Department of Agricultural Botany
Mahatma Phule Krishi Vidyapeeth, Rahuri
Tal. Rahuri 413 722, Dist. Ahmednagar (MS)

Master's Programme
in
Genetics and Plant Breeding

Course Layout

Minimum Credit Requirements

Sr. No.	Subject	Minimum credit(s)
1.	Major	20
2.	Minor	09
3.	Supporting	05
4.	Seminar	01
5.	Research	20
	Total Credits	**55**
	Compulsory Non Credit Courses	06

Sr. No.	Course Number	Course Title	Credits
A) Major subjects (Min. 20 credits)			
1.	GP-501*	Principles of Genetics	2+1=3
2.	GP-502*	Principles of Cytogenetics	2+1=3
3.	GP-503*	Principles of Plant Breeding	2+1=3
4.	GP-504*	Principles of Quantitative Genetics	2+1=3
5.	GP-508*	Cell Biology and Molecular Genetics	2+1=3
6.	GP-510*	Breeding for Biotic and Abiotic Stress Resistance	2+1=3
7.	GP-515	Maintenance Breeding, Concepts of Variety Release and Seed Production.	1+1=2
B) Minor Subjects (Min. 9 credits)			
1	BIOCHEM-501	Basic Biochemistry	2+1=3
2.	MBB-501	Principles of Biotechnology	2+1=3
3.	MBB-504	Plant Tissue culture and genetic transformation	1+2=3

C) Supporting Subjects (Min. 5 credits)			
1.	STAT-511	Statistical Methods for Applied Sciences	2+1=3
2.	STAT-506	Design of Experiment for Genetics and Plant Breeding	2+1=3
D) Seminar (1 credit)			
1.	GP-591	Master Seminar	0+1=2
E) Master's Research (20 credits)			
1.		Master's Research	0+20=20
F) Non Credit Compulsory Courses			
1.	PGS-501	Library and Information Services	0+1=1
2.	PGS-504	Basic concepts in Laboratory techniques	0+1=1
3.	PGS-502	Technical Writing and Communication Skill	0+1=1
4.	PGS-503	Intellectual Property and Its Management in Agriculture	1+0=1
5.	PGS-505	Agriculture Research Ethics and Rural Development Programmes	1+0=1
6.	PGS-506	Disaster Management	1+0=1

**** Compulsory course**

Course Contents

A)Major Subjects:

Syllabus of Theory and practical with suggested Readings/Books

Course No. : GP-501- PRINCIPLES OF GENETICS. Credits : 2+1=3

Theory

Lecture No.	Topic to be Covered
1	**Introduction to Genetics**: Important concepts of genetics, important landmarks of genetics
2- 4	**Cell :** Cell structure, cell division, importance. **Inheritance:** Early concepts of inheritance, Mendels Work, Laws of inheritance and papers of Mendel, Chromosomal theory of inheritance. Extra chromosomal inheritance
5-6	Multiple alleles, gene interactions, sex determination, sex differentiation and sex linkage. Sex influenced and sex limited traits.
7-8	**Linkage:** Detection of linkage, estimation; recombination and genetic mapping of eukaryotes, Somatic cell genetics
9-10	**Population:** Concept of population. Mendelian population, Random mating population. Frequencies of genes and genotypes. Causes of changes in gene frequency. Hardy – Weinberg equilibrium
11-12	**Chromosomal Abberations:** Structural and numerical changes in chromosomes.
13-14	**Genetic Material:** Nature of genetic material, Structure and replication of the genetic material. Organization of DNA in chromosomes. Genetic code, properties of genetic code, Protein biosynthesis
15-16	Fine structure of gene, analysis, allelic complementation, split genes. Transposable genetic elements, overlapping genes, pseudogenes, oncogenes, gene families and clusters.

17-18	Gene regulation in prokaryotes, **Mutation:** Molecular mechanism of mutation, repair and suppression
19-20	**Plasmids:** Bacterial plasmids, insertion (IS) and transposable (Tn) elements. Molecular chaperons and gene expression. Gene regulation in eukaryotes,
21-24	Gene isolation, synthesis and cloning, genomic and cDNA libraries, PCR based cloning, positional cloning
25-27	Nucleic acid hybridization and immunochemical detection; DNA sequencing; DNA restriction and modification, Anti-sense RNA and ribozymes; Micro RNAs (miRNAs)
28-29	**Genomics & Proteomics:** Introduction to genomics and proteomics; functional and pharmacogenomics;mutagenomics
30	**Genetic Polymorphism :** Methods of studying polymorphism at biochemical and DNA level
31	**Transgenic :** Transgenic bacteria, biothics
32	**Gene Silencing Genetics of Mitochondria and chloroplast**

Suggested Readings :

1) Gardner E.J. & Snustad D.P. 1991 *Principles of Genetics*. John Wiley & Sons
2) Gupta P.K. 2002. *Genetics* Rastogi Publication.
3) Klug W.S. & Cummings M.R. 2003 *Concepts of Genetics*. Peterson Edu.
4) Lewin B. 2008. *Gene IX* Jones & Bartlett Publication.
5) Strickberger M.W. 2005 *Genetics* (III Ed) Prentice Hall, New Delhi, India

PRACTICAL :

Exercise No.	Title of the exercise
1	Estimation of probability and Chi- Square
2	Study of chromosomal mapping using three point test cross
3	Study of Tetrad Analysis
4-5	Study of induction and detection of mutation through genetic tests
6-7	Laboratory method of DNA Extraction
8-9	Study of PCR Amplification
10	Study of Extraction techniques of proteins
11	Study of extraction techniques of isozymes
12-13	Study of Gene Transfer: Agrobacterium mediated method
14-15	Study of Gene transfer: Direct Method
16	Visit to Biotechnology Laboratory for study of transgenic glasshouse.

