ANIMAL GENETICS AND BREEDING
Course Structure - at a Glance

CODE	COURSE TITLE	CREDITS
AGB 601	ANIMAL CYTOGENETICS AND IMMUNOGENETICS	2+1
AGB 602	MOLECULAR GENETICS IN ANIMAL BREEDING	2+1
AGB 603	POPULATION AND QUANTITATIVE GENETICS IN ANIMAL BREEDDING	2+1
AGB 604	SELECTION METHODS AND BREEDING SYSTEMS	3+1
AGB 605	BIOMETRICAL TECHNIQUES IN ANIMAL BREEDING	3+1
AGB 606	CONSERVATION OF ANIMAL GENETIC RESOURCES	2+0
AGB 607	CATTLE AND BUFFALO BREEDING	2+1
AGB 608	SMALL FARM ANIMAL BREEDING (SHEEP, GOAT, SWINE AND RABBIT)	2+0
AGB 609	POULTRY BREEDING	2+1
AGB 610	LABORATORY ANIMAL BREEDING	1+0
AGB 691	MASTER'S SEMINAR	1+0
AGB 699	MASTER'S RESEARCH	20
AGB 701	RECENT ADVANCES IN ANIMAL GENETICS	2+0
AGB 702	RECENT TRENDS IN ANIMAL BREEDING	2+0
AGB 703	ADVANCES IN BIOMETRICAL GENETICS	2+1
AGB 704	ADVANCES IN SELECTION METHODOLOGY	2+1
AGB 705	BIOINFORMATICS IN ANIMAL GENETICS AND BREEDING	2+0
AGB 706	ADVANCES IN MOLECULAR CYTOGENETICS	2+0
AGB 707	UTILISATION OF NON-ADDITIVE GENETIC VARIANCE IN FARM ANIMALS	2+1
STAT 511 / BST 511	STATISTICAL METHODS FOR APPLIED SCIENCES	3+1
AGB 791	DOCTORAL SEMINAR I	1+0
AGB 792	DOCTORAL SEMINAR II	1+0
AGB 799	DOCTORAL RESEARCH	45

AGB 601: ANIMAL CYTOGENETICS AND IMMUNOGENETICS   **2+1**

Objective: To educate about basic principles of cytogenetics and immunogenetics and their applications in improving farm animals.

Theory
UNIT I
Development in animal cytogenetics and immunogenetics of farm animals. Immunoglobulins and their types: antigen-antibody interactions, Immune response, ELISA.

UNIT II
Major histocompatibility complex; genetics of biochemical variants and their applications; Ir-genes and concepts of disease resistance including major genes; hybridoma and its significance; concept of immuno-fertility, BoLA, BuLA, TLRs, Interleukins.

UNIT III
Chromatin structure of eukaryotes; chromosome number and morphology in farm animals banding and karyotyping; chromosomal and genetic syndromes, DNA packing in chromosomes, Z+B DNA, FISH chromosome painting and PRINS. RH Panel Mapping.

UNIT IV
Mutation and assays of mutagenesis; sister chromatid exchanges; recombinant DNA technique and its application in animal improvement programme.

Practical
Polymorphism of haemoglobulins, transferrins, enzymes/proteins; preparation of monovalent blood reagent-isoimmunization, titre testing and absorption of polyvalent serum; identification of bar bodies; in vitro and in vivo preparation of somatic metaphase chromosomes; screening of chromosomal abnormalities; microphotography and karyotyping; banding procedures for comparing the chromosomal complement, FISH and PRINS.

Suggested Readings
Hare WCD & Elizabeth L Singh 1999. *Cytogenetics in Animal Reproduction.* CABI.
Roitt I. 1997. *Essential Immunology.* Blackwell.
Stine GJ. 1989. *The New Human Genetics.* Wm C Brown Publ.
Summer AT & Chandley AC. 1993. *Chromosome Today.* Chapman & Hall.

