

Name of the Programme M.Sc. (Horticulture) Fruit Science

Courses offer in Master Degree programme

Group	Number	Title of Course	Credit	
<b>Major</b>	1.	FSC 501	Tropical and dry land fruit production	3 (2+1)
	2.	FSC 502	Sub tropical and temperate fruit production	3 (2+1)
	3.	FSC 504	Canopy management in fruit crops	2 (1+1)
		FSC 513	Climate Management in Horticultural crops	1(1+0)
	4.	FSC 503	Biodiversity and Conservation of fruit crops	3 (2+1)
	5.	FSC 505	Propagation and nursery management for fruit crops	3 (2+1)
	6.	FSC 506	Breeding of fruit crops	3 (2+1)
	7.	FSC 510	Organic Horticulture	2 (1+1)
	<b>Total</b>		<b>20 (13+7)</b>	
<b>Seminar</b>	1	FSC 591	Credit Seminar	<b>1(0+1)</b>
<b>Thesis research</b>	1	FSC 599	Research	<b>20(0+20)</b>
<b>Minor</b>	1.	PL.PATH 511	Chemicals in plant disease management	3(2+1)
	2.	GP 503	Principle of Plant Breeding	3(2+1)
	3.	PP 504	Hormonal regulation of plant growth and development	3(2+1)
	<b>Total</b>		<b>9 (7+3)</b>	
<b>Supporting</b>	1.	STAT 511	Statistical Methods for Applied Sciences	4 (3+1)
	2.	STAT 512	Experimental Designs	3 (2+1)
	<b>Total</b>		<b>7(5+2)</b>	
<b>Non-Credit Compulsory Course</b>	1.	PGS 501	Library and Information Services	1(0+1)
	2.	PGS 502	Technical Writing and Communications Skills	1(0+1)
	3.	PGS 503	Intellectual Property and its Management in Agriculture	1(1+0)
	4.	PGS 504	Basic Concepts in Laboratory Techniques	1(0+1)
	5.	PGS 505	Agril Res. Ethics and Rural Dev. Programs	1(1+0)
	6.	PGS 506	Disaster Management	1(1+0)
	7.		Human value and Professional Ethics	2(1+1)
	<b>Total</b>		<b>8(4+4)</b>	
<b>Grand total</b>			<b>65( 29+36)</b>	

Name of the Programme M.Sc. (Horticulture) Fruit Science

Semester wise distribution of courses

Course	Course Title	Code	Credits
<b>Semester-I</b>			
<b>Major</b>	Tropical and dry land fruit production	FSC - 501	3 (2+1)
	Sub tropical and Temperate fruit production	FSC - 502	3 (2+1)
	Canopy management in fruit crops	FSC – 504	2 (1+1)
	Climate Management in Horticultural Crops	FSC - 513	1(1+0)
<b>Minor</b>	Principles of Plant Breeding	GP-503	4 (3+1)
	Chemicals in plant disease management	PL.PATH	3(2+1)
<b>Supporting</b>	Statistical Methods for Applied Science	STAT 511	4 (3+1)
<b>Compulsory NC</b>	Library and information services	PGS - 501	1 (0+1)
	Basic concepts in laboratory techniques	PGS – 504	1 (0+1)
	IPR & Its management in Agriculture	PGS – 503	1(1+0)
	Human Value & Professional Ethics	HVE	2(1+1)
<b>Semester-II</b>			
<b>Major</b>	Biodiversity and Conservation of fruit crops	FSC – 503	3 (2+1)
	Propagation and nursery management for fruit crops	FSC – 505	3 (2+1)
	Breeding of fruit crops	FSC – 506	3 (2+1)
	Organic Horticulture	FSC – 510	2 (1+1)
<b>Minor</b>	Hormonal Regulation of Plant Growth and Development	PP-504	3 (2+1)
<b>Supporting</b>	Experimental Designs	STAT 512	3 (2+1)
<b>Compulsory NC</b>	Agricultural Research, Research Ethics and Rural Development Programme	PGS – 505	1 (1+0)
	Disaster Management	PGS – 506	1 (1+0)
	Tech. Writing & communication skill	PGS - 502	1(0+1)
<b>Semester-III</b>			
	<i>Written Comprehensive examination</i>		
<b>Major</b>	Master Seminar	FSC - 591	1(0 + 1)
	Master's Research	FSC - 599	10 (0+10)
<b>Semester IV</b>			
<b>Major</b>	Master's Research	FSC - 599	10 (0+10)



**FSC 502                      Subtropical and Temperate Fruit Production                      2+1**

**Objective**                      To impart basic knowledge about the importance and management of subtropical and temperate fruits grown in India.