Course No. : GP-502 - PRINCIPLES OF CYTOGENETICS . Credits : 2+1=3

Theory

Lecture No.	Topics to be covered
1	**Introduction to Cytogenetics**: Important concepts of cytogenetics, important landmarks of cytogenetics
2-3	**Chromosome:** Structure of Chromosomes in prokaryotes and eukaryotes, chromonemata, chromosome matrix, chromomere, centromere, secondary constriction and teleomere. Special types of chromosomes.
4-5	**Chromosomal theory of inheritance**

	Cell: Cell structure, Cell cycle, cell division, mitosis and meiosis; differences, significance and deviation. Synapsis, structure and functions of synaptonemal complex and spindle apparatus, anaphase movement of chromosomes.
6-7	**Crossing over**: mechanism of crossing over, mechanism and theories of crossing over, recombination models, cytological basis. Variation in chromosome structure. Evolutionary significance
8	**Karyotype:** Introduction to techniques of Karyotyping, Chromosome banding and painting, in situ hybridization and various application
9-11	**Chromosomal aberrations:** Structural and numerical variations of chromosomes and implication. Symbols and terminologies for chromosome number euploidy, haploids, diploids and polyploids. Utilization of aneuploids in gene location.
12-13	**Variation in chromosome behaviour:**, somatic segregation and chimeras, endomitosis and somatic reduction. Evolutionary significance of chromosomal aberrations, balanced lethals and chromosome complexes.
14-15	Inter-varietal chromosome substitutions **Polyploidy**: concept of polyploidy, role of polyploidy in crop breeding. Evolutionary advantages of auto polyploids and allopolyploids.
16-17	**Aneuploids:** Role of aneuploids in basic and applied aspects of crop breeding, maintenance and utilization in gene mapping.
18-19	**Alien Addition and Alien substitution lines**, creation and utlization.
20	**Apomixis** Evolutionary and genetic problems in crop with apomixes.
21-22	Reversion of autopolyploids to diploids. Genome mapping in polyploids. Interspecific hybridization and allopolyploids.
23-24	Synthesis of new crops viz., wheat, triticate and brassica.
25-27	**Distant Hybridization:** Hybrids between species with same chromosome number, alien translocations. Hybrids between species with different chromosome number. Gene transfer using amphidiploids in Bridge species.
28-29	Fertilization barriers in crop plants at pre and post fertilization levels In-vitro techniques to overcome the fertilization barriers in crops.
30-32	Chromosome manipulations in wide hybridization; production and use of haploids, dihaploids and doubled haploids in genetics and plant breeding.

Suggested Reading :

1. Becker K & Hardin 2004. The world of Cell. 5th Ed. Pearson Edu.
2. Carroll M. 1989 Organelles. The Guilford Press
3. Gupta P.K. Cytogenetics Rastogi Publication.
4. Strickberger M.W. 2005 *Genetics* (III Ed) Prentice Hall, New Delhi, India

PRACTICAL :

Exercise No.	Title of the exercise
1	Study of cytological techniques
2	Study of compound microscope
3-4	Preparation of specimen for observation.
5-6	Study of Mitosis in agricultural crops
7-8	Study of Meiosis in agricultural crops
9-10	Study of Micrometery and study of pollen grain size of different agricultural crops
11-12	Study of staining and preparations of permanent slides

13	Study of Polyploidy.
14-15	Study of induction of haploids (Anther culture & Ovule culture)
16	Study of somaclonal variation

Course No. : GP-503: PRINCIPLES OF PLANT BREEDING . Credit : 2+1=3

Theory

Lect. No.	Topics to be covered
1	**Plant Breeding**, Definition, Indian & world history of plant breeding (pre & Post Mendelian era)
2	**Aims, Objective and scope of plant breeding ,** Characteristics improved by plant breeding
3	**Pattern of evolution in crop plants –** center of origin, biodiversity and its significance
4	**Genetics Basis of Breeding** 1. **Mode of pollination –** Types, genetic consequences , difference in self and cross pollinated crops
5	2. **Mode of reproduction** – Asexual reproduction- types, vegetative reproduction, Apomixis, examples, Significance
6	**Nature of variability** – Types and components of variation
7	**Heritability-**Types , genetic advance and genotype environment instruction
8	**Combining ability** 1. Types – General combing ability, specific combining ability 2. Utilizations in crop improvement
9	Types of gene actions and implications in plant breeding
10	**Methods of plant breeding** – Introduction: defination n types, procedure merits and demerits, role of plant genetic resources in plant breeding
11	**Incompatibility** – definition, 1.Types incompatibility 2. Commercial exploitation 3. Mechanism, of incompatibility 4. Utilization in crop improvement
12	**Male sterility** – 1.Types of Male sterility 2. Commercial exploitation 3.Methods of transfer of male sterility, methods of transfer of restorer genes, 4. Utilization of male sterility in crop improvement achievements, limitations.
13	**Breeding Methods**- Selection: 1 Pure line theory (Johanssons) 2 Pure line selection 3 Mass Selection. Types, Procedure, Merits and demerits and achievements
14	**Pedigree method**- definition, Pedigree record, maintenance of pedigree record, procedure of pedigree methods, Applications, merits, demerits & achievements.
15	**Back cross method**- definition, procedure, Applications, merits, demerits, achievements
16	**Single seed descent method and multiline methods** definition, procedure, Applications, merits, demerits, achievements
17	**Population breeding** -Self pollinated crops, diallel selective mating approach
18	**Breeding methods in cross pollinated crops** -definition, procedure, Applications, merits, demerits, achievements