AGB 602: MOLECULAR GENETICS IN ANIMAL BREEDING   2+1

Objective: To educate about molecular techniques to identify molecular markers as an aid to selection.

Theory
UNIT I
Basic concept: Genesis and importance of molecular techniques; Genome organization - physical and genetic map, current status of genome maps of Livestock

UNIT II
Molecular markers and their application; RFLP, RAPD, Microsatellite/ Minisatellite markers, SNP marker, DNA fingerprinting.

UNIT III
DNA sequencing, Genome sequencing, Genomic Library, Polymerase Chain Reaction (PCR), its types (PCR-RFLP, AS-PCR etc.) and applications; Transgenesis and methods of gene transfer.

UNIT IV
Statistical techniques for analyzing molecular genetic data, Quantitative Trait Loci (QTL) mapping and its application in animal breeding, Genome scan, Candidate gene approach, Genomic selection, Marker Assisted Selection- basic concept.

Practical
Extraction and purification of genomic DNA, Gel electrophoresis, Restriction enzyme digestion of DNA and analysis, PCR, PCR-RFLP, PCR-SSCP, Bioinformatics tool for DNA sequence analysis, Design of primer, Isolation of RNA, cDNA synthesis, Statistical methods for analyzing molecular genetic data.

Suggested Readings
Akano IE 1992. *DNA Technology.* IAP Academic Press.
Micklos DA, Fryer GA & Crotty DA. 2003. *DNA Science.* Cold Spring Harbour.
Setlow JK. 2006. *Genetic Engineering - Principles and Methods.* Springer.

AGB 603: POPULATION AND QUANTITATIVE GENETICS IN ANIMAL BREEDING   2+1

Objective : To study genetic structure of animal population and importance of genetic variation and covariation among traits.

Theory
UNIT I
Individual verses population. Genetic Structure of population. Factors affecting changes in gene and genotypic frequencies and their effect on genetic structure of animal popultions. Approach to equilibrium under differnet situations: Viz: Single autosomal locus with two alleles, single sex-linked locus, two pairs of autosomal linked and unlinked loci;

UNIT II
Small population: random genetic drift, effective popultion size, pedigreed populations, regular and irregular inbreeding systems.

UNIT III
Quantitative genetics-gene effects, population mean and variance and its partitioning, biometric relations between relatives.

UNIT IV
Genetic and phenotypic parameters-their methods of estimation, uses, possible biases and precision. Scale effects and threshold traits.

Practical
Problems relating to gene and genotypic frequencies under different conditions. Estimation orf inbreeding in regular and irregular systems. Estimation of effective population size. Computation of quantiatative genetic effects. Estimation of variance components. Computation of heritability, repeatability, genetic, environmental and phenotypic correlations and their standard errors.

Suggested Readings
Bulmer MG. 1980. *The Mathematical Theory of Quantitative Genetics.* Clarendon Press.
Crow JF & Kimura M. 1970. *An Introduction to Population Genetics. Theory.* Harper & Row.
Falconer DS & Mackay TFC 1996. *An Introduction to Quantitative Genetics.* Longman.
Jain JP. 1982. *Statistical Techniques in Quantitative Genetics.* Tata McGraw-Hill.
Pirchner F. 1981. *Population Genetics in Animal Breeding.* S. Chand.

AGB 604: SELECTION METHODS AND BREEDING SYSTEMS   3+1

Objective: To explain the methodology of selection and breeding systems for genetic improvement of livestock and poultry.

Theory
UNIT I
Type of selection and their genetic consequences. Response to selection and its prediction and improvement of response to selection.

UNIT II
Theoretical aspects of accuracy and efficiency of different base of selection. Prediction of breeding value using different criteria. Combined Selection. Correlated response to selection and efficiency of indirect selection.

UNIT III
Selection of several traits. Evaluation of short term and long term selection experiments viz: bidirectional selection and asymmetry of response, selection plateux and limit.

UNIT IV
Genetic aspects and consequences of various mating systems. Effects of mating systems on mean and variance. Application of various mating system in animal improvement. Selection for general and specific combining ability. Genetic polymorphysim and its application in genetic improvement.

