DEVI AHILYA VISHWAVIDYALAYA, INDORE

School of Statistics

1.1.1
Syllabus of all programs

Choice Based Credit SystemCore Courses

School of Statistics,DAVV for courses 2015- 2016

Section 1

The syllabus modified in 2014 has already made provisions for CBCS in the following manner:

(i) C programming : Enabling an exposure to other discipline and providing an expanded scope for computation based research

(ii) Other core courses are mentioned in section 2

Elective Courses: courses are mentioned in section 2 with *

(iii) Real analysis: Providing an expanded scope for students wishing to appear for NET examinations as a major part of NET syllabus comprises of mathematics courses.

(iv) Econometrics

(v) PIE

(vi) Operations Research (i)

(vii) Operations Research (ii)

iv,v,vi,vii above are all elective papers intended towards Enabling an exposure to other discipline and supportive to discipline of study

(viii) Word and EXCEL: Nurturing students' proficiency/ soft skill and providing an expanded scope for corporate jobs.

Following is the relevant excerpt from the syllabus modified in Jan 2014 by the Board of Studies in statistics:

Nomenclature:

CB: Choice Based for SOSTAT students;

O: May be opted for study by students of other departments (Depending upon availability of space and faculty)

C: Core course for SOSTAT students

G: generic course for SOSTAT students.

Semester I (Total valid credits = 24)

Paper Code Title of the Paper Nomenclature	Credits	SOSTAT Students	Students of other departments
ST – 101 : Measure and Probability Theory	4	**C**	**NA**
ST – 102 : Linear algebra *	4	**CB**	**NA**
ST – 103 : Distribution Theory	4	**C**	**O**
ST- 104 Statistical methods	4	**C**	**O**
ST – 104 : Statistical Computing *	4	**CB,G**	**O**
SP – 106 : Practical paper	4	**C**	**NA**

(Practical paper is based on the contents of Papers ST – 102 .ST – 104 ST 103, ST-104, ST-104)

SEMESTER II : (Total Valid credits = 24)

4 Theory papers of 4 credits each : Total 20 credits

1 Practical of 6 credits : Total 6 credits1 Comprehensive viva voce Examination of 4 virtual credits: Total 4 credits

The courses to be covered in this semester are:

Departmental Core Courses (Compulsory papers) :

Paper Code	Title of the Paper	Credits	SOSTAT Students	Students of other departments
ST – 201	: Sample Surveys and Indian Official Statistics	4	**C**	**NA**
ST – 202	: Stochastic Processes	4	**C**	**NA**
ST – 203	: Statistical Inference - I	4	**C**	**NA**
ST – 204	:Word Processing Through MS Word and Spreadsheets: MS Excel*	4	**CB,G**	**O**
ST – 205	: Multivariate Analysis	4	**C**	**NA**
SP – 206	: Practical Paper	4	**C**	**NA**

(based on the contents of Papers ST –201 6,ST – 202 and ST – 203, ST 204, ST 204)

SEMESTER III : (Total valid credits = 22)

4 Theory papers of 4 credits each : Total 16 credits

1 Major Project of 6 credits : Total 6 credits

1 Comprehensive viva voce Examination of 4 virtual credits: Total 4 credits

The courses to be covered in this semester are:

Departmental Core Courses(compulsory papers):

Paper Code	Title of the Paper	Credits	SOSTAT Students	Students of other departments
ST – 301	Statistical Inference II	4	**C**	**NA**
ST – 302	Design and Analysis of Experiments	4	**CB**	**O**
	Major Elective Courses :			
ST – 303	Operations Research (i)*	4	**CB,G**	**O**
ST – 304	Statistical process and Quality Control *	4	**CB,G**	**O**
ST - 304	Project involving: Statistical techniques/Operations research/ Computer software/Programming	6	**C**	**NA**

SEMESTER IV : (Total credits = 22)