19	**Population Breeding** : 1.Mass selection and ear to row method , S1 and S2 progeny testing, progeny selection
20-21	**Population improvement programme –** Recurrent selection, schemes for intra and inter population improvement
22	**Synthetic Variety** – definition ,steps involved in developments of Synthetic merits, demerits, achievements
23	**Composite Variety** – definition ,steps involved in developments of composites merits, demerits, achievements
24-25	**Breeding methods in asexually propagated crops,** Clonal selection apomixis, clonal selection - definition ,steps involved in developments merits, demerits, achievements
26	**Self – incompatibility** – definition, types , mechanism, utilization in plant breeding and limitations
27	**Plant ideotypes** – Concepts of Plant ideotypes, role in crop improvement, transgressive breeding
28-29	**Special breeding techniques** – 1. Mutation breeding : definition, types , procedure of mutation breeding , application in crop improvement , achievements limitations
30	**Special breeding techniques-** 1. Biotic and abotic stresses
31	**Cultivar development** – testing, release and notification, Maintenance breeding
32	Plant Breeding , Plant Breeders rights, Regulation for plant variety protection and farmers rights

Suggested Reading :

1. Allard R.W.1981. Principles of plant Breeding. John Wiley & Sons
2. Chopra VL.2001 Breeding. Oxford & TBH.
3. Gupta S.K..2004. Practical Plant Breeding. Agribios.
4. Pohlman JM & Bothakur DN. 1972. Breeding Asian Field Crops. Oxford & IBH.
5. Singh P. 2006. Essentials of Plant Breeding. Kalyani Publication, New Delhi
6. Singh B.D. 2005 Plant Breeding : Principles and methods Kalyani Publication, New Delhi

PRACTICAL :

Exerc. No.	Title of the exercise
1.	Plant Breeder's Kit.
2	Botanical description and floral biology ; Floral morphology, Selfing emasculation and crossing techniques in Cotton.
3	Botanical description and floral biology ; Floral morphology, Selfing emasculation and crossing techniques in Sorghum
4	Botanical description and floral biology ; Floral morphology, Selfing emasculation and crossing techniques in Pigeonpea
5	Botanical description and floral biology ; Floral morphology, Selfing emasculation and crossing techniques in Sunflower
6	Botanical description and floral biology ; Floral morphology, Selfing emasculation and crossing techniques in Maize
7	Botanical description and floral biology ; Floral morphology, Selfing emasculation and crossing techniques in Chilli
8	Botanical description and floral biology ; Floral morphology, Selfing emasculation and crossing techniques in Okra

9	Selection methods in segregating populations
10	Evaluation of breeding material
11	Analysis of variance (ANOVA)
12	Estimation of heritability and genetics advance
13	Maintenance of experimental records
14	Techniques in hybrids seed production
15-16	Use of male – sterility in field crops

Course No. : GP -504 - PRINCIPLES OF QUANTITATIVE GENETICS
Credits : 2+1=3

Theory Teaching Schedule

Lecture No.	Topics to be covered
1 -2	Mendelian traits *vs* polygenic traits. Nature of quantitative traits and its Inheritance. Genetical foundation of quantitative traits.
3 -4	Multiple factor hypothesis. Analysis of continuous variation. Important features of multiple factor hypothesis
5 -6	Variations associated with polygenic traits. Phenotypic, genotypic & environmental, Non allelic interactions. Nature of gene action - additive, dominance,, epistatic and linkage effect
7 & 8	Principles of Analysis of Variance (ANOVA). Expected variance components, random and fixed models.;
9 -10	Biplot analysis. Comparison of means and variances for significance.
11	Designs for plant breeding experiments. Principles and applications.
12 - 13	Genetic diversity analysis Association analysis. Path analysis. Metroglyph, cluster and D^2 analysis phenotypic and genotypic correlations Parent-Progeny regression analysis.
14 -15	Discriminant function Selection indices. Principal component analysis selection of parents, Simultaneous selection models.
16	Heritability and genetic advance.
17	Generation mean analysis action 3, 5, and 6 parameter models, scaling tests.
18-22	Mating designs. Diallel, partial diallel, line x tester analysis, NCDs and TTC Concepts of combining ability and gene action .
23-27	Analysis of genotype x environment interaction. Adaptability and stability. Models for GxE analysis and stability parameters. Methods & features of stability models. AMMI analysis. Principles and interpretation.
28-29	QTL mapping. Strategies for QTL mapping - desired populations for QTL mapping.
30-32	Approaches to apply MAS in Plant breeding. Selection based on marker - simultaneous selection based on marker and phenotype - factors influencing MAS.

Suggested Reading :

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

7.Singh P & Narayanan SS. 1993. Biometrical Techniques in Plant Breeding. Kalyani.
8.Singh RK & Choudhary BD. 1987. Biometrical Methods in Quantitative Genetics. Kalyani.
9.Weir DS. 1990. Genetic Data Analysis. Methods for Discrete Population Genetic Data. Sinauer Associates.
10.Wricke G & Weber WE. 1986. Quantitative Genetics and Selection in Plant Breeding. Walter de Gruyter.
11. Elements of Biometrical Genetics : A.R. Dabholkar.

PRACTICAL :

Exercise No.	Title of the exercise
1 -2	Partitioning of variance. (ANOVA)
3	Estimation of heritability and genetic advance. Covariance analysis.
4-5	Models in stability analysis, AMMI & PCA model.
6	Metroglyph analysis :- D^2 analysis - Grouping of clusters and interpretation. Cluster analysis - Construction of cluster diagrams and dendrograms.
7 -8	Correlation and Path analysis.
9 - 10	Generation mean analysis :- Analytical part and Interpretation – Estimation of different types of gene actions.
11-13	Parent-progeny, Regression analysis.. Griffing's methods of Diallel analysis. Hayman's graphical approach. Interpretation of results. NCD and their interpretations, Line x tester analysis and interpretation of results.
14	Estimation of heterosis and inbreeding depression.
15	Quadriallel & Triple test cross (TTC) analysis
16	Construction of saturated linkage maps and QTL mapping.