Practical
Estimation of breeding values from different sources of information.Prediction of direct and correlated response to different bases of selection. Computation of breeding values using different sources of information for female and male selection.Compuatation of realized heritability and genetic correlation. Selection index: Computation, Accuracy and response in component traits.Estimation of hetrerosis for different types of crosses. Estimation of GCA and SCA.

Suggested Readings
Falconer DS & Mackay TFC. 1996. *An Introduction to Quantitative Genetics.* Longman.
Jain JP. 1982. *Statistical Techniques in Quantitative Genetics.* Tata McGraw-Hill.
Tomar SS 1996. *Text Book of Population Genetics.* Vol. I. *Qualitative Inheritance;* Vol. II. *Quantitative Inheritance.* Universal Publ.

AGB 605: BIOMETRICAL TECHNIQUES IN ANIMAL BREEDING   3+1

Objective: To educate about the various biometrical techniques for data analysis and their applications in animal breeding research.

Theory
UNIT I
Review of basic concepts in statistical inference and balanced experimental designs. Nature of structure of animal breeding data and sources of variation.
UNIT II
Introduction to matrix algebra, types of matrices and matrix operations. Determinants and their properties, methods of finding inverse of a matrix and their application
UNIT III
ANOVA, Regression and Correlations, Henderson's methods for estimation of variance components, Basic concepts of linear models, Least-squares analysis, maximum likelihood; Method of estimation; Generalized LS and weighted LS. Fisher's discriminant function and its application, D2 -Statistics in divergent analysis.
UNIT IV
Linear models in animal breeding, Methods of analysis of unbalanced animal breeding data. Adjustment of data. Data base management and use of software packages in animal breeding.
Practical
Matrix applications, determinant and inverse of matrices; Building of models for various types of data; Estimation of variance components; Least squares method for analysis of research data; Collection, compilation, coding, transformation and analysis of animal breeding data by using above bio metrical techniques with computer application.

Suggested Readings
Henderson CR. 1984. *Application of Linear Models in Animal Breeding.* Univ. of Guelph.
Kaps M & Lamberson WR. 2004. *Biostatistics for Animal Science.* CABI.
Mather K & Jinks Jl. 1977. *Introduction to Biometrical Genetics.* Chapman & Hall.
Searle Sr. 1971. *Linear Models.* John Wiley & Sons.
Singh RK & Choudhary BD. 1977. *Biometrical Methods in Quantitative Genetic Analysis.* Kalyani
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AGB 606: CONSERVATION OF ANIMAL GENETIC RESOURCES   2+0

Objective: To educate about the concept of conservation of Animal Genetic Resources and their sustainable utilization.

Theory
UNIT I
Domestic Animal Diversity in India, its origin, history and utilization. Present status and flow of Animal Genetic Resources and its contribution to livelihood security. Methodology for genotypic characterization of livestock and poultry breeds through systematic surveys. Fodder availability; management of breed; physical, biochemical and performance traits and uniqueness of animals of a breed; social, cultural and economic aspects of their owners/communities rearing the breed.

UNIT II
Methodology for molecular genetic characterization, diversity analysis and relationship among the breeds. Concept of conservation, *In-situ* and *exsitu (in-vivo* and *in-vitro);* models of conservation; prioritization of breeds for conservation. National and international strategies for conservation of Animal Genetic Resources.

UNIT III
Status, opportunities and challenges in conservation of AnGR. IPR issues pertaining to animal genetic resources/animal products or by-products. Registration of livestock breeds and protection of livestock owner's rights in India.

Suggested Readings
Lasley JF. 1987. *Genetics of Livestock Improvement.* 3rd Ed. IBH.
Nicholas FW. 1987. *Veterinary Genetics.* Claredon Press.
Ross CV. 1989. *Sheep Production and Management.* Prentice Hall.
Schmidt GM & Van Vleck LD. 1974. *Principles ofDairy Science.* WH Freeman.
Van Vleck LD, Pollak EJ & Bltenacu EAB. 1987. *Genetics for AnimalSciences.* WH Freeman.