**Theory**

Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, bioregulation, abiotic factors limiting fruit production, physiology of flowering, fruit set and development, abiotic factors limiting production, physiological disorders-causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, precooling, storage, transportation and ripening techniques; industrial and export potential, Agri Export Zones (AEZ) and industrial support.

**Crops**

**UNIT I**                      Apple, pear, quince, grapes

**UNIT II**                      Plums, peach, apricot, cherries, hazlenut

**UNIT III**                      Litchi, loquat, persimmon, kiwifruit, strawberry

**UNIT IV**                      Nuts- walnut, almond, pistachio, pecan

**UNIT V**                      Minor fruits- mangosteen, carambola, bael, wood apple, fig, jamun, rambutan, pomegranate

**Practical**

- Identification of important cultivars.
- Observations on growth and development, practices in growth regulation, malady diagnosis, analyses of quality attributes.
- Visit to tropical, subtropical, humid tropical and temperate orchards.
- Project preparation for establishing commercial orchards.

**Suggested Readings**

Bose TK, Mitra SK & Sanyol D. (Ed.). 2002. Fruits of India – Tropical and Sub-tropical. 3rd Ed. Vols. I, II. Naya Udyog.

Chadha KL & Pareek OP. 1996. (Eds.). Advances in Horticulture. Vol. I. Malhotra Publ. House.

Chadha KL & Shikhmani SD. 1999. The Grape Improvement, Production and Post-Harvest Management. Malhotra Publ. House.

Janick J & Moore JN. 1996. Fruit Breeding. Vols. I-III. John Wiley & Sons. Nijjar GS. 1977. (Eds.). Fruit Breeding in India. Oxford & IBH.

Radha T & Mathew L. 2007. Fruit Crops. New India Publ. Agency.

Singh S, Shivankar VJ, Srivastava AK & Singh IP. (Eds.). 2004. Advances in Citriculture. Jagmander Book Agency.

<b>FSC 503</b>	<b>Biodiversity and Conservation of Fruit Crops</b>	<b>2+1</b>
<b>Objective</b>	Understanding the principles of biodiversity and strategies in germplasm conservation of fruit crops.	
<b>Theory</b>		
<b>UNIT I</b>	Biodiversity and conservation; issues and goals, centers of origin of cultivated fruits; primary and secondary centers of genetic diversity.	
<b>UNIT II</b>	Present status of gene centers; exploration and collection of germplasm; conservation of genetic resources – conservation <i>in situ</i> and <i>ex situ</i> .	
<b>UNIT III</b>	Germplasm conservation- problem of recalcitrancy - cold storage of scions, tissue culture, cryopreservation, pollen and seed storage; inventory of germplasm, introduction of germplasm, plant quarantine.	
<b>UNIT IV</b>	Intellectual property rights, regulatory horticulture. Detection of genetic constitution of germplasm and maintenance of core group.	
<b>UNIT V</b>	GIS and documentation of local biodiversity, Geographical indication.	
<b>Crops</b>	Mango, sapota, citrus, guava, banana, papaya, grapes, jackfruit, custard, apple, ber, aonla, malus, <i>Prunus</i> sp, litchi, nuts, coffee, tea, rubber, cashew, coconut, cocoa, palmyrah, arecanut, oil palm and betelvine.	
<b>Practical</b>	<ul style="list-style-type: none"><li>• Documentation of germplasm – maintenance of passport data and other records of accessions.</li><li>• Field exploration trips, exercise on <i>ex situ</i> conservation – cold storage, pollen/seed storage, cryopreservation, visits to National Gene Bank and other centers of PGR activities.</li><li>• Detection of genetic constitution of germplasm, core sampling, ermplasm characterization using molecular techniques.</li></ul>	

### **Suggested Readings**

- Frankel OH & Hawkes JG. 1975. Crop Genetic Resources for Today and Tomorrow. Cambridge University Press.
- Peter KV & Abraham Z. 2007. Biodiversity in Horticultural Crops. Vol. I Daya Publ. House.
- Peter KV. 2008. Biodiversity of Horticultural Crops. Vol. II. Daya Publ. House.