Course No. : GP 508 CELL BIOLOGY AND MOLECULAR GENETICS
Credit : 2+1=3

Theory Teaching Schedule

Lecture No.	Topics to be covered
1	**Ultra structure of The Cell** **Types of Cell:** - Parenchyma cells, Collenchyma cells, Sclerenchyma cells
2	**Structure and function of cell wall**
3	**Tissue types:** - Xylem, Phloem
4-5	**Parts of Cells: -** Cell membrane, Cell wall, Nuclear membrane, Plasma membrane, Vacuole, Plastids, Chloroplast and other photosynthetic organelles, Leucoplast, Chromoplast, Golgi Complex, Lysosomes, Peroxisomes, Ribosome, Endoplasmic reticulum, Mitochondrion, Lysosome, Cytoplasm, Nucleus, DNA, Chromatin, RNA
6	**Eukaryotic Cells: -** Origin and evolution **Cell features:** Internal membrane , Mitochondria and plastids, Cytoskeletal structures , Plant cell wall
7	**Differences between eukaryotic and Prokaryotic cells:** - Animal cell, Plant cell, Fungal cell, Other eukaryotic cells
8	**Prokaryotic Cells:** - Evolution of prokaryotes, Relationship to eukaryotes, Difference between eukaryotic and prokaryotic cells

9	**Bioenergetics:-** Overview, Ultra structure and function of mitochondrial and biological membrane, Cell division and physiology of cell division, Photosynthetic membrane and Organelles
10	**Historical background of molecular genetics** **Mendelian inheritance and classical genetics**
11	**Structure and properties of nucleic acid**
12-13	**Physical definitions: -** RNA genes and genomes, Functional structure of a gene, Chromosomes
14	**Gene expression** : Genetic code, Transcription factors and their role , Translation, Regulation of protein synthesis in prokaryotes and eukaryotes, t-RNA and translational factors
15	**DNA replication and inheritance:** Molecular inheritance, Mutation
16	**Genome**: Chromosomal organization, Number of genes, Genetic and genomic nomenclature
17	**Transposable elements**: -Types of transposons, Retrotransposons,
18	**Retroviruses as transposable elements, DNA transposons**
19	**Examples of Transposable elements, Evolution of transposons, Applications of transposons**
20-21	**Mechanisms of recombination in prokaryote:** Chromosomal crossover, Gene Conversion, Non-homologous recombination
22-23	DNA organization in eukaryotic chromosomes – Chromosomes in eukaryotes, Chromatin- Interphase chromatin, Metaphase chromatin and division, DNA content variation
24	**Repeated sequence (DNA)** Tandem repeats: Satellite DNA, Minisatellite, Microsatellite Uses of repeated sequence
25-26	**Gene amplification and its significance: -** PCR principles and procedure, PCR stages, Application of PCR , Isolation of genomic DNA, Amplification and quantitation of DNA, PCR in diagnosis of diseases, Variations on the basic PCR technique
27	**Proteomics: -** Examples of post-translational modifications:- Phosphorylation, Ubiquitination, Additional modifications
28	**Methods of studying proteins:** - Determining proteins which are post-translationally modified, Determining the existence of proteins in complex mixtures
29	**Establishing protein-protein interactions** Practical applications of proteomics:- Biomarkers, Alzheimer's disease, Heart disease
30	**Protein databases** **Limitations to genomic study**
31	**Applications of proteomics**
32	**Singal transduction, Gene in development, Cancer and Cell aging**

Suggested Reading :

1.Bruce A.2004. Essential Cell Biology. Garland. Karp G.2004. Cell and Molecular Biology: Concepts and Experiments. John Wiley.

2.Klug WS & Cummings MR 2003. Concepts of Genetics. Scot, Foreman & Co.

3.Lewin B. 2008. IX Genes. John Wiley & Sons

4.Lodish H, Berk A & Zipursky SL. 2004. Molecular Cell Biology. 5th Ed. WH Freeman.

5.Nelson DL & Cox MM. 2005. Lehninger's Principles of Biochemistry. WH Freeman & Co.

6.Russell PJ. 1996. Essential Genetics. Blackwell Scientific Publ.
7.Schleif R.1986. Genetics and Molecular Biology. Addison-Wesley Publ. Co.

PRACTICAL :

Exercise No.	Title of the exercise
1	Safety Rules in the Laboratory
2	Morphological and Gram staining of natural bacteria
3	Cultivation of bacteria in synthetic medium
4	Determination of growth rate and doubling time of bacterial cells in culture
5	Demonstration of bacteriophage by plaque assay method
6	Determination of soluble protein content in a bacterial culture
7	Isolation, purification and raising clonal population of a bacterium
8	Biological assay of bacteriophage and determination of phage population in lysate
9	Study of lytic cycle of bacteriophage by one step growth experiment
10	Determination of latent period and burst size of phages per cell
11	DNA isolation from Plant, bacteria using CTAB method
12	DNA isolation from Plant DNA by using potassium acetate method
13	Gel electrophoresis technique
14-15	Quantitative estimation of DNA
16	RNA and protein in an organism

Course No. : GP-510 - BREEDING FOR BIOTIC AND ABIOTIC STRESS RESISTANCE. Credits : 2+1=3

Theory Teaching Schedule

Lecture No.	Topics to be covered
1.	Importance of plant breeding with special reference to biotic and abiotic stress resistance, classification of biotic stresses
2.	Major pests and diseases of economically important crops, concepts in insect and pathogen resistance
3.	Analysis and inheritance of resistance variation, Host defense responses to pathogen invasions,
4.	Biochemical and molecular host defense mechanisms
5.	Acquired and induced immunity and systemic acquired resistance (SAR), host pathogen interaction,
6.	Gene-for-gene hypothesis, molecular evidence for its operation and exceptions.
7.	Concept of signal transduction and other host defense mechanisms against viruses and bacteria
8.	Types and genetic mechanisms of resistance to biotic stresses-horizontal and vertical resistance in crop plants.
9.	Quantitative resistance / adult plant resistance and slow rusting resistance.
10-11	Classical and molecular breeding methods.
12	Measuring plant resistance using plant fitness, behavioural, physiological and insect gain studies.
13	Phenotypic screening methods for major pests and diseases.
14	Gene pyramiding methods and their implications.
15-16	Classification of abiotic stresses, stress inducing factors- moisture stress/drought and water logging and submergence.
17	Stress inducing factors-Acidity, salinity/sodicity