AGB 607: CATTLE AND BUFFALO BREEDING   2+1

Objective : To educate about the concept of cattle and buffalo breeding.

Theory
UNIT I
History of dairy cattle and buffalo breeding. Breeds of cattle and buffallo and their Characterisation.Inheritance of important economic traits. Recording and handeling of breeding data. Standardization of records. Computation of correction factors for the adjustment of the data. Estimation of breeding values of the cows and bulls. Sire evaluation methods using single trait and multiple traits: construction of Sire indices, Sire evaluation under animal model, sire mode; and matrenal grand sire model. Open nucleus breeding systems with MOET.

UNIT III
Methods of cross breeding.Breeding of type, milk quality and production efficency. Plans for developing new breeds of dairy cattle. History of development of important breeds of dairy cattle.

UNIT IV
Considerations in the import of exotic germplasm for breeding cattle in the tropics. Appraisal of buffalo and cattle breeding programme. Role of breed assocaitions in dairy improvement.

Practical

Performance recording - milk recording - Estimation of economic traits -Standardization of records - Index cards - Sire evaluation -Comparison of latest methods - Computation of genetic parameters - Genetic gain -Estimation of heterosis - Culling and replacement.

Suggested Readings

Lasley JF. 1987. *Genetics of Livestock Improvement.* 3rd Ed. IBH.
Nicholas FW. 1987. *Veterinary Genetics.* Claredon Press.
Ross CV. 1989. *Sheep Production and Management.* Prentice Hall.
Schmidt GM & Van Vleck LD. 1974. *Principles ofDairy Science.* WH Freeman.
Van Vleck LD, Pollak EJ & Bltenacu EAB. 1987. *Genetics for Animal Sciences.* WH Freeman.

AGB 608: SMALL FARM ANIMAL BREEDING (Sheep, Goat, Swine and Rabbit)   2+0

Objective: To educate about the small farm animal breeding concepts.

Theory
UNIT I
Breeds-Economic traits-Prolificacy-Breeding records and standardization.

UNIT II
Genetic parameters - Selection of males and females - Breeding systems. Development of new breeds.

UNIT III
Breeding policy - Breeding research - Conservation of breeds.

UNIT IV
Culling and replacement - EADR.

Suggested Readings

Ross CV. 1989. *Sheep Production and Management.* Prentice Hall.
Turner HN & Young SSY. 1969. *Quantitative Genetics in Sheep Breeding.* MacMillan.
Van Vleck LD, Pollak EJ & Bltenacu EAB. 1987. *Genetics for Animal Sciences.* WH Freeman.

AGB 609: POULTRY BREEDING   2+1

Objective : To educate about the advances in poultry breeding practices.

Theory
UNIT I
Origin and history of poultry species: Chicken, turkey, duck and quail -Important qualitative traits in poultry including lethals - Economic traits of egg-type chicken and their standardization - Selection criteria - Aids to selection: Index selection and Osborne index - Restricted selection index - Economic traits of meat - type chicken and their standardization.

UNIT II
Selection criteria and selection indices - Response to selection - Genetic controls - Genotype and environment interaction - Inbreeding, and its effects on production traits in egg and meat-type chickens - Inbred lines - Strain development - Crossing : strain and line crosses - Introduction to diallel cross - Utilisation of heterosis and reciprocal effect - Reciprocal recurrent selection and recurrent selection.

UNIT III
Industrial breeding - Artificial insemination in chicken - Autosexing -Random Sample Test.

UNIT IV
Biochemical variants and immunogenetics of poultry - Use of molecular genetics in poultry breeding - Quantitative trait loci and marker-assisted selection - Conservation of poultry genetic resources.