4 Theory papers of 4 credits each : Total 16 credits

1 Major Project of 6 credits : Total 6 credits

1 Comprehensive viva voce Examination of 4 virtual credits: Total 4 credits

The courses to be covered in this semester are :

Major Elective Courses : Paper Code Title of the Paper Credits

		SOSTAT Students	Students of other departments
ST – 401 Linear Models and Regression Analysis	4	**C**	**NA**
ST – 402 Econometrics*	4	**CB,G**	**MA**
ST – 403 Operations Research (ii)*	4	**CB,G**	**NA**
ST – 404 Planning and Analysis of Industrial Experiments *	4	**CB,G**	**O**
ST-404 Analysis *	**4**	**C**	**NA**
ST - 406 Project involving: Statistical techniques/Operations research/Computer software/Programming	6	**C**	**NA**

ST- 101 Measure And Probability

Classes of sets, fields, fields, minimal fields, Borel fields In Rk , sequence of sets, limSup and limInf of sequence of sets, (8 L)

Measure , Carathedeory extension theorem(statement only), Lebesgue and Lebesgue Steiltjes measures on Rk. Properties of measure, Probability measure, Classical, statistical and axiomatic definitions of Probability, compound Probability, additive, multiplicative and other important theorems (of probability) and their applications. Conditional probability, Baye's theorem, their applications, Independence of events. (15 L)

Measurable functions, random variables, distribution functions, Independence of random variables, sequence of random variables, almost sure convergence, convergence in probability, integration of a measurable function with respect to a measure, monotone convergence theorem, Fatou's lemma, dominated convergence theorem.(10 L)

Convergence in distribution, Cramer and Slutsky's Theorems.

Characteristic function, uniqueness theorem, Levy's continuity theorem (statement only),Inversion theorem and applications based on them. (6 L)

Borel- Cantelli Lemma, Weak law and strong law of large numbers, (6)

CLT for sequence of independent random variables under Linderberg's condition, CLT for iid random variables. (6 L)

Reference:

Bhat, B.R. : Modern probability Theory, New Age Publishers

Rohatgi, VK. .(1984) : An Introduction to Probability Theory And Mathematical Statistics, Wiley Eastern.

Additional References:

Billingsley, P. (1986). Probability and Measure. Wiley.

Dudley, R. M. (1989). Real Analysis and Probability, Wadsworth and Brooks/Cole. Cambridge University Press.

Basu, A. K. (2003) : Measure theory and probability. PHI.

ST- 102 Linear Algebra

Vector space and subspaces, linear dependence and independence, basis and dimension of a vector space, finite dimensional vector spaces, completion theorem, examples of vector spaces over real and complex fields, linear equations. (5 L)

Vector spaces with an inner product, Gram-Schmidt
ortf301hogonalization process, orthonormal basis and orthogonal
projection of a vector (5 L)

Liner transformations, algebra of matrices, row and column spaces of a matrix, elementary matrices, determinants, rank and inverse of a matrix, null space and nullity, partitioned matrices, Kronecker product. (4 L)

Hemite canonical form, generalized inverse, Moore-Penrose generalized inverse, idem potent matrices, solutions of matrix equations. (6 L)

Real quadratic forms, reduction and classification of quadratic forms, index and signature, triangular reduction of a positive definite matrix. (6 L)

Characteristic roots and vectors, Cayley-Hamilton theorem, minimal polynomial, similar matrices, algebraic and geometric multiplicity of a characteristic root, spectral decomposition of a real symmetric matrix, reduction of a pair of real symmetric matrices, Hermitian matrices. (6 L)

Singular values and singular value decomposition, Jordan decomposition, extreme of quadratic form, vector and matrix differentiation. (8 L)

References

Graybill, F.A.(1983), matrices with application and statistics, second edition, Wadsworth

Rao, C.R.(1973), Linear Statistical Inference and its application, second edition. John Wiley and Sons, Inc.Scarle, S.R.(1982), Matrix Algebra useful for Statistics, John Wiley and Sons, Inc.