18	Stress inducing factors-high/low temperature, wind etc.
19	Stress due to soil factors and mineral toxicity, physiological and phonological responses.
20	Emphasis of abiotic stresses in developing breeding methodologies.
21	Genetics of abiotic stress resistance
22-23	Genes and genomics in breeding cultivars suitable to low water regimes and water logging and submergence.
24	Genes and genomics in breeding cultivars suitable to high and low/freezing temperatures.
25-26	Utilizing MAS procedures for identifying resistant types in important crops like rice, sorghum, wheat, cotton. Recording of observations, correlating the observations using marker data.
27	Breeding for resistance to stresses caused by toxicity, deficiency, and pollutants/contaminants in soil, water and environment.
28	Exploitation of wild relatives as a source of resistance to biotic and abiotic factors in major field crops.
29-30	Transgenics in management of biotic and abiotic stresses, use of toxins, protease inhibitors, lectins
31-32	Transgenic in management of biotic and abiotic stresses, use of chitnases and Bt for disease and insect pest management. Achievement.

Suggested Reading :

1. Agrios GN 2000. Principals of plant pathology. Academic press New York.
2. BlumA 1988. Plant breeding for stress environment. CRC press.Christiansen MN and Lewis CF 1982. Breeding plants for less favourable environments. Wiley International.
3. Chahal GS & Ghosal SS. 2002. Priciples and Procedures of plant breeding- Biotechnological and conventional Approaches. Narosa Pbl.
4. Fritz RS and Simms EL (Eds.). 1992. Plant resistance to herbivores and pathogens : Ecologigy, evolution, and genetics. The University of Chicago Press.
5. 5. Li PH and Sakai A 1987. Plant cold hardiness. Liss, New York.
6. Luginpill P. 1969. Developing resistant plant-The ideal method of controlling insects. USDA, ARS, Washington DC.
7. Maxwell FG and Jennings PR (Eds.). 1980. Breeding plant resistant to insects. John Wiley and Sons.
8. Painter RH. 1951. Insect resistance in crop plants. MacMillan, New Yark.
9. Russel GE. 1978. Plant breeding for pest and disease resistance. Butteworths.
10. Saki A and Larcher W. 1987. Forst survival in plants. Spinger Verlag.
11. Singh BD 2005. Plant Breeding : Principals and methods Kalyani Publications. New Delhi.
12. Turner NC and Kramer PJ. 1980. Adaptation to of plants to water and high temperature stress. John Wlliey Sons.
13. Van der Plank. 1982. Host-pathogen interactions in plant disease. Academic Press.

PRACTICAL :

Exercise No.	Title of the exercise
1-2	Phenotypic screening techniques for sucking and chewing pests and ways to combating them. Traits to be observed at plant and insect level.
3-4	Phenotypic screening techniques for nematodes and borers and ways to combating them.
5	Weeds, ecological and environmental impacts on the crops and breeding for herbicide resistance.
6-7	Evaluating the populations like RILs, NILs etc. for pest resistance.
8-9	Use of standard MAS procedures
10	Phenotypic screening methods for disease caused by fungi and bacteria, symptoms and data recording and use of MAS procedures.
11	Screening forage crops for resistance to sewage water and tannery effluents and quality parameters evaluation.
12	Screening of breeding material of different crops for drought and flood resistance, factors to be considered and breeding strategies.
13-14	Screening varieties of major crops for acidity and alkalinity-their effects and breeding strategies.
15-16	Understanding the climatological parameters and predisposal of biotic and abiotic stress factors and ways of combating them.

Course No. GP : 515 - MAINTENANCE BREEDING AND CONCEPTS OF VARIETY RELEASE AND SEED PRODUCTION. Credit : 1+1=2

Theory Teaching Schedule

Lecture No.	Topics to be covered
1-2	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.
3-4	DUS testing DUS Descriptors for major crops; Genetic purity concept and maintenance breeding.
5	Factors responsible for genetic deterioration of varieties Safeguards during seed production.
6-7	Maintenance of varieties Maintenance of varieties in self and cross-pollination crops, isolation distances in various crops
8	Principles of seed production Methods of nucleus and breeder seed production.
9	Generation system of seed multiplication Nucleus, breeders, foundation and certified seeds
10-13	Quality seed production technology 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); Oilseeds (groundnut, soybean, sesame, castor, sunflower, safflower, linseed, rapeseed and mustard); fibres (cotton, jute) and forages (guar, forage sorghum, teosinte, oat, berseem, lucerne).
14	Seed certification procedures The steps involved in seed certification, Seed certification Agencies
15-16	Seed laws and plant variety protection regulations in India and international systems What is seed law? What is PVP & FRA? The procedure

Suggested Reading :

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 Publications. New Delhi.
8. Thompson JR. 1979. An Introduction to Seed Technology. Leonard Hill.
9. Tunwar NS & Singh SV. 1985. Handbook of Cultivars. ICAR.