Practical
Inheritance of qualitative traits - Economic traits of egg-type and meat-type chicken - Procedures of standardization - Estimations of heritability, correlation between various production traits, inbreeding co-efficient and heterosis - Selection of sires and dams - Osborne index – Restricted selection index - Collection and evaluation of semen and insemination - Diallel cross.

Suggested Readings

Crawford RD.1990. *Poultry Breeding and Genetics.* Elsevier.
Hutt FB. 2003. *Genetics of Fowl.* Norton Greek Press.
Singh RP & KumarJ. 1994. *Biometrical Methods in Poultry Breeding.* Kalyani.

AGB 610: LABORATORY ANIMAL BREEDING   1+0

Objective : To educate about the laboratory animal breeding principles.

Theory
UNIT I
Introduction to laboratory animal genetics - Breeding colonies of mice, rats, hamsters, guinea pigs and rabbits.

UNIT II
Selection and Mating methods/systems - monogamous, polygamous and others. Development of genetically controlled laboratory animals - Rules for nomenclature, inbred strains, outbred stocks, mutant stocks, recombinant inbred strains, transgenic strains, gene targeting and production of 'gene knock-out' animals.

UNIT IV
Genetic control and monitoring - Record keeping - Ethics of laboratory animal use.

Suggested Readings

Van Vleck LD, Pollak EJ & Bltenacu EAB. 1987. *Genetics for AnimalSciences.* WH Freeman.

AGB 701: RECENT ADVANCES IN ANIMAL GENETICS 2+0

Objective : To impart knowledge about the latest tools and techniques of animal genetics and their uses in animal sciences.

Theory
UNIT I
Eukaryotic genome: Gene families, Pseudogenes SnRNPs, Gene conversion, tandemly repeated genes, Nuclear Organiser region, mRNA splicing, Minisatellites, Microsatellites and its usage.

UNIT II
Transprosons, RNA processing Transcuplion regulation of gene expression, selective gene amplification, post transceptional regulation. The proteasome and longevity of proteins.

UNIT III
Transgenic animals their benefits in livestock production, somatic cell nuclear transfer, transgenic animals in biomedical research, ethical consideration of transgenic animals; gene therapy and transgenic animal production. Pharming of Pharmaceutical.

UNIT IV
Radiation hybrid panels and their usage in livestock, microdissection of chromosomes, *In-situ* hybridization, chromosome painting, meiotic crossing over, genome selection; Structure and functions of major histocompatibility complex, T Cell receptor, CD4, Toll Like Receptors and their functions.

Suggested Readings : Selected articles from journals

AGB 702: RECENT TRENDS IN ANIMAL BREEDING 2+0

Objective: To acquaint with recent trends in animal breeding and designing of need-based breeding strategies.

Theory
UNIT I
Biometrical models and their analytical techniques on simulated and actual animal breeding data using computer application and use of programme in the field of animal breeding. Formulation of detailed breeding plans ongoing breed improvement programmes and their impact analysis in various species of livestock under different situations.

UNIT III
Advanced techniques in genetic manipulation for multiplication and improvement of livestock species.

Suggested Readings : Selected articles from journals.

AGB 703: ADVANCES IN BIOMETRICAL GENETICS 2+1

Objective: To impart knowledge about recent advances in population genetic theory and application in animal breeding.

Theory
UNIT I
Mating designs; genetic basis of tripple test cross analysis (TTC); triallel analysis, partial diallel crosses and mating design for studying reciprocal and maternal differences.

UNIT II
Models for studying the inheritance of endosperm characters; classificatory problems; discriminant function, D2 analysis; principal component analysis.

UNIT III
Use of genetic parameters for prediction of recombinant inbred lines; advances in studies of genotype environment interaction and selection indices.

UNIT IV
Generation matrix and its use in population genetics; gene mapping of QTL (quantitative trait loci).

Practical
Estimation of genetic parameters - Diallel analysis - Triallel analysis -D2 analysis - Problems in Matrix.

Suggested Readings : Selected articles from journals.

