

AGRICULTURAL STATISTICS

TRIMESTER WISE DISTRIBUTION OF COURSES

I Trimester

		L	P
AS 101	ELEMENTARY STATISTICAL METHODS	2	1
AS 150	MATHEMATICAL METHODS	4	0
AS 160	PROBABILITY THEORY	2	0
AS 161	STATISTICAL METHODS-I	2	1
AS 167	APPLIED MULTIVARIATE ANALYSIS	2	1
AS 168	ECONOMETRICS	2	1
AS 169	PLANNING OF SURVEYS / EXPERIMENTS	2	1
AS 200	DESIGN OF EXPERIMENTS-II	1	1
AS 201	SAMPLING TECHNIQUES – II	1	1
AS 202	STATISTICAL GENETICS – II	1	1
AS 203	REGRESSION ANALYSIS	1	1
AS 204	LINEAR MODELS	2	0
AS 206	OPTIMIZATION TECHNIQUES	1	1

II Trimester

AS 102	ELEMENTARY DESIGN OF EXPERIMENTS	2	1
AS 151	MATHEMATICAL METHODS IN STATISTICS	4	0
AS 162	STATISTICAL METHODS – II	2	1
AS 165	SAMPLING TECHNIQUES – I	3	1
AS 170	STATISTICAL MODELLING	2	1
AS 171	BIOINFORMATICS– I	3	1
AS 205	ADVANCED STATISTICAL INFERENCE	1	1
AS 207	STOCHASTIC PROCESSES	3	0
AS 301	ADVANCED DESIGN OF EXPERIMENTS-I	2	1
AS 303	ADVANCED SAMPLE SURVEYS – I	2	1
AS 305	ADVANCED STATISTICAL GENETICS-I	2	1

III Trimester

AS 103	ELEMENTARY SAMPLING & NON- PARAMETRIC METHODS	2	1
AS 163	STATISTICAL INFERENCE	4	1
AS 164	DESIGN OF EXPERIMENTS – I	3	1
AS 166	STATISTICAL GENETICS – I	3	1
AS 208	BIOINFORMATICS-II	2	1
AS 302	ADVANCED DESIGN OF EXPERIMENTS-II	2	1
AS 304	ADVANCED SAMPLE SURVEY-II	2	1
AS 306	ADVANCED STATISTICAL GENETICS-II	2	1
AS 307	FORECASTING TECHNIQUES	1	1
AS 308	BAYESIAN INFERENCE IN SURVEY SAMPLING	1	1
AS 370	RECENT ADVANCES IN THE FIELD OF SPECIALIZATION I / II / III	1	0
AS 299	SEMINAR I / II / III	1	0

Core Courses

For M.Sc. : Within the discipline: AS160, AS161, AS162, AS163, AS164, AS165, AS166 and AS167.

Agricultural Statistics

Major Field : **Agricultural Statistics**

Minor Field : In addition to the major field, every student shall take not less than two minor fields of study (one for M.Sc.students) from disciplines other than Agricultural Statistics with at least 9 credits of course work in each.

The total minimum credit requirements of course work for M.Sc. (Ph.D.) in Agricultural Statistics is 55(45) including minor field(s). Courses AS 160 to AS 167 are core courses for M.Sc. (Ag. Statistics)

DESCRIPTION OF COURSES

AS 101 ELEMENTARY STATISTICAL METHODS (2L+1P) I

Classification, tabulation and graphical representation of data. Descriptive statistics. Theory of probability. Random variable and mathematical expectation. Probability distributions: Binomial, Poisson, negative binomial, normal distributions and their applications. Concept of sampling distribution: t, chi-square and F distributions. Tests of significance based on normal, t, chi-square and F distributions. 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. Coefficient of determination. Polynomial regression models and their fitting. Selection of variables, validation of models. Introduction to multivariate analytical tools- cluster analysis, discriminant function, principal component analysis.

AS 102 ELEMENTARY DESIGN OF EXPERIMENTS (2L+1P) II

Basic principles of design of experiments. Uniformity trials. Analysis of variance. Completely randomised design, Randomised block design (RBD), Latin square design (LSD), Balanced incomplete block design, Lattice design - concepts, randomisation procedure, analysis and interpretation of results. Analysis of covariance. Missing plot technique and its application to RBD, LSD. Factorial experiments (symmetrical as well as asymmetrical). Confounding in factorial experiments - application in 2^5 and 3^3 factorial experiments. Factorial experiments with control treatment. Groups of experiments. Split plot and Strip plot designs. Change-over design. Sampling in field experiments. Transformation of data. Response surfaces. Experiments with mixture.