Additional References

Bellman, R. (1970) Introduction to Matrix Analysis, Second Edition.
McGraw Hill Biswas, S.(1984), Topics in Algebra of Matrices.
Academic Publications. Hadley, G.(1987). Linear Algebra, Narosa
Publishing House

Halmos, P.R.(1958), Finite Dimensional Vector Spaces, Second Edition, D.Van Nostrand Company, Inc.

Hoffman, K. and Kunze, R.(1971), Linear Algebra , Second Edition, Prentice Hall, Inc.

Rao, A. R. and Bhimasankaram, R(1992) Linear Algebra, Tata Mcgraw Hill
Publishing Company Limited.

Rao, C. R. and Mtra, S.K.(1971) Generalized Inverse of Matrices and its
Applications, John Wiley and Sons, Inc.

Practicals: Ranks,Finding Eigenvalues Eigenvectors, Quadratic forms,Linear transformations, Orthogonal transformation, Gram Schmidt Orthogonalisation, Finding G Inverse, Solving system of Linear Equations.

ST- 103 Distrution Theory

Distribution: function pdf, pmf, mgf, pgf, cgf, joint, marginal and conditional distribution, Compound, truncated and mixture distribution, conditional expectation independence of random variables, functions of random variables and their distributions using jacobian of transformation and other tools, convolutions. (15)

Expectation, Markov, Holder, Jensen and Liapunov inequalities. (4)

Sampling distributions. Distribution of sum of iid random varribles. Distribution of sample mean and

variance for random samples form bivariate normal distribution, Chi-square, t-and F-distributions and their properties. Tests of hypotheses based on them. Non central - Chi-square, t-and F-distributions. (15)

Order statistics – their distributions and properties. Joint and marginal distributions of order statistics. Distribution of median, range etc., Extreme values and their asymptotic distributions (Statement only) with Applications. Approximating distributions of sample moments. (10)

REFERENCES

Dudewicz, E.J. and Mishra, S.N.(1988): Modern Mathematical Statistics, Wiley, lnt'l Students' Edition. Rohatgi, VK. .(1984) : An Introduction to Probability Theory And Mathematical Statistics, Wiley Eastern. Mukhopadhyay. P. Mathematical Statistics P. ,Books & Allied (P)

Mood A., Graybill ,I and Boes, D.C., Introduction to the Theory of Statistics, McGraw Hill, Kogakusha, Int Student Edition

Goon, A.M., Gupta, M.K., Dasgupta, B., An Outline of statistical Theory Vol I and Vol II: World Press

S.C.Gupta And V.K. Kapoor: Fundamentals Of Mathematical Statistics

ADDIIIONAL REFERNCES

Rao, C.R. (1973): Linear Statistial Inference and Its Applications, 2/e, Wiley

Eastern. Pitmam J. (1993): Probability, Narosa Publishing House,

Johnson, S. and Kotz, (1972): Distributions in Statistics, Vol. I, II and III, Houghton

and Miffin, Cramer H. (1946), Mathematical Methods of Statistics, Princeton.

Practicals: Large sample tests, Tests of significance based on chi-square , t, F, z distribution

ST-104 Statistical Methods

Review of basic statistical methods: Frequency distributions, Measures of location, dispersion, skewness and kurtosis, factorial and absolute moments, Bivariate frequency distributions. (8)

Method of least squares, Curve fitting: linear, non-linear and curvilinear, Orthogonal polynomials. Regression and correlation. Product moment correlation coefficient, correlation index, correlation ratio, intra-class correlation coefficient, Measures of association and contingency. (12)

Discrete distributions: degenerate, Bernoulli, Binomial, Poisson, Geometric, Negative binomial, hypergeometric, uniform, Multinomial distribution and its marginal and conditional distributions.(12)

Continous distributions : Uniform, Normal, Lognormal, Exponential, Laplace, Pareto, Beta, Gamma, Cauchy. (12)

Fitting of commonly used discrete and continuous distributions. (4)

REFERENCES:

An Introduction to probability and Statistics: Rohtagi, V.K.