AGB 704 ADVANCES IN SELECTION METHODOLOGY 2+1

Objective : To educate about the latest advances in selection theory and their application in animal breeding.

Theory
UNIT I
Fundamental theorem of natural selection; Selection in finite populations-effect on genetic structure and variance. Optimum designs for the estimation of genetic parameters. Design of selection experiments for testing selection theory.

UNIT II
Methods of measurement of genetic and environmental trends. Advances in selection indices Multistage, Restricted and retrospective selection indices. Multi-information, Empirical evaluation of selection theory: genetic slippage, limits to selection, asymmetry of response, selection experiments, effect of selection on varaiance.

UNIT IV
Selection for threshold traits; single and multiple trait best linear unbiased estimation (BLUE) and prediction (BLUP); selection under single and multiple trait animal models; direct and correlated response through various selection indices, relationship between BLUP and selection index; fundamentals of marker assisted selections.

Practical
Estimation of relative economic values; determination of culling levels and selection intensity; construction of various indices; estimation of direct and correlated response; QTL analysis using LDMAS & LEMAS.

Suggested Readings : Selected articles from journals.

AGB 705: BIOINI ORMATICSIN ANIMAL GENETICS AND BREEDING 2+0

Objective : To educate about basic concepts of bioinformatics and their applications in Animal Genetics and Breeding.

Theory
UNIT I
Overview of bioinformatics, Database concepts, Algorithms, Information resources for protein and genome databases: Gene Bank, EMBL, SWISSPROT, PROSITE.

UNIT II
Nucleotide and protein sequence analysis, Pair-wise and multiple sequence alignments, Phylogeny, Micro-array processing, Clustering, Analysis software, Secondary database search.

UNIT III
Genetic characterisation, Use of bioinformatics tools for identifying QTL and selection of elite germplasm.

Suggested Readings : Selected articles from journals.

AGB 706: ADVANCES IN MOLECULAR CYTOGENETICS 2+0

Objective : To educate about the advances in cytogenetics and their application in animal genetic and breeding

Theory
UNIT I
Structure of eukaryotic chromosomes - Evolution of karyotype - Various in vitro cell culture techniques - Cell lines and utility - Genotoxicity.

UNIT II
Somatic cell genetics - Stem cell genetics - Molecular cytogenetics and gene mapping - ISH, FISH, Radiation hybrid mapping, Fibre-FISH, PRINS. Positional cloning - Spectral karyotyping.

UNIT IV
Image analysis - Chromosome walking - Chromosome painting.

Suggested Readings : Selected articles from journals.

AGB 707: UTILISATION OF NON-ADDITIVE GENETIC VARIANCE IN FARM ANIMALS 2+1

Objective : To educate about the recent advances in estimation of non-additive genetic variation and possible use in developing synthetic population of livestock and poultry.

Theory
UNIT I

Heterosis - forms and genetic basis; detection and estimation of non-additive genetic variance - average dominance, overdominance.

UNIT II
Partitioning of between cross variance - general combining ability, specific combining ability and reciprocal effects; methods of analyzing diallel crosses; utilization of non-additive genetic variance.

UNIT III
Crossbreeding systems - crossbreeding effects; recurrent and reciprocal recurrent selection and their forms.

UNIT IV
Development of specialized sire and dam lines; inbred lines and their maintenance; inbreeding and hybridization.

Practical
Computation of degree of dominance using NC Plans; analysis of partial and complete diallel cross data; estimation of crossbreeding effects; estimation of genetic correlation among paternal purebred and crossbred half sibs; computation of response through RS and RRS.

Suggested Readings
Selected articles from journals.

STAT 511 / BST 511: STATISTICAL METHODS FOR APPLIED SCIENCES 3+1

Objective
This course is meant for students who do not have sufficient background of Statistical Methods. The students would be exposed to concepts of statistical methods and statistical inference that would help them in understanding the importance of statistics. 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; 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 Tests of hypothesis about the mean vector of a multinormal population.
Classificatory problems and discriminant function, D-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; Non-parametric 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.