stress etc. Rapeseed and

mustard: breeding objectives, utilization of wild relatives for yield and quality improvement, biotic and abiotic stress etc, oil quality, characteristics in different oils, evolution and distribution of species and forms, wild relatives and germplasm, genetics, cytogenetics and genome relationship.

UNIT III

Soybean: Breeding objectives, utilization of wild relatives for yield and quality improvement, biotic and abiotic stress etc., oil quality, characteristics, evolution and distribution of species and forms, wild relatives and germplasm, genetics, cytogenetics and genome relationship. Other oilseed crops: sunflower, sesame, linseed, safflower, niger: evolution and distribution of species and forms, wild relatives and germplasm, cytogenetics and genome relationship, breeding objectives, yield, quality characters, biotic and abiotic stress. Castor: evolution and distribution of species and forms, wild relatives and germplasm, cytogenetics and genome relationship, breeding objectives yield, quality characters, biotic and abiotic stress etc - hybrid breeding in castor, opportunities, constraints and achievements.

UNIT IV

Cotton: evolution of cotton, breeding objectives, yield, quality characters, biotic and abiotic stress etc, development and maintenance of male sterile lines, hybrid development and seed production, scenario of Bt cottons, evaluation procedures for Bt cotton. Jute: evolution and distribution of species and forms, wild relatives and germplasm, cytogenetics and genome relationship; breeding objectives, yield, quality characters, biotic and abiotic stress etc, mesta and minor fibre crops: evolution and distribution of species and forms, wild relatives and germplasm, cytogenetics and genome relationship, breeding objectives- yield, quality characters, biotic and abiotic stress etc. Distinguishing features of the released varieties in pulses, oilseeds and cotton, maintenance of seed purity and seed production.

Practical: Use of descriptors for cataloguing, floral biology; emasculation; pollination techniques; study of range of variation for yield and yield components; study of segregating populations in redgram, greengram; blackgram and other pulse crops; attempting crosses between blackgram and greengram; use of descriptors for cataloguing; floral biology; emasculation; pollination techniques of oilseed crops like sesame; groundnut; sunflower and castor; cotton: use of descriptors for cataloguing; floral biology; learning on the crosses between different species; cotton: study of range of variation for yield and yield components; study of segregating populations; evaluation; trait based screening for stress resistance; cotton fibre quality evaluation; conventional and modern approaches; analysing the lint samples of different species; interspecific and interracial derivatives for fibre quality and interpretation; development and maintenance of male sterile lines; evaluation of cotton cultures of different species for insect and disease resistance; learning the mechanisms of resistance; quantifying the resistance using various parameters; 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 cotton yarn production; its quality evaluation and uses.

Suggested Readings

1. Agarwal RL. 1996. Identifying Characteristics of Crop Varieties. Oxford & IBH.
2. Bahl PN & Salimath PM. 1996. Genetics, Cytogenetics and Breeding of Crop Plants. Vol. I. Pulses and Oilseeds. Oxford & IBH.
3. Chahal GS & Ghosal SS. 2002. Principles and Procedures of Plant Breeding -Biotechnological and Conventional Approaches. Narosa Publ.
4. Chopra VL. 1997. Plant Breeding. Oxford & IBH.
5. Nath V & Lal C. 1995. Oilseeds in India. Westvill Publ. House.
6. Nigam J. 1996. Genetic Improvement of Oilseed Crops. Oxford & IBH.
7. Ram HH & Singh HG. 1993. Crop Breeding and Genetics. Kalyani.
8. Singh DP. 1991. Genetics and Breeding of Pulse Crops. Kalyani.

9. Singh HG, Mishra SN, Singh TB, Ram HH & Singh DP. (Eds.). 1994. Crop Breeding in India. International Book Distributing Co.
10. Smartt J. 1994. The Groundnut Crop - a Scientific Basis for Improvement. Chapman & Hall.

Paper Code	Course Title	L	T	P	Cr
AGS526	Breeding for quality traits	2	0	2	3

Objective: To impart knowledge about quality traits of importance in different crops and breeding methodologies to incorporate quality traits to develop improved varieties.

Theory

UNIT I

Developmental biochemistry and genetics of carbohydrates, proteins, fats, vitamins, amino acids and anti-nutritional factors, nutritional improvement, a human perspective, breeding for grain quality parameters in rice and its analysis, golden rice and aromatic rice, breeding strategies, achievements and application in Indian context, molecular basis of quality traits and their manipulation in rice, post harvest manipulation for quality improvement.