Fundamentals of Statistics Vol. I : Goon Gupta and Dasgupta

Fundamentals of Mathematical Statistics: Kapoor, V.K. and Gupta, S.C. Sultan Chand & Sons,

Mathematical Statistics : Mukhopadhyay, P. Books & Allied (P) Ltd.

ADDITIONAL REFERENCES

Pitman, J. (1993) : Probability, Narosa Publishing House,Johnson, S. and Kotz, (1972): Distributions in Statistics, Vol. I,II and III, Houghton and Miffin.

Cramer, H. (1946) Mathematical Methods of Statistics, Princeton.

Practicals: Graphical Techniques and measures of central tendency, dispersion, skewness and kurtosis.Method of least squares, Curve fitting: linear, non-linear and curvilinear, Orthogonal polynomials. Regression and correlation. correlation index, correlation ratio, intra-class correlation coefficient, Measures of association and contingency. Fitting of distributions: Binomial, Hypergeometric, Poisson, Normal,Exponential,

St-105 : Statistical Computing

Programming in a high level language such as C (or C++) . The purpose of this unit is to introduce programming with the eventual aim of developing skills required to write statistical software Should there be previous exposure to programming, this unit can be replaced by a more advanced unit in object-oriented programming in C + + or Java. Topics should include simple svntax, loops pointers and arrays functions, input/output, and linking to databases. (25)

Numerical analysis and statistical applications. The purpose of this unit is to apply programming skills in methods and algorithms useful in probability, statistics and data analysis, Topics should include numerical integration, root extraction, random number generation, Monte Carlo integration, and matrix computations, Should these be previous exposure to numerical analysis, more advance techniques such as permutation tests and simulation of Poission processes can be presented. (10)

A statistical package such as MINITAB, SAS OR SPSS. The purpose of this unit is to use a statistical package to carry out statistical procedures already known to students. No new statistical methods should be presented but interesting data can be analyzed using known methods on the package. Topics should include graphics, descriptive statistics representation of multivariate data, simple hypothesis tests, analysis of variance, and linear regression. (5)

REFERENCES

B.W.Kernighan and D.M. Ritchie (1988): The C Programming Language, Second Edition, Prentice Hall.

W.H. Press, S.A. Teukolsky, W.T. Vellering, and B.P. Flannery (1993), Numerical Recipes in C, Second Edition. Cambridge University Press.

B. Ryan and B.L. Joiner (2001): MINITAB Handbook, Fourth

Edition, Duxbury. R.A. Thisted (1988). Elements of Statistical

Computing Chapman and Hall.

Note on suggested books : The choice of textbooks and references depends on the programming language and statistical package used. The above assumes C and MINITAB.

Practicals: Programming through C for the practicals mentioned in ST 103,104,102 and for numerical techniques(numerical integration, differentiation , finding roots of equations, search and sort

techniques. measures of central tendency, dispersion, skewness and kurtosis. Fitting of distributions: Binomial, Hypergeometric, Poisson.

ST- 201 Sample Surveys and Indian Official Statistics

A Sample surveys:

Review of basic finite sampling techniques [SRSWR/WOR, Stratified, Systematic] and related result on estimation of population mean/total, allocation problem in stratified sampling (10)

Unequal probability sampling: PPSWR/WOR methods [including Lahiri's scheme] and related estimators of a finite population mean [Hansen-Hurwitz and Desraj estimators for a general sample size and murthy's estimator for a sample of size 2] (10)

Ratio and regression estimators based on SRSWOR method of sampling. Two stage sampling with

equal number of second stage units. Double sampling. Cluster sampling. (10)Randomized response technique [Warner's model: related and unrelated questionnaire methods] (5)

Indian Official Statistics and its use and applications in various fields viz Agriculture, Industry etc.; Census (6)

REFERENCES

Chaudhuri, A. and Mukherjee, R.(1988) Randomized response: Theory and techniques, New York: Marcel Dekker Inc.