<b>FSC 504</b>	<b>Canopy Management in Fruit Crops</b>	<b>1+1</b>
<b>Objective Theory</b>	To impart knowledge about the principles and practices in canopy management of fruit crops.	
<b>UNIT I</b>	Canopy management-importance and advantages; factors affecting canopy development.	
<b>UNIT II</b>	Canopy types and structures with special emphasis on geometry of planting, canopy manipulation for optimum utilization of light. Light interception and distribution in different types of tree canopies.	
<b>UNIT III</b>	Spacing and utilization of land area-Canopy classification; Canopy management through rootstock and scion.	
<b>UNIT IV</b>	Canopy management through plant growth inhibitors, training and pruning and management practices.	
<b>UNIT V</b>	Canopy development and management in relation to growth, flowering, fruiting and fruit quality in temperate fruits, grapes, passion fruits, mango, sapota, guava, citrus and ber.	

**Practical**

- Study of different types of canopies, training of plants for different canopy types, canopy development through pruning, use of plant growth inhibitors, geometry of planting.
- Study on effect of different canopy types on production and quality of fruits.

**Suggested Readings**

- Chadha KL & Shikhamany SD. 1999. The Grape, Improvement, Production and Post Harvest Management. Malhotra Publ. House.
- Pradeepkumar T, Suma B, Jyothibhaskar & Satheesan KN. 2008. Management of Horticultural Crops. New India Publ. Agency.

<b>FSC 505</b>	<b>Propagation and Nursery Management for Fruit Crops</b>	<b>2+1</b>
<b>Objective</b>	Familiarization with principles and practices of propagation and nursery management for fruit crops.	
<b>Theory</b>		
<b>UNIT I</b>	Introduction, life cycles in plants, cellular basis for propagation, sexual propagation, apomixis, polyembryony, chimeras. Principles factors influencing seed germination of horticultural crops, dormancy, hormonal regulation of germination and seedling growth.	
<b>UNIT II</b>	Seed quality, treatment, packing, storage, certification, testing. Asexual propagation – rooting of soft and hard wood cutting under mist by growth regulators. Rooting of cuttings in hotbeds. Physiological, anatomical and biochemical aspects of root induction in cuttings. Layering – principle and methods.	
<b>UNIT III</b>	Budding and grafting–selection of elite mother plants, methods. Establishment of bud wood bank, stock, scion and inter stock, relationship –Incompatibility. Rejuvenation through top working–Progeny orchard and scion bank.	
<b>UNIT IV</b>	Micro-propagation–principles and concepts, commercial exploitation in horticultural crops. Techniques– <i>in vitro</i> clonal propagation, direct organogenesis, embryogenesis, micrografting, meristem culture. Hardening, packing and transport of micro-propagules.	
<b>UNIT V</b>	Nursery–types, structures, components, planning and layout. Nursery management practices for healthy propagule production.	

**Practical**

- Anatomical studies in rooting of cutting and graft union.
- Construction of propagation structures, study of media and PGR.
- Hardening–case studies, micropropagation, explant preparation, media preparation.
- Culturing–*in vitro* clonal propagation, meristem culture, shoot tip culture, axillary bud culture, direct organogenesis.
- Direct and indirect embryogenesis, micro grafting, hardening.
- Visit to TC labs and nurseries.

**Suggested Readings**

- Hartmann HT & Kester DE. 1989. Plant Propagation – Principles and Practices. Prentice Hall of India.
- Bose TK, Mitra SK & Sadhu MK. 1991. Propagation of Tropical and Subtropical Horticultural Crops. Naya Prokash.
- Peter KV. (Ed.). 2008. Basics of Horticulture. New India Publ. Agency.
- Singh SP. 1989 Mist Propagation. Metropolitan Book Co.
- Rajan S & Baby LM. 2007. Propagation of Horticultural Crops. New India Publ. Agency.
- Radha T & Mathew L. 2007. Fruit Crops. New India Publ. Agency.