UNIT II

Breeding for baking qualities in wheat, characters to be considered and breeding strategies, molecular and cytogenetic manipulation for quality improvement in wheat, Breeding for quality improvement in barley and oats.

UNIT III

Breeding for quality improvement in Sorghum and pearl millet, quality protein maize, concept and breeding strategies, breeding for quality improvement in forage crops, genetic resource management for sustaining nutritive quality in crops.

UNIT IV

Breeding for quality in pulses, in groundnut, sesame, sunflower and minor oilseeds, molecular basis of fat formation and manipulation to achieve more PUFA in oil crops, genetic manipulation for quality improvement in cotton. Genetic engineering protocols for quality improvement, achievements made, value addition in crops, classification and importance, nutritional genomics and second generation transgenics.

Practical: Grain quality evaluation in rice; correlating ageing and quality improvement in rice; quality analysis in millets; estimation of antinutritional factors like tannins in different varieties/hybrids; a comparison; quality parameters evaluation in wheat; quality parameters evaluation in pulses, quality parameters evaluation in oilseeds; value addition in crop plants; post harvest processing of major field crops; quality improvement in crops through tissue culture techniques; evaluating the available populations like RIL, NIL etc. for quality improvement using MAS procedures.

Suggested Readings:

1. Chahal GS & Ghosal SS. 2002. Principles and Procedures of Plant Breeding - Biotechnological and Conventional Approaches. Narosa Publ.
2. Chopra VL. 1997. Plant Breeding. Oxford & IBH.
3. FAO 2001. Speciality Rices of the World - Breeding, Production and Marketing. Oxford & IBH.
4. Ghosh P. 2004. Fibre Science and Technology. Tata McGraw Hill.
5. Hay RK. 2006. Physiology of Crop Yield. 2nd Ed. Blackwell.

6. Nigam J. 1996. Genetic Improvement of Oilseed Crops. Oxford & IBH.
7. Singh BD. 1997. Plant Breeding. Kalyani.
8. Singh RK, Singh UK & Khush GS. 2000. Aromatic Rice. Oxford & IBH.

Paper Code	Course Title	L	T	P	Cr
AGS527	Heterosis breeding	2	0	2	3

Objective: To provide understanding about mechanisms of heterosis and its exploitation for yield improvement through conventional and biotechnological approaches.

Theory

UNIT I

Historical aspect of heterosis, nomenclature and definitions of heterosis, heterosis in natural population and inbred population, evolutionary aspects, genetic consequences of selfing and crossing in self-and cross-pollinated and asexually propagated crops. Pre-Mendelian and Post-Mendelian ideas, genetic theories of heterosis, physiological, biochemical and molecular factors underlining heterosis, theories and their estimation, evolutionary concepts of heterosis.

UNIT II

Prediction of heterosis from various crosses, Inbreeding depression, frequency of inbreeding and residual heterosis in F_2 and segregating populations, importance of inbreeding in exploitation of heterosis, case studies, relationship between genetic distance and expression of heterosis, case studies, divergence and genetic distance analyses-morphological and molecular genetic distance in predicting heterosis, development of heterotic pools in germplasm/genetic stocks and inbreds, their improvement for increasing heterosis.

UNIT III

Types of male sterility and use in heterosis breeding, maintenance, transfer and restoration of different types of male sterility, use of self incompatibility in development of hybrids, hybrid seed production system: 3-line, 2-line and 1-line system, development of inbreds and parental lines- A, B and R lines – functional male sterility, commercial exploitation of heterosis- maintenance breeding of parental lines in hybrids.

UNIT IV

Fixation of heterosis in self, cross and often cross- pollinated crops, asexually/clonally propagated crops, male sterile line creation and diversification in self pollinated, cross pollinated and asexually propagate crops, problems and prospects, apomixis in fixing heterosis-concept of single line hybrid. Organellar heterosis and complementation, creation of male sterility through genetic engineering and its exploitation in heterosis. Heterosis breeding in wheat, rice, cotton, maize, pearl millet, sorghum and oilseed crops.

Practical: Selection indices and selection differential; calculations and interpretations; Male sterile line characterization in millets; using morphological descriptors; restorer line identification and diversification of male sterile sources; Male sterile line creation in dicots comprising oilseeds, pulses and cotton ; problems in creation of CGMS system; ways of overcoming them; Male sterile line creation; diversification and restoration in forage crops; understanding the difficulties in breeding apomicts; estimation of heterotic parameters in self, cross and asexually propagated crops; estimation from the various models for heterosis parameters; Hybrid seed production in field crops; an account on the released hybrids; their potential; problems and ways of overcoming it; hybrid breeding at National and International level; opportunities ahead.