Cochran, W. G.: Sampling techniques [3 rd edition,(1977)],Wiley

Desraj and Chandak (1998): Sampling theory, Narosa

Murthy, M.N.(1977) : Sampling theory & methods, Statistical publishing society. Calcutta

Sukhatme et al (1984), Sampling theory of surveys with applications. Iowa state University press &

IARS

Singh, D and Chaudhary, F.S.(1986), Theory and analysis of sample survey design. New Age international Publishers.

Practicals : SRSWR/WOR, Stratified, Systematic-- Finding mean, variance, Allocations(for stratified sampling). Sample size determination.

B Official Statistics: (10L)

Population growth, Economic development, Indices of development, Human development indices, Measuring inequality in incomes, Gini Coefficient, Poverty measurement, different issues, estimation of national income- product approach, income approach and expenditure approach, GDP

Reference:

CSO(1980) National Accounts Statistics – Sources and health

UNESCO: Principles of Vital Statistics Systems Series M-12

Ministry of Statistics and Program Implementation Website:
MOSPI.nic.in

ST- 202 :Stochastic Processes

Introduction to stochastic processes (sp's) classification of SP's according to state space and time domain. Countable state markov chains (ms's), Chapman- kolmogrov equations; calculations of n-step transition probability and its limit. Stationary distribution, classification of states; transient MC; random walk and gambler's ruin problem; application from social, biological and physical sciences. (10)

Branching process: Galton- Watson branching process, probability of ultimate extinction, distribution of population size. Martingale in discrete time. Statistical inference in MC and Markov processes. (10) Discrete state space continuous time MC: Kolmogrov-Feller differential equations; Poisson process, birth and death process; Applications to queues and storage problems. Wiener processes as a limit of random walk; first passage time and other problems. (15)

Renewal theory elementary renewal theorem and application and uses of key renewal theorem, study of residual lifetime process. (10)

Stationary process: weakly stationary and strongly stationary processes; moving average and auto regressive processes. (5)

REFERENCES

Adke, S.R. and Manjunath, S.M. (1984): An introduction to Finite Markov processes, Wiely Eastern.

Bhat, B.R. (2000) Stochastic Models: Analysis and Applications, New age International, India. Ross, S. Introduction to Probability Model, Elsevier Publication.

Cinlar, E. (1975): Introduction to Stochastic Processes, Prentice, Hall.

Feller, W. (1968): Introduction to Probability and its Applications Vol. 1, Wiely

Eastern. Harrils, T.E. (1963): The Theory of Branching Process, Springer

Verlag.

Hoel, RG, Port, S.c. and Stone, C.J. (1972): Introduction to Stochastic Processes,

Houghton Miffin & Co.

Jagers, P.(1974): Branching Processes with Biological Applications, Wiley.Karlin, S. and Taylor, H.M. (1975): A first course in Stochastic Processes, Vol. 1, and Academic Press

Medhi, J. (1982): Stochastic Processes, Wiley Eastern.

Parzen, E. (1962): Stochastic Processes, Holden-Day.

ST 203 : Statistical Inference - I

Parametric models: Estimation

Point estimation:

Properties of a good estimator: Unbiased, consistent, efficient , sufficient estimators. Consistent

Estimation of real and vector valued parameter., Extension to multiparameter exponential family,

Examples of consistent but not asymptotically normal estimators from Pitman family.

Consistent Asymptotic Normal (CAN) estimator, lnvariance of CAN estimator, Mean squared error

criterion, (10)

Information in data about the parameters as variation in Likelihood Function, concept of no

information, Sufficiency, Neyman Factorizability