<b>FSC 508</b>	<b>Growth and Development of Horticultural Crops</b>	<b>2+1</b>
<b>Objective</b>	To develop understanding of growth and development of horticultural crops which have implications in their management.	
<b>Theory</b>		
<b>UNIT I</b>	Growth and development- definition, parameters of growth and development, growth dynamics, morphogenesis.	
<b>UNIT II</b>	Annual, semi-perennial and perennial horticultural crops, environmental impact on growth and development, effect of light, photosynthesis and photoperiodism vernalisation, effect of temperature, heat units, thermoperiodism.	
<b>UNIT III</b>	Assimilate partitioning during growth and development, influence of water and mineral nutrition during growth and development, biosynthesis of auxins, gibberellins, cytokinins, abscissic acid, ethylene, brassinosteroids, growth inhibitors, morphactins, role of plant growth promoters and inhibitors.	
<b>UNIT IV</b>	Developmental physiology and biochemistry during dormancy, bud break, juvenility, vegetative to reproductive interphase, flowering, pollination, fertilization and fruit set, fruit drop, fruit growth, ripening and seed development.	
<b>UNIT V</b>	Growth and developmental process during stress - manipulation of growth and development, impact of pruning and training, chemical manipulations in horticultural crops, molecular and genetic approaches in plant growth development.	
<b>Practical</b>	<ul style="list-style-type: none"><li>• Understanding dormancy mechanisms in seeds, tubers and bulbs and stratification of seeds, tubers and bulbs.</li><li>• Visit to arid, subtropical and temperate horticultural zones to identify growth and development patterns.</li><li>• Techniques of growth analysis, evaluation of photosynthetic efficiency under different environments</li><li>• Study of growth regulator functions, hormone assays, understanding ripening phenomenon in fruits and vegetables.</li><li>• Study of impact of physical manipulations on growth and development.</li><li>• Study of chemical manipulations on growth and development, understanding stress impact on growth and development.</li></ul>	

### **Suggested Readings**

- Buchanan B, Gruessam W & Jones R. 2002. *Biochemistry & Molecular Biology of Plants*. John Wiley & Sons.
- Epstein E. 1972. *Mineral Nutrition of Plants Principles and Perspectives*. Wiley.
- Fosket DE. 1994. *Plant Growth and Development a Molecular Approach*. Academic Press.
- Leopold AC & Kriedermann PE. 1985. *Plant Growth and Development*. 3<sup>rd</sup> Ed. Mc Graw-Hill.
- Peter KV. 2008. (Ed.) *Basics of Horticulture*. New India Publ. Agency.
- Roberts J, Downs S & Parker P. 2002. *Plant Growth Development*. In *Plants* (I. Ridge, Ed.), pp. 221-274, Oxford University Press.
- Salisbury FB & Ross CW. 1992. *Plant Physiology*. 4th Ed. Wadsworth Publ.



<b>PP 504</b>	<b>Hormonal Regulation of Plant Growth and Development</b>	<b>2+1</b>
<b>Objective</b>	To apprise the students about structure function of plant growth regulator on growth and development of plant.	
<b>Theory</b>		
<b>UNIT I</b>	Definition and classification of plant growth regulators-Hormones, endogenous growth substances and synthetic chemicals, Endogenous growth regulating substances other than hormones. triconanol, Phenols-polyamines, jasmonates, concept of death hormone.	
<b>UNIT II</b>	Site of synthesis, biosynthetic pathways and metabolism and the influence on plant growth development of individual group of hormones- Auxins, Gibberellins, cytokinins, Abscisic acid and Ethylene Brassinosteroids.	
<b>UNIT III</b>	Hormone mutants and transgenic plants in understanding role of hormones.	
<b>UNIT IV</b>	Signal perception, transduction, and effect at functional gene level of different hormones- Auxins- cell elongation, Gibberellins -, germination of dormant seeds, cytokinins- cell division. Retardation of senescence of plant parts, Abscisic acid-Stomatal closure and induction of drought resistance, Ethylene- fruit ripening.	
<b>UNIT V</b>	Interaction of hormones in regulation of plant growth and development processes. Rooting of cuttings-Flowering. Apical dominance, molecular aspects of control of reproductive growth and development.	
<b>UNIT VI</b>	Synthetic growth regulators- Classification, their effect on plant growth and development. Practical utility in agriculture and horticulture.	
<b>Practical</b>	<ul style="list-style-type: none"><li>• Quantification of Hormones- Principles of bioassays, physico chemical techniques and immunoassay.</li><li>• Extraction of hormones from plant tissue. Auxins- bioassays- auxins effect on rooting of cuttings, abscission, apical dominance.</li><li>• Gibberellins- bioassays-GA effect on germination of dormant seeds, cytokinin- bioassays- estimation using immunoassay technique cytokinin effect on apical dormance and senescence, ABA bioassays estimation using immunoassay technique.</li><li>• ABA effect on stomatal movement, Ethylene bioassays, estimation using physico chemical techniques- effect on breaking dormancy in sunflower and groundnut.</li></ul>	