PRACTICAL :

Exercise No.	Title of the exercise
1	Identification of suitable areas/locations for seed production
2	Ear-to-row method
3-4	Nucleus seed production
5-6	Main characteristics of released and notified varieties, hybrids and parental lines
7-8	Identification of important weeds/objectionable weeds
9-10	Determination of isolation distance and planting ratios in different crops
11-13	Quality Seed production techniques in different field crops
14-16	Hybrid seed production technology of important crops e.g. Cotton, Sorghum, Bajra

A) Minor Subjects:

Course No. : BIOCHEM 501 BASIC BIOCHEMISTRY Credits 2+1=3

Theory

Lecture No.	Topics to be covered
1	Scope and importance of biochemistry in agriculture
2	Fundamental principles governing life
3	Structure of water, acid-base concept
4	Buffer and pH, hydrogen bonding, hydrophobic, electrostatic and van der Waals forces
5-6	Fundamentals of thermodynamic principles applicable to biological processes, bioenergetics
7	Classification, structure and functions of carbohydrates
8-9	Metabolism of carbohydrates
10	Electron transport chain and oxidative phosphorylation
11-12	Photosynthesis
13-14	Classification, structure and functions of lipids Metabolism of lipids
15-16	Classification, structure and functions of amino acids and proteins. Metabolism of proteins
17	Structure, biological functions and classification of vitamins

18	Enzyme classification, factors affecting on enzyme action
19-20	Mechanism of enzyme action
21	Regulation of enzyme activity
22-23	Hormones: animals, plants and insects
24	Structure and functions of nucleic acids
25-26	Metabolism of nucleic acids
27	DNA replication
28-29	DNA transcription
30-31	Translation
32	Recombinant DNA technology

Suggested Readings:

1.Conn EE & Stumpf PK. 1987. *Outlines of Biochemistry*. John Wiley.
2.Metzler DE. 2006. *Biochemistry*. Vols. I, II. Wiley International.
3.Nelson DL & Cox MM. 2004. *Lehninger Principles of Biochemistry*. 4th Ed. MacMillan.
4.Voet D, Voet JG & Pratt CW. 2007. *Fundamentals of Biochemistry*. JohnWiley.

PRACTICAL :

Exercise No.	Title of the exercise
1-2	Preparation of standard and buffer solutions
3	Estimation of reducing sugars by Nelson-somogyi method
4	Estimation of free amino acids by ninhydrin method
5-6	Estimation of protein by Lowry et al. (1951) method
7-9	Isolation of DNA and its quantification
10	Estimation of ascorbic acid
11-12	Isolation of RNA and its quantification
13-14	Separation of amino acid by TLC
15-16	Separation of amino acids by paper chromatography

Course No : MBB 501 - PRINCIPLES OF BIOTECHNOLOGY Credits : 2+1 =3

Theory

Lecture No.	Topics to be Covered
1-2	History, scope and importance;
	DNA structure, function and metabolism.
3-4	DNA modifying enzymes and vectors;
5-6	Methods of recombinant DNA technology;
7-8	Nucleic acid hybridization;
9-10	Gene libraries;
11-12	PCR amplification;
13-14	Plant and animal cell and tissue culture techniques and their applications.
15-17	Molecular markers and their applications;

18-19	DNA sequencing;
20-22	Applications of gene cloning in basic and applied research;
23-24	Genetic engineering and transgenics;
25-28	Genomics, transcriptomics and proteomics.
29	General application of biotechnology in Agriculture, Medicine, Animal husbandry, Environmental remediation, Energy production and Forensics
30	Public perception of biotechnology;
31	Bio-safety and bioethics issues;
32	Intellectual property rights in biotechnology.

Suggested Readings :

1.Becker JM, Coldwell GA & Zachgo EA. 2007. *Biotechnology – a Laboratory Course*. Academic Press.

2.Brown CM, Campbell I & Priest FG. 2005. *Introduction to Biotechnology*. Panima Pub.

3.Brown TA. *Gene Cloning and DNA Analysis*. 5th Ed. Blackwell Publishing.

4.Dale JW & von Schantz M. 2002. *From Genes to Genomes: Concepts and Applications of DNA Technology*. John Wiley & Sons.

5.Gupta PK. 2004. *Biotechnology and Genomics*. Rastogi Publications.

6. Sambrook J, Fritsch T & Maniatis T. 2001. *Molecular Cloning – a Laboratory Manual*. 2nd Ed. Cold Spring Harbour Laboratory Press.

7. Singh BD. 2007. *Biotechnology Expanding Horiozon*. Kalyani Publishers.

PRACTICAL :

Exercise No.	Title of the exercise
1-2	Isolation of genomic and plasmid DNA
3	Gel electrophoresis techniques
4-8	Restriction enzyme digestion, ligation, transformation and screening- of transformants
9-12	PCR and molecular marker analysis
13-16	Plant tissue culture: media preparation, cell and explants culture, regeneration and transformation.

Course No. : MBB 504 PLANT TISSUE CULTURE AND GENETIC TRANSFORMATION Credits : 1+2 =3

Theory

Lecture No.	Topics to be Covered
1	History of Plant cell & Tissue Culture
2	Culture media, Various types of culture, callus, suspension, nurse, root meristem etc.
3	*In vitro* differentiation: Organogenesis & somatic embryogenesis,.
4	Plant – growth regulators: Mode of action, effects on *In vitro* culture & regeneration

5	Molecular basis of plant organ differentiation.
6	Micropropogation, Anther and Microspore culture
7	Somaclonal variation, *In vitro* mutagenesis, *in vitro* fertilization
8	*In vitro* germplsam conservation, production of secondary metabolites synthetic seeds.
9	Embryo rescue & wide hybridization.
10	Protoplast culture & regeneration
11	Somatic hybridization; protoplast fusion; cybrids, asymmetric hybids etc.
12-13	Methods of plant transformation
14-15	Vectors for Plant transformation, Genetic & Molecular analysis of transgenics.
16	Target trait & transgenic crops.
17	Biosafety Issues, testing of transgenics, regulatory procedures for commercial approval.