AS 103 ELEMENTARY SAMPLING AND NON-PARAMETRIC METHODS (2L+1P) III

Concept of sampling, sampling vs complete enumeration, simple random sampling, inverse sampling, stratified sampling, cluster sampling, systematic sampling, multistage sampling. Ratio method of estimation. Non-sampling errors. Concept and levels of measurement. 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.

AS 150 MATHEMATICAL METHODS**(4L) I**

Matrix Algebra: Basic terminology, linear independence and dependence of vectors. Row and column spaces, Echelon form. Determinants, rank and inverse of matrices. System of linear equations. Special matrices – idempotent, symmetric, orthogonal. Eigen values and eigen vectors.

Calculus: Limit and continuity, differentiation of functions, successive differentiation, partial differentiation, mean value theorems, Taylor and Maclaurin's series. Application of derivatives, L'hospital's rule. Integration of rational, irrational and trigonometric functions. Application of integration.

Differential equation: Differential equations of first order, linear differential equations of higher order with constant coefficient.

Numerical Analysis: Simple interpolation, Divided differences, Numerical differentiation and integration.

Linear Programming: Formulation and graphical solution, simplex method, duality, transportation and assignment problem.

AS 151 MATHEMATICAL METHODS IN STATISTICS**(4L) II**

Linear Algebra: Group, ring, field and vector spaces, Sub-spaces, basis, Gram Schmidt's orthogonalisation, Galois field - Fermat's theorem and primitive elements. Linear transformations.

Real Analysis: Convergence and divergence of infinite series, use of comparison tests - D'Alembert's Ratio - test, Cauchy's n^{th} root test, Raabe's test, Kummer's test, Gauss test. Absolute and conditional convergence. Riemann integration, concept of Lebesgue integration, power series, Fourier, Laplace and Laplace -Steiltjes' transformation, multiple integrals.

Matrix Algebra: Unitary, Similar, Hadamard, Circulant, Helmert's matrices. Kronecker and Hadamard product of matrices. Sub-matrices and partitioned matrices, Permutation matrices, Full rank factorization, Equations having many solutions, Generalized inverses, Moore-Penrose inverse, Applications of g-inverse. Spectral decomposition of matrices, Differentiation and integration of matrices, Quadratic forms.

Graph theory: Concepts and applications. Fuzzy set theory.

AS 160 PROBABILITY THEORY**(2L) I**

Elements of measure theory. Probability - classical and frequency definitions, Axiomatic approach, laws of probability, conditional probability. Bayes theorem. Random variable- discrete and continuous. Probability mass and probability density functions, distribution function, Mathematical expectation and its laws. Probability generating, moment generating and characteristic functions. Inversion and Uniqueness theorems for characteristic functions. Markov's, Chebychev's and Kolmogorov's inequalities. Modes of stochastic convergence. Weak and strong laws of large numbers, Central limit theorems. Concepts of stochastic processes. Random walk, Markov chains.

AS 161 STATISTICAL METHODS - I**(2L+1P) I**

Descriptive statistics- exploratory data analysis techniques. Random variable. Discrete probability distributions: Uniform, Bernoulli, binomial, Poisson, negative - binomial, geometric, hypergeometric, multinomial. Continuous probability distributions: rectangular, exponential, Cauchy, normal, gamma, beta, Weibull, lognormal, logistic, Pareto. Exact sampling distributions. Central t, χ^2 and F distributions. Bivariate normal distribution - conditional and marginal. Correlation, rank correlation, correlation ratio, intra-class correlation. Regression analysis, partial and multiple correlation and regression.

AS 162 STATISTICAL METHODS - II

(2L+1P) II

Sampling distribution of correlation coefficient, regression coefficient, correlation ratio, intra class correlation coefficient. Non-central t, χ^2 and F distributions. Distribution of quadratic forms. Cochran's theorem. Tests for normality. Large sample tests. Tests of significance based on t, χ^2 and F distributions. Truncated and compound distributions. Fitting of orthogonal polynomials. Pearsonian curves. Categorical data analysis - loglinear models, Association between attributes. Distributions of order statistics. Variance stabilizing transformations.