Suggested Readings

1. Abstracts of the Genetics and Exploitation of Heterosis in Crops - An International Symposium CIMMYT.
2. Akin E. 1979. The Geometry of Population Genetics. Springer-Verlag.
3. Ben Hiu Lin. 1998. Statistical Genomics–Linkage, Mapping and QTL Analysis. CRC Press.
4. De Joung G. 1988. Population Genetics and Evolution. Springer-Verlag.
5. Hartl DL. 2000. A Primer of Population Genetics. 3rd Ed. Sinauer Assoc.
6. Mettler LE & Gregg TG. 1969. Population Genetics and Evolution. Prentice Hall.
7. Montgomery DC. 2001. Design and Analysis of Experiments. 5th Ed., Wiley & Sons.
8. Richards AJ. 1986. Plant Breeding Systems. George Allen & Unwin.
9. Srivastava S &Tyagi R. 1997. Selected Problems in Genetics. Vols. I, II. Anmol Publ.

Paper Code	Course Title	L	T	P	Cr
AGS528	Maintenance breeding and concepts of variety release and seed production	2	0	2	3

Objective: To acquaint students about procedures of varietal development, registration, release notification and their maintenance during seed production.

Theory

UNIT I

Variety development and maintenance, definition- variety, cultivar, extant variety, essentially derived variety, independently derived variety, reference variety, farmers' variety, hybrid and population, Variety testing, release and notification systems 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, maintenance of varieties in self and cross-pollination crops, isolation distance, principles of seed production

UNIT III

Methods of nucleus and breeder seed production. Generation system of seed multiplication, nucleus, breeders, foundation, certified, quality seed production technology of self and cross-pollinated crop varieties viz. cereals & millets (wheat, barley, paddy, pearlmillet, sorghum, maize and ragi etc.), pulses (greengram, blackgram, cowpea, pigeonpea, chickpea, fieldpea, lentil),

UNIT IV

Generation system of seed multiplication, nucleus, breeders, foundation, certified, quality seed production technology of self and cross-pollinated crop varieties viz. oilseeds (groundnut, soybean, sesame, castor, sunflower, safflower, linseed, rapeseed and mustard), fibres (cotton, jute) and forages (guar, forage sorghum, teosinte, oats, berseem, lucerne)., seed certification procedures, seed laws and 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; 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.

Suggested Readings:

1. Agarwal RL. 1997. Seed Technology. 2nd Ed. Oxford & IBH.

2. Chhabra AK. 2006. Practical Manual of Floral Biology of Crop Plants. Department of Plant Breeding. CCS HAU Hisar.
3. Kelly AF. 1988. Seed Production of Agricultural Crops. Longman.
4. McDonald MB Jr & Copeland LO. 1997. Seed Production: Principles and Practices. Chapman & Hall.
5. Musil AF. 1967. Identification of Crop and Weed Seeds. Handbook No. 219, USDA, Washington, DC.
6. Poehlman JM & Borthakur D. 1969. Breeding Asian Field Crops. Oxford & IBH.
7. Singh BD. 2005. Plant Breeding: Principles and Methods. Kalyani.
8. Thompson JR. 1979. An Introduction to Seed Technology. Leonard Hill.
9. Tunwar NS & Singh SV. 1985. Handbook of Cultivars. ICAR.

Paper Code	Course Title	L	T	P	Cr
AGS529	Data base management, evaluation and utilization of PGR	2	0	2	3

Objective: To teach students about germplasm database management using various statistical software and utilization of germplasm collection.

Theory

UNIT I

Statistical techniques in management of germplasm, core identification, estimation of sample size during plant explorations, impact of sampling on population structure, sequential sampling for viability estimation, introduction of binomial, normal and negative cumulative normal, use of probit scales, viability equations and numograms, estimation of sample size for storage and viability testing.

UNIT II

Germplasm documentation, basics of computer and operating systems, database management system, use of statistical softwares, pictorial and graphical representation of data, introduction to communication network.

UNIT III

Germplasm management system- global scenario, genetic variation in crop plants and management of germplasm collection, limitations in use of germplasm collections, necessity of germplasm evaluation, predictive methods for identification of useful germplasm, characterization of germplasm and evaluation procedures including specific traits, gene markers and their use in PGR management.

UNIT IV

Management and utilization of germplasm collections, concept of core collection, molecular markers and their use in characterization, evaluation and utilization of genetic resources, pre-breeding/ genetic enhancement, utilizing wild species for crop improvement, harmonizing Agro biodiversity and Agricultural development crop diversification participatory plant breeding.