### **Suggested Readings**

Hopkins WG & Huner NPA. 2004. Introduction to Plant Physiology. John Wiley & Sons.  
Salisbury FB & Ross C. 1992. Plant Physiology. 4th Ed. Wadsworth Publ.  
Taiz L & Zeiger E. 2006. Plant Physiology. 4th Ed. Sinauer Associates.

<b>GP 503</b>	<b>PRINCIPLES OF PLANT BREEDING</b>	<b>2+1</b>
<b>Objective</b>	To impart theoretical knowledge and practical skills about plant breeding objectives, modes of reproduction and genetic consequences, breeding methods for crop improvement.	
<b>Theory</b>		
<b>UNIT I</b>	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.	
<b>UNIT II</b>	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.	
<b>UNIT III</b>	Self-incompatibility and male sterility in crop plants and their commercial exploitation.	
<b>UNIT IV</b>	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).	
<b>UNIT V</b>	Breeding methods in cross pollinated crops; population breeding-mass selection and ear-to-row methods; S <sub>1</sub> and S <sub>2</sub> progeny testing, 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.	
<b>UNIT VI</b>	Breeding methods in asexually/clonally propagated crops, clonal selection apomixes, clonal selection.	
<b>UNIT VII</b>	Concept of plant ideotype and its role in crop improvement; Transgressive breeding.	
<b>UNIT VIII</b>	Special breeding techniques-mutation breeding; breeding for resistance to abiotic and biotic stresses.	
<b>UNIT IX</b>	Cultivar development- testing, release and notification, maintenance breeding, participatory plant Breeding, plant breeders' rights and regulations for plant variety protection and farmers rights.	
<b>Practical</b>	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**

- Allard RW. 1981. Principles of Plant Breeding..  
Chopra VL. 2001. Breeding Field Crops. IBH.  
Chopra VL. 2004. Plant Breeding. Oxford & IBH.  
Pohlman JM & Bothakur DN. 1972. Breeding Asian Field Crops. Oxford & IBH.  
Roy D. 2003. Plant Breeding, Analysis and Exploitation of Variation. Narosa Publ. House.  
Sharma JR. 2001. Principles and Practice of Plant Breeding. Tata McGraw-Hill.  
Simmonds NW. 1990. Principles of Crop Improvement. English Language Book Society.  
Singh BD. 2006. Plant Breeding. Kalyani.  
Singh S & Pawar IS. 2006. Genetic Bases and Methods of Plant Breeding. CBS.  
Singh S & Pawar IS. 2006. Genetic Bases and Methods of Plant Breeding. CBS.

**STAT 511**      **Statistical Methods for Applied Sciences**      **3+1**

**Objective**      The student is exposed statistical methods and statistical inference to help them in understanding the concepts involved in data presentation, analysis and interpretation.

**Theory**

**UNIT I**      Classification, tabulation and graphical representation of data. Box-plot, Descriptive statistics. Exploratory data analysis; Theory of probability. Random variable and mathematical expectation.

**UNIT II**      Discrete and continuous probability distributions 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. Large sample theory.

**UNIT III**      Introduction to theory of estimation and confidence-intervals. Correlation and regression. Simple and multiple linear regression model, estimation of parameters, predicted values and residuals, correlation, partial correlation coefficient, multiple correlation coefficient, rank correlation, test of significance of correlation coefficient and regression coefficients. Coefficient of determination. Polynomial regression models and their fitting. Probit regression analysis by least squares and maximum likelihood methods, confidence interval for sensitivity; Testing for heterogeneity.

**UNIT IV**      Non-parametric tests - sign, Wilcoxon, Mann-Whitney U-test, Wald Wolfowitz run test, Run test for the randomness of a sequence. Median test, Kruskal- Wallis test, Friedman two-way ANOVA by ranks. Kendall's coefficient of concordance.