(Pre requisite: AS 161)

AS 163 STATISTICAL INFERENCE

(4L+1P) III

Point estimation, Properties of estimators: Unbiasedness, consistency, efficiency and sufficiency. Frechet-Cramer-Rao inequality, Rao-Blackwell theorem, completeness and bounded completeness, Basu's theorem. Methods of estimation - Maximum likelihood, least squares, minimum χ^2 , minimum distance, moments, maximum entropy. Testing of hypothesis: Neyman-Pearson lemma, power function, uniformly most powerful tests and their constructions, unbiased tests, likelihood ratio tests. Confidence-interval estimation. Sequential analysis, Sequential probability ratio test. Elements of Decision theory and Bayesian inference. Non-parametric tests: run, sign, rank, median, Wilcoxon-Mann-Whitney, Kruskal-Wallis, Friedmann two - way ANOVA by ranks.

(Pre-requisite: AS 162)

AS 164 DESIGN OF EXPERIMENTS - I

(3L+1P) III

Basic principles of design of experiments, uniformity trials - shape and size of plots and blocks. Elements of linear estimation. Analysis of variance and covariance. Completely randomized, Randomised block and Latin square designs. Mutually orthogonal latin squares. Missing plot techniques. Balanced incomplete block (BIB) designs - general properties and analysis with and without recovery of information. Construction of BIB designs, Youden square designs, Lattice designs. Change-over designs. Groups of experiments. Factorial experiments, Confounding in symmetrical factorial experiments (2^n and 3^n series), Split plot and Strip-plot designs.

AS 165 SAMPLING TECHNIQUES - I

(3L+1P) II

Probability sampling. simple random sampling, estimation of proportions, confidence-interval, determination of sample size, inverse sampling. Sampling with varying probabilities with replacement. Stratified sampling, ratio, difference and regression estimators, cluster sampling, multi - stage sampling with equal probability. Systematic sampling, double sampling, successive sampling. Non-sampling errors - sources and classification, non-response survey

techniques, imputation methods, measurement errors, repeated measurement techniques, interpenetrating sub-sampling.

AS 166 STATISTICAL GENETICS - I (3L+1P) III

Physical basis of inheritance. Analysis of segregation, detection and estimation of linkage for qualitative characters. Amount of information about linkage, Combined estimation, Disturbed segregation. Gene and genotypic frequencies, Random mating and Hardy-Weinberg law, Application and extension of the equilibrium law, Fisher's fundamental theorem of natural selection. Disequilibrium due to linkage for two pairs of genes, sex-linked genes, forces affecting gene frequency - selection, mutation and migration, equilibrium between forces in large populations, polymorphism. Polygenic system for quantitative characters, concepts of breeding value and dominance deviation. Genetic variance and its partitioning, Correlations between relatives, Heritability, Repeatability and Genetic correlation. Response due to selection, Selection index and its applications in plants and animals improvement programmes, Correlated response to selection. Restricted selection index, Inbreeding and cross-breeding, Changes in mean and variance.

AS 167 APPLIED MULTIVARIATE ANALYSIS (2L+1P) I

Multivariate normal distribution, marginal and conditional distribution, Wishart distribution, Hotelling's T^2 and Mahalanobis' D^2 statistics, Test of hypothesis on means, Multivariate analysis of variance and covariance, Cluster analysis, Classification by linear discriminant function, Canonical correlations, Principal components, Factor analysis.

(Pre-requisite: AS 160, AS 161, AS 162)

AS 168 ECONOMETRICS (2L+1P) I

Study of single equation linear regression models: Maximum likelihood and ordinary least-squares methods of estimation, Statistical inference in linear regression, Estimation subject to linear restrictions, Use of dummy variables, Multicollinearity. Generalized least-squares method of estimation, Seemingly Unrelated Regression Equations, Heteroscedasticity, Auto-correlation, Distributed lag models.

Elements of time-series analysis-measurement of secular trend, seasonal fluctuations, cyclical fluctuations, periodogram analysis, harmonic analysis, serial correlation and correlogram. Index numbers – their characteristics and construction. Index numbers of wholesale and consumer prices.