Practical: Basics of computer and operating systems; identification of useful germplasm, evaluation of crop germplasm; statistical techniques in management of germplasm, estimation of sample size for storage and viability testing; evaluation procedure and experimental protocols (designs and their analysis), assessment of genetic diversity; techniques of characterization of germplasm; molecular markers and their use in characterization.

Suggested Readings

1. Painting KA, Perry MC, Denning RA &Ayad WG. 1993. Guide Book for Genetic Resources Documentation. IPGRI, Rome, Italy.

2. Puzone L & Th. Hazekamp 1996. Characterization and Documentation of Genetic Resources Utilizing Multimedia Database. NBPGR, New Delhi.
3. Rana RS, Sapra RL, Agrawal RC & Gambhir R. 1991. Plant Genetic Resources, Documentation and Information Management. NBPGR, New Delhi.

Paper Code	Course Title	L	T	P	Cr
AGS501	Library and Information services	0	1	2	1

Objective: This course is intended to equip students with skills to use different e-resources to get information.

Practical

UNIT I

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library;

UNIT II

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.);

UNIT III

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;

UNIT IV

Use of Internet including search engines and its resources; e-resources access methods.

Suggested Readings:

1. Wu Diana Yuhfen and Liu Mengxiong. 2001. Academic librarianship: changing roles in the digital age. Available at http//www.sssu.edu/ridwu/academic librarianship P&F. Accessed March 10, 2008
2. Library.2004. Encyclopedia Britannica premium service http//www.britannica.com/eb/ article eu=09616. Accessed March 10, 2008
3. Young, P.V. (1984). Scientific social survey and research. Rev. 4th Ed. Prentice Hall, New Delhi.
4. https://guides.library.manoa.hawaii.edu/PlantPath/Books
5. https://unl.libguides.com/c.php?g=51695&p=334113
6. https://libraries.unl.edu/citation-tools

Paper Code	Course Title	L	T	P	Cr
AGS503	Intellectual Property and its management in Agriculture	1	0	0	1

Objective: To impart knowledge about IPRs and issues related to IPRs.

Theory

UNIT I

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;

UNIT II

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 bio-diversity protection;

UNIT III

Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity;

UNIT IV

International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer Agreements, Research collaboration Agreement, License Agreement.

Suggested Readings:

1. Erbisch FH & Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.
2. Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw Hill.
3. Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC & Aesthetic Technologies.
4. Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.
5. Rothschild M & Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.
6. Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House.
7. 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; National Biological Diversity Act, 2003.

Paper Code	Course Title	L	T	P	Cr
AGS504	Basic concepts in laboratory techniques	0	0	2	1

Objective: To provide practical skill to the students to handle and use various laboratory instruments.

Practical

UNIT I

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; washing, drying and sterilization of glassware;

UNIT II

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;

UNIT III

Preparation of solutions of acids; Neutralisation of acid and bases; preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sand bath, water bath, oil bath; Electric wiring and earthing.

UNIT IV

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

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

Paper Code	Course Title	L	T	P	Cr
AGS505	Agricultural Research, ethics and rural developmental programmes	1	0	0	1

Objective: To acquaint students about Agriculture Research Systems globally, research ethics and about various rural development programmes.

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; Consultative Group on International Agricultural Research (CGIAR):

UNIT II

International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global Agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility. Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

UNIT III

Concept and connotations of rural development, rural development policies and strategies. Rural development programs: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP),

UNIT IV

Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/Non-Governmental Organisations. Critical evaluation of rural development policies and programs. Constraints in implementation of rural policies and programs.

Suggested Readings:

1. Bhalla GS & Singh G. 2001. Indian Agriculture - Four Decades of Development. Sage Publ.
2. Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.
3. Rao BSV. 2007. Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives. Mittal Publ.
4. Singh K. 1998. Rural Development - Principles, Policies and Management. Sage Publ.

Paper Code	Course Title	L	T	P	Cr
ENG551	Technical Writing and Communication skills	0	1	2	1

Objective: This course is intended to help students in enhancing their technical writing and communication skills.

Practical

UNIT I

Technical Writing - 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);

UNIT II

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;

UNIT III

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;

UNIT IV

Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers.