Suggested Readings :

1.Bhojwani SS. 1983. Plant Tissue Culture: Theory and Practice. Elsevier.
2. Christou P & Klee H. 2004. Handbook of Plant Biotechnology. John Wiley & Sons.
3. Dixon RA. 2003. Plant Cell Culture. IRL Press.
4. George EF, Hall MA & De Klerk GJ. 2008. Plant Propagation by Tissue Culture. Agritech
5. Gupta PK. 2004. Biotechnology and Genomics. Rastogi Publ.
6. Herman EB. 2005-08. Media and Techniques for Growth, Regeneration and Storage.
7. Pena L. 2004. Transgenic Plants: Methods and Protocols. Humana Press.
8.Pierik RLM. 1997. In vitro Culture of Higher Plants. Kluwer.
9. Singh BD. 2007. Biotechnology: Expanding Horiozon. Kalyani

PRACTICAL :

Exercise No.	Title of the exercise
1-2	Laboratory set up
3-7	Preparation of nutrient media, handling & sterilization of plant material, inoculation sub culturing & plant regeneration.
8-10	Anther & pollen culture
11-13	Embryo rescue
14-16	Suspension culture & production of secondary metabolites
17-21	Protoplast isolation, culture & fusion
22-26	Gene cloning & vector construction
27-32	Gene transfer using different methods, reporter gene expression, selection of transformed tissues /plant – molecular analysis.

B) Supporting Subjects:

Course No.: STAT-506 - DESIGN OF EXPERIMENT FOR GENETICS AND PLANT BREEDING. Credits : 2 +1=3

Theory

Lecture No.	Topics to be covered
1-3	Definition , Basic principle of Design and field experimentation Concept of Analysis of variance
4-6	Practical consideration of one way and two way classification for field experiments
7-8	Completely Randomized Design, models for analysis, method randomization of treatment and analysis, its merits, demerits for and applications
9-10	Randomized Block Design, Method of layout and randomization of treatments, model and analysis of experiments, its merits demerits and applications
11	Latin Square Design, model ,randomization of treatments analysis its merits, demerits and applications and
12-13	Factorial concept : Definition of main and interaction effects
14-15	Symmetric factorial 2^2 , 2^3 , --- , 2^n factorial experiments, general method of analysis
16-17	Yates method of analysis in factorial experiments.
18	Asymmetric Factorial experiments, method of analysis
19	Factorial experiments with additional treatments
20	Concept of orthogonal comparison and its application
21-22	Analysis of covariance technique (RBD)
23-24	Concept of BIBD
25-26	Analysis of Simple Lattice
27-29	Augmented designs (Plan, layout, analysis)
30-32	Replicated Progeny Row and Compact Family design

Suggested Readings:

i. Panse, V.G. and Sukhatme, P.V. 1978. Statistical Methods for Agricultural Workers. III Edition, I.C.A.R, New Delhi.

ii. Cochran, W.G. and Cox. G.M. 1957. Experimental Designs. II Edition, John Wiley & Sons, Inc. New York.

iii. Snedecor, G.W. and Cochran, W.G. 1967. Statistical Methods. VI Edition, Oxford & IBH Publishing Company, Bombay.]

iv. Gomez, K.A. and Gomez, A.A. 1984. Statistical procedures for Agricultural Research - II Edition, John Wiley & Sons, New York (International Rice Research institute, Phillipines).

v. Nigam, A.K. and Gupta, V.K. 1979. Handbook on Analysis of Agricultural Experiments, I Edition, Indian Agril. Statistics Research Institute, New Delhi.

vi. Das, M.N. and Giri, N.C. 1986. Design & Analysis of Experiments. II Edition, Wiley Reastern Ltd., New Delhi.

vii. Kempthorne, Oskar. 1952. The Design and Analysis of Experiments I Edition, John Wiley & Sons Inc., London.

PRACTICAL :

Exercise No.	Title of the exercise
1	CRD with unequal analysis
2	RBD
3	LSD
4	Analysis of Covariance in RBD
5	2^2 (Two way table)
6	2^3 (Two way table)
7	2^2 (Yates method)
8	2^3 (Yates method)
9	Asymmetrical factorial experiment (Two factor)
11-12	Lattice design
13-14	Augmented design
15	Replicated progeny row trial
16	Compact family block design

Course No. : STAT-511 -STATISTICAL METHODS FOR APPLIED SCIENCES
Credits : 2+1

Theory

Lecture No.	Topics to be covered
1-2	The role of Statistics in agricultural research, some basic concepts.
3	Limitations
4-5	Measures of central tendency and dispersions
6-7	Correlation : partial and multiple correlation.
8	Rank correlation coefficient.
9-10	Regression : Linear and multiple.
11	Determination and testing of multiple regression coefficient.
12	Stepwise regression
13	Non linear regression equations (quadratic, exponential, power).
14	Path analysis
15	Theory of Probability : Random experiment, trial, event, equally likely cases, Exhaustive cases, Mathematical Expectation
16-17	Definition of classical, empirical and axiomatic probability : additive and multiplicative law of probability. Random variable, mathematical expectation
18	Discrete and continuous probability distribution.
19	Binomial – Probability law, parameter, mean, variance, properties and applications.
20	Poisson distribution : mean, variance, properties, uses.
21	Normal distribution : Normal probability law, area of probability / ordinate probability, standard normal distribution
22	Sampling distribution : concept of parameter. .
23	Estimation of parameter, statistic, sample, population , S.E.
24-25	Sampling and non-sampling errors, level of significance, Type I and II error, one and two tailed

26	Z – test : One and two sample for population
27	t – test : One sample, paired and independent test, testing of significance of correlation coefficient
28	F – test : Properties and application, testing of two variance
29-30	Chi – square test: Properties, application and limitation testing of goodness of fit, 2 x 2, m x n contingency table
31	Non parametric test: Run test, Sign test
32	Median test, Mann Whitney U test.

Suggested Readings:

1. Snedecor G.W. and Cochran, W.G. 1967. Statistical Methods. Sixth Edition, Oxford & IBH Pub. Co., Bombay.
2. Ostle B , (1967) Statistics in Research Oxford & IBH Pub. Co., Bombay.
3. Steel, Robert G.D. and Torrie James H. 1971. Principles and Procedures of Statistics. Biometrical Approach, McGraw Hill International Book Company, New York
4. Gupta S. C., Kapoor, V.K. 1991. Fundamental of Mathematical Statistics. Sultan Chand and Sons Pub., New Delhi.