AS 169 PLANNING OF SURVEYS / EXPERIMENTS (2L+1P) I

Agricultural statistical system in India, Organisation of agricultural and livestock census, Nature of surveys - adhoc or repetitive, methods of data collection, problem of sampling frame, choice of sampling design, Agricultural surveys - some case studies, Crop estimation surveys, Statistics of livestock and livestock products, fisheries statistics, Land use statistics, Prices of agricultural commodities, Crop forecasting, Role of different organisations engaged in data collection in India, Sources of agricultural statistics.

Planning and designing of experiments, Preparation of layout plans and field visits related to applications of designs. Sampling in field experiments, Experiments on cultivators'

fields. Long-term and rotational experiments. Intercropping and agroforestry experiments.

(Pre-requisite: AS 164, AS 165; or AS102, AS103)

AS 170 STATISTICAL MODELLING

(2L+1P) II

Empirical and mechanistic models. Nonlinear growth models like monomolecular, logistic, Gompertz, Richards. Applications in agriculture and fisheries. Formulation of nonlinear statistical model. Estimation of parameters using iterative procedures like Taylor's, Steepest descent, Levenberg - Marquardt's. Choice of initial values. Examination of residuals and adequacy of a model. Fitting of nonlinear statistical models using nonlinear estimation procedures and software packages.

Compartmental modelling - First and second order input-output systems, Dynamics of a multivariable system. Applications in plant growth and animal physiology. Two-species systems. Lotka-Volterra, Leslie-Gower and Holling-Tanner non-linear prey-predator models. Volterra's principle and its applications. Gause competition model. Multi-species modelling.

(Pre-requisite: AS 150)

AS 171 BIOINFORMATICS – I

(3L+1P) II

Basic Biology: Proteins and enzymes, genes, gene structures, gene expression and regulation, Molecular tools, nucleotides, nucleic acids, Markers, bioenergetics.

Structural and functional genomics: Organization and structure of genomes, genome mapping, assembling of physical maps, strategies and techniques for genome sequencing and analysis.

Computing techniques: Languages useful for browsing biological databases on web; Computer networks – Internet, World wide web, Web browsers – EMBnet, NCBI; Databases pertaining to Nucleic acid sequences, protein sequences, Genome and Proteome; Searching sequence databases, Structural databases.

Statistical Techniques: MANOVA, Cluster analysis, Discriminant analysis, Principal component analysis, Principal coordinate analysis, Multidimensional scaling; Multiple regression analysis; Likelihood approach in estimation and testing; Resampling techniques – Bootstrapping and Jack-knifing; Markov Models.

Tools for Bioinformatics: DNA Sequence Analysis – Features of DNA sequence analysis, Approaches to EST analysis; Pairwise alignment techniques: Comparing two sequences, PAM and BLOSUM, Global alignment (The Needleman and Wunsch algorithm), Local Alignment (The Smith-Waterman algorithm), Dynamic programming, Pairwise database searching; Sequence analysis– BLAST and other related tools, Different methods of Multiple sequence alignment, Searching databases with multiple alignments; Alignment Scores, Design and Analysis of microarray experiments.

AS 200 DESIGN OF EXPERIMENTS - II

(1L+1P) I

Partially balanced incomplete block designs with two associate classes - properties, analysis and construction. Multiple comparison procedures. Fractional replication of symmetrical

factorials. Asymmetrical factorials - construction and analysis of balanced confounded designs. Response surface designs, second order rotatable designs.

(Pre-requisite: AS164)

AS 201 SAMPLING TECHNIQUES - II

(1L+1P) I

Sampling with varying probabilities without replacement, Horvitz – Thompson estimator, Ordered and unordered estimators, Sampling strategies: Midzuno-Sen, Rao-Hartley-Cochran. π PS Sampling: Procedures such as Brewer, Durbin and Sampford, etc. Super population concept - comparison of various sampling strategies. Imperfect frames, Post – stratified estimator, multiple frames. Randomized response techniques.