**UNIT V**      Introduction to multivariate analytical tools- Hotelling's  $T^2$  Tests of hypothesis about the mean vector of a multinormal population. Classificatory problems and discriminant function,  $D^2$  - statistic and its applications; Cluster analysis, principal component analysis, canonical correlations and Factor analysis.

**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**

- Anderson TW. 1958. An Introduction to Multivariate Statistical Analysis. John Wiley.  
Dillon WR & Goldstein M. 1984. Multivariate Analysis - Methods and Applications. John Wiley.  
Goon AM, Gupta MK & Dasgupta B. 1977. An Outline of Statistical Theory. Vol. I. The World Press.  
Goon AM, Gupta MK & Dasgupta B. 1983. Fundamentals of Statistics. Vol. I. The World Press.  
Hoel PG. 1971. Introduction to Mathematical Statistics. John Wiley.  
Hogg RV & Craig TT. 1978. Introduction to Mathematical Statistics. Macmillan.  
Morrison DF. 1976. Multivariate Statistical Methods. McGraw Hill.  
Siegel S, Johan N & Casellan Jr. 1956. Non-parametric Tests for Behavior Sciences. John Wiley.  
Learning Statistics <http://freestatistics.altervista.org/en/learning.php>.  
Electronic Statistics Text Book  
<http://www.statsoft.com/textbook/stathome.html>.

**STAT 512**      **Experimental Designs**      **2+1**

**Objective**      The students would be exposed to concepts of Design of Experiments so as to enable them to understand the concepts involved in planning, designing their experiments and analysis of experimental data.

**Theory**

**UNIT I**      Need for designing of experiments, characteristics of a good design. Basic principles of designs- randomization, replication and local control.

**UNIT II**      Uniformity trials, size and shape of plots and blocks; Analysis of variance; Completely randomized design, randomized block design and Latin square design.

**UNIT III**      Factorial experiments, (symmetrical as well as asymmetrical). orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment.

**UNIT IV**      Split plot and strip plot designs; Analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, crossover designs, balanced incomplete block design, resolvable designs and their applications ~ Lattice design, alpha design-concepts, randomisation procedure, analysis and interpretation of results. Response surfaces. Experiments with mixtures.

**UNIT V**      Bioassays- direct and indirect, indirect assays based on quantal dose response, parallel line and slope ratio assays potency estimation.

**Practical**

- Uniformity trial data analysis, formation of plots and blocks, Fairfield Smith Law; Analysis of data obtained from CRD, RBD, LSD; Analysis of factorial experiments without and with confounding; Analysis with missing data; Split plot and strip plot designs; Transformation of data; Analysis of resolvable designs; Fitting of response surfaces.

**Suggested Readings**

Cochran WG & Cox GM. 1957. Experimental Designs. 2<sup>nd</sup> Ed. John Wiley.

Dean AM & Voss D. 1999. Design and Analysis of Experiments. Springer.

Federer WT. 1985. Experimental Designs. MacMillan.

Fisher RA. 1953. Design and Analysis of Experiments. Oliver & Boyd.

Nigam AK & Gupta VK. 1979. Handbook on Analysis of Agricultural Experiments. IASRI Publ.

Pearce SC. 1983. The Agricultural Field Experiment A Statistical Examination of Theory and Practice. John Wiley.

Design Resources Server [www.iasri.res.in/design](http://www.iasri.res.in/design).



**UNIT II** 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 programmes Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

### **Suggested Readings**

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

**PGS 506 Disaster Management 1(1+0)**

**Objective** 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.

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

### **Suggested Readings**

Gupta HK. 2003. Disaster Management. Indian National Science Academy. Orient Blackswan.  
Hodgkinson PE & Stewart M. 1991. Coping with Catastrophe A Handbook of Disaster Management. Routledge.  
Sharma VK. 2001. Disaster Management. National Centre for Disaster Management, India.

**PGS 502 Technical Writing and Communications Skills 1(0+1)**

### **Objective**

To equip the students/scholars with skills to write dissertations, research papers, etc. To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

### **Practical**

- **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); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.



- **Communication Skills** - Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription; Accentual pattern Weak forms in connected speech Participation in group discussion Facing an interview; presentation of scientific papers.

### **Suggested Readings**

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

### **PGS 503 Intellectual Property and Its management in Agriculture 1(1+0)**

#### **Objective**

The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

#### **Theory**

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

### **Suggested Readings**

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