PRACTICAL :

Exercise No.	Title of the exercise
1	Measures of central Tendency and dispersion.
2-3	Karl Pearson Correlation coefficient, Rank Correlation coefficient.
4-5	Partial and multiple correlation.
6	Linear regression (a, b, r, Tests of significance).
7-8	Multiple Linear regression of Y on X_1, X_2, R^2 and Tests of significance.
9-10	Non-linear regression, Fitting of quadratic, exponential and power functions
11	Path analysis.
12	Fitting of Binomial distribution.
13	Fitting of Poisson distribution.
14	Fitting of Normal distribution.
15	Sign and run test.
16	Median test. Mann Whitney U test.

D)Seminar

E)Doctoral Research

F) Compulsory Non Credit Courses

Course No. : PGS 501 -LIBRARY AND INFORMATION SERVICES
Credits : 0+1=1

PRACTICAL :

Exercise No.	Title of the exercise
1-2	Introduction to library and its services; types of library.
3	Role of libraries in education, research and technology transfer;
4	Classification systems and organization of library;
5-6	Sources of information- Primary sources, secondary sources and tertiary sources;
7-9	Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABs reference sources;
10	Literature survey;
11	Citation techniques/Preparation of bibliography;
12	Use of CD-ROM Databases,
13	Online Public Access Catalogue and other computerized library services;
14-15	Use of Internet including search engines and its resources;
16	e-resources access methods.

Course No. : PGS 502 - TECHNICAL WRITING AND COMMUNICATIONS SKILLS Credits : 0+1=1

PRACTICAL :

Exercise No.	Title of the exercise
1	Various forms of scientific writings- theses, technical papers, reviews, manuals, etc;
2	Various parts of thesis and research communications (title page, authorship, contents page, preface, introduction, review of literature, material and methods, experimental results and discussion);
3	Writing of abstracts, summaries, précis, citations etc.;
4	Commonly used abbreviations in the theses and research communications;
5	Illustrations, photographs and drawings with suitable captions;
6	Pagination, numbering of tables and illustrations;
7	Writing of numbers and dates in scientific write-ups;
8	Editing and proof-reading;
9	Writing of a review article.
10-11	Grammar (Tenses, parts of speech, clauses, punctuation marks);
12	Error analysis (Common errors);
13	Concord; Collocation; Phonetic symbols and transcription; Accentual pattern:
14	Weak forms in connected speech:
15	Participation in group discussion: Facing an interview;
16	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. Hornby AS. 2000. *Comp. Oxford Advanced Learner's Dictionary of CurrentEnglish*. 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.
11. Wren PC & Martin H. 2006. *High School English Grammar and Composition*. S. Chand & Co.

Course No. : PGS 503 INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE Credits : 1+0=1

Theory

Lecture No.	Topics to be covered
1-2	Historical perspectives and need for the introduction of Intellectual Property Right regime
3-4	TRIPs and various provisions in TRIPS Agreement
5	Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs
6	Indian Legislations for the protection of various types of Intellectual Properties
7-9	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
10-11	Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection
12	National biodiversity protection initiatives
13	Convention on biological diversity
14-15	International Treaty on Plant Genetic Resources for Food and Agriculture
16	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. Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V.
4. Technology Generation and IPR Issues. Academic Foundation. Rothschild M & Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.
5. Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House.
6. 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.

Course No. : PGS 504 -BASIC CONCEPTS IN LABORATORY TECHNIQUES
Credits : 0+1=1
PRACTICAL :

Exerc. No.	Title of the exercise
1	Safety measures while in Lab;
2	Handling of chemical substances;
3	Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets;
4	washing, drying and sterilization of glassware;
5	Drying of solvents/chemicals.
6	Weighing and preparation of solutions of different strengths and their dilution;
7	Handling techniques of solutions;
8	Preparation of different agro-chemical doses in field and pot applications;
9	Preparation of solutions of acids;
10	Neutralization of acid and bases;
11	Preparation of buffers of different strengths and pH values.
12	Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath;
13	Electric wiring and earthlings.
14	Preparation of media and methods of sterilization;
15	Seed viability testing, testing of pollen viability;
16	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.

Course No. : PGS 505 -AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES. Credits : 1+0=1

Theory

Lecture No.	Topics to be covered
1	History of agriculture in brief;
2	Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment;
3	National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions;
4	Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS,
5	role as a partner in the global agricultural research system, strengthening capacities at national and regional levels;
6	International fellowships for scientific mobility.
7	Research ethics: research integrity, research safety in laboratories,
8	Welfare of animals used in research,
9	Computer ethics,
10	Standards and problems in research ethics.

11	Concept and connotations of rural development,
12-13	rural development policies and strategies.
14	Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP), Panchayati Raj Institutions, Co-operatives, and Voluntary Agencies/Non R Governmental Organizations.
15	Critical evaluation of rural development policies and programmes.
16	Constraints in implementation of rural policies and programmes.

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.

Course No. : PGS 506- DISASTER MANAGEMENT. Credits : 1+0=1

Theory

Lecture No.	Topics to be covered
1-3	To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards and risks vulnerability; and capacity building.
4-5	Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold waves
6-7	Climatic Change: Global warming, Sea level rise, Ozone depletion
8-10	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
11-12	Disaster Management- Efforts to mitigate natural disasters at national and global levels.
13-14	International Strategy for Disaster reduction.
15-16	Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, 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 HK. 2003. Disaster Management. Indian National Science Academy. Orient Blackswan.
2. Hodgkinson PE & Stewart M. 1991. Coping with Catastrophe: A Handbook of Disaster Management. Routledge.
3. Sharma VK. 2001. Disaster Management. National Centre for Disaster Management, India.