(Pre-requisite: AS 165)

AS 202 STATISTICAL GENETICS-II

(1L+1P) I

Genetic load, Random genetic drift, Effect of finite population size, Theory of path coefficients. Regular system of inbreeding. Effect of inbreeding on quantitative characters, Multiple allelism in continuous variation, Sex-linked genes, Maternal effects - estimation of their contribution. Variance component approach and linear regression approach for the analysis of GE interactions. Measurement of stability and adaptability for genotypes. Concepts of general and specific combining ability. Diallel and partial diallel crosses - construction and analysis.

(Pre-requisite: AS 166)

AS 203 REGRESSION ANALYSIS

(1L+1P) I

Regression diagnostics - non-normal errors, non-constant error variances, non-independent observations, influential observations (outliers), non-linearity of the model, multicollinearity in the data. Remedial measures - regression under non-normal errors, transformation of data, generalized least-squares, robust regression, ridge regression, Regression using principal components. Model over-fitting, model under-fitting, selection of variables, adequacy and validation of models. Use of dummy variables, regression with ordinal data. Introduction to non-parametric regression.

AS 204 LINEAR MODELS

(2L) I

General Gauss Markoff set up, Gauss-Markoff's theorem, Theory of linear estimation, Test of hypothesis in linear models. Restricted least squares. Special cases of one and two way classifications (including disproportionate cell frequencies and interaction, cross and nested classifications). Analysis of covariance. Variance components models, estimation of variance components from unbalanced data. Unified theory of least -squares, MINQUE, MIVQUE. Mixed models.

AS 205 ADVANCED STATISTICAL INFERENCE

(1L+1P) II

Robust estimation and robust tests. Asymptotic techniques, Bayesian inference. Estimation of density function, Conditional inference, Detection and handling of outliers in statistical data. Loglinear models, saturated models, hierarchical models, Analysis of multi - dimensional contingency tables.

AS 206 OPTIMIZATION TECHNIQUES

(1L+1P) I

Classical and numerical methods of optimization - Constrained optimization, Lagrange multipliers, Direct search methods, Gradient methods. Linear programming techniques -

Simplex method, Karmarkar's algorithm, Duality and Sensitivity analysis, Non-linear programming, Kuhn-Tucker sufficient conditions, Elements of multiple objective programming, Dynamic Programming, Optimal control theory - Pontryagin's maximum principle, Time-optimal control problems.

AS 207 STOCHASTIC PROCESSES (3L) II

Basics of stochastic processes. Random walk models. Markov chains and their applications. Discrete branching processes. Markov processes in continuous time: Poisson process, Random - variable technique. Birth and death processes like pure birth process, linear birth and death process, immigration-birth-death process. Elements of queuing processes - queues in series, queuing networks. Applications of queuing theory. Epidemic processes: Simple deterministic and stochastic epidemic model. General epidemic models - Kermack and McKendrick's threshold theorem. Recurrent epidemics. Chain binomial models. Diffusion processes. Diffusion limit of a random walk and discrete branching process. Forward and backward Kolmogorov diffusion equations and their applications.

AS 208 BIOINFORMATICS – II (2L+1P) III

Genomic databases and analysis of high-throughput data sets, sequence annotation, ESTs, SNPs. BLAST and related sequence comparison methods.

Bayesian techniques and use of Gibbs Sampling, EM algorithm and other statistical methods to discover common motifs in biosequences. Multiple alignment and database search using motif models, ClustalW and others. Concepts in phylogeny.

Gene prediction based on codons, Decision trees, Classificatory analysis, Neural Networks, Genetic algorithms, Pattern recognition, Hidden Markov models. Computational analysis of protein sequence, structure and function.

Expression profiling by microarray/gene chip, proteomics etc., Multiple alignment of protein sequences, Modelling and prediction of structure of proteins, Designer proteins, Drug designing. Advanced topics in design and Analysis of DNA microarray experiments.

(Pre-requisite: AS 171)

AS 299 SEMINAR (1L) I, II, III

AS 301 ADVANCED DESIGN OF EXPERIMENTS- I (2L+1P) II

General properties and analysis of block designs. Balancing criteria. m-associate PBIB designs and their association schemes including lattice designs - properties and construction. Properties and construction of mutually orthogonal latin squares. Designs for two - way elimination of heterogeneity including lattice square designs. Designs for test treatment – control(s) comparisons, Nested designs, Mating designs. Optimality criteria and optimality of designs, robustness of designs. Diagnostics in design of experiments.