Suggested Readings:

1. Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.
2. Collins' Cobuild English Dictionary. 1995. Harper Collins.
3. Gordon HM & Walter JA. 1970. Technical Writing. 3rd Ed. Holt, Rinehart & Winston.
4. Gupta RH. 2010. Essentials of Communication. 7th Ed. Pragati Prakashan. Hornby AS. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press.
5. James HS. 1994. Handbook for Technical Writing. NTC Business Books.
6. Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.
7. Mohan K. 2005. Speaking English Effectively. MacMillan India.
8. Richard WS. 1969. Technical Writing. Barnes & Noble.
9. Robert C. (Ed.). 2005. Spoken English: Flourish Your Language. Abhishek.
10. Sethi J & Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India

Paper Code	Course Title	L	T	P	Cr
CSA559	Computer Fundamentals and Programming	2	0	2	3

Objective: To impart knowledge of computers and to develop skills to operate computers, different operating systems.

Theory

UNIT I

Computer Fundamentals - Number systems: decimal, octal, binary and hexadecimal; Representation of integers, fixed and floating point numbers, character representation; ASCII, EBCDIC.

UNIT II

Functional units of computer, I/O devices, primary and secondary memories. Programming Fundamentals with C - Algorithm, techniques of problem solving, flowcharting, stepwise refinement; Representation of integer, character, real, data types; Constants and variables; Arithmetic expressions, assignment statement, logical expression.

UNIT III

Sequencing, alteration and iteration; Arrays, string processing. Sub-programs, recursion, pointers and files.

UNIT IV

Program correctness; Debugging and testing of programs. Practical Conversion of different number types; Creation of flow chart, conversion of algorithm/flowchart to program; Mathematical operators, operator precedence; Sequence, control and iteration; Arrays and string processing; Pointers and File processing.

Practical

Introduction to computer parts, Input output devices, learning various operators, learning Microsoft office.

Suggested reading:

1. Goel, A. (2010). Computer fundamentals, Pearson publishers.
2. Wempen, F. (2015) Computing Fundamentals: Introduction to Computers. John Willey & Sons Inc.

Paper Code	Course Title	L	T	P	Cr
EVS 658	Disaster Management	1	0	0	1

Objective: To impart knowledge about various calamities and their management at national and international level and role of different organizations in disaster management.

Theory

UNIT I

Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion.

UNIT II

Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.

UNIT III

Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs,

UNIT IV

Community-based organizations, and media. Central, State, District and local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.

Suggested Readings:

1. Gupta, H.K., 2003. Disaster Management. Indian National Science Academy. Orient Blackswan. Hodgkinson, P.E. & Stewart, M., 1991. Coping with Catastrophe: A Handbook of Disaster Management. Routledge.
2. Sharma, V.K., 2001. Disaster Management. National Centre for Disaster Management, India.

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Paper Code	Course Title	L	T	P	Cr
MTH670	**Statistical methods for applied sciences**	3	0	2	4

Objective:

It would also help them in understanding the concepts involved in data presentation, analysis and interpretation. The students would get an exposure to presentation of data, probability distributions, parameter estimation, tests of significance, regression and multivariate analytical techniques.

Theory:

UNIT I

Classification, tabulation and graphical, representation of data. Box-plot, Descriptive statistics. Exploratory data analysis;

UNIT II

Measures of central tendancy- Mean, Median, Mode, Geometric mean, Harmonic mean. Measures of Dispersion- Range, Quartile deviation, Mean deviation, Standard deviation.

UNIT III

Theory of probability. Random variable and mathematical expectation. Discrete and continuous probability distributions. Correlation and regression

UNIT IV

Binomial, Poisson, Negative Binomial, Normal distribution, Beta and Gamma distributions and their applications. Concept of sampling distribution: chi-square, t and F distributions. Tests of significance based on Normal, chi-square, t and F distributions.

Practical

Exploratory data analysis, Box-Cox plots; Fitting of distributions~ Binomial, Poisson, Negative Binomial, Normal; Large sample tests, testing of hypothesis based on exact sampling distributions-chi square, t and F; Confidence interval estimation and point estimation of parameters of binomial, Poisson and Normal distribution; Correlation and regression analysis, fitting of orthogonal polynomial regression; applications of dimensionality reduction and discriminant function analysis; Nonparametric tests.

Suggested Readings

1. Anderson TW. 1958. An Introduction to Multivariate Statistical Analysis. John Wiley.
2. Goon AM, Gupta MK & Dasgupta B. 1977. An Outline of Statistical Theory. Vol. I
3. Goon AM, Gupta MK & Dasgupta B. 1983. Fundamentals of Statistics. Vol. I.
4. Hoel PG. 1971. Introduction to Mathematical Statistics. John Wiley.
5. Aggrawal, S. C. and Rana, R. K., 2007. Basis Statistics. VK publication.
6. Singh, S., Singh, T.P., Babsal, M.L. and Kumar R. 2004. Statistical Method for Research workers. Kalyani Publishers, Ludhiana.