AS 302 ADVANCED DESIGN OF EXPERIMENTS - II (2L+1P) III

Balanced factorial experiments - characterisation and analysis (symmetrical and asymmetrical factorials). Factorial experiments with extra treatment(s). Orthogonal and

balanced arrays, Fractional replication, Regular and irregular fractions. Response surface designs - Symmetrical and asymmetrical factorials, Response optimization and slope estimation, Blocking. Canonical analysis and ridge analysis. Experiments with mixtures: design and analysis. Experiments with qualitative cum quantitative factors.

AS 303 ADVANCED SAMPLE SURVEYS - I

(2L+1P) II

Design effect. Number of strata and optimum stratification. Controlled selection. Two way stratification, collapsed strata. Unbiased ratio and regression type estimators, multivariate ratio and regression methods of estimation. Systematic sampling in two dimensions. Multi-stage sampling with unequal probabilities. Self weighting designs. Integration of surveys - Lahiri and Keyfitz's procedures. Variance estimation in complex surveys. Taylor's series linearisation, balanced repeated replication, Jackknife and bootstrap methods. Use of softwares for survey data analysis.

AS 304 ADVANCED SAMPLE SURVEYS - II

(2L+1P) III

Unified theory of sampling from finite populations. UMV - Non-existence theorem and existence theorem under restricted conditions. Concept of sufficiency and likelihood in survey sampling. Admissibility and hyper-admissibility. Inference under super population models - concept of designs and model unbiasedness, prediction approach. Regression analysis and categorical data analysis with data from complex surveys. Domain estimation. Small area estimation.

AS 305 ADVANCED STATISTICAL GENETICS-I

(2L+1P) II

Hardy-Weinberg law with multiple allelic systems, auto-tetraploids and self-sterility alleles. Complex cases of selection with two or more loci. Different approaches to study inbreeding process, methods of path co-efficient, probability and generation matrix. Fisher's approach to inbreeding. Stochastic process of gene frequency change, transition matrix approach using finite Markov chains, diffusion approximation, Steady decay and distribution of gene frequency, Probability of fixation of a gene, Conditional process - Markov chains and diffusion approaches, Distribution of time until fixation, random fluctuations in selection intensity, stationary distribution of gene frequency. Effective population size.

AS 306 ADVANCED STATISTICAL GENETICS - II

(2L+1P) III

Prediction and estimation of genetic merit. Best linear unbiased prediction, Use of mixed model methodology in analysis of animal and plant breeding experiments. Newer reproductive technology and its effect in genetic evaluation of individual merit. Estimation of genetic parameters - problems relating to computational aspects of genetic variance components, parameter estimation in variance component models for binary response data. Identification of genes with large effects, Use of molecular markers (RFLP, PCR-AFLP, RAPD and SSR), Gene mapping and Quantitative trait loci. Molecular manipulation for genetic variability. Survival analysis and concept of censored observation in animal breeding. Phylogeny and analysis of molecular variance.

AS 307 FORECASTING TECHNIQUES**(1L+1P) III**

Forecasting techniques with special reference to agriculture. Forecast based on time series data – exponential smoothing, Box - Jenkins approach and non-linear models. Forecast models using weather parameters crop-weather relationships and their use in yield forecast. Forecast using plant characters, forecast surveys, between-year models (regression model, Markov chain probability model and group method of data handling) and within-year models. Agro-meteorological models - climatic water balance model and crop yield assessment. Forewarning of crop pests and diseases. Applications of remote sensing techniques in forecasting. Use of ANN in forecasting.

AS 308 BAYESIAN INFERENCE IN SURVEY SAMPLING**(1L+1P) III**

Super population models in sample surveys, Stochastic parameter models, Bayes' linear predictor, Bayesian models with multi-stage sampling. Measurement error and small area estimation, Time series approach in survey sampling. Dynamic Bayesian prediction, Kalman filter, Empirical and Hierarchical Bayes predictors, Robust linear prediction, Bayesian robustness.

AS 370 RECENT ADVANCES IN THE FIELD OF SPECIALISATION**(1L) I, II, III**

Recent advances in the field of specialisation-sample surveys/design of experiments/statistical genetics/statistical modelling, etc. will be covered by various speakers from the Institute as well as from outside the Institute in the form of seminar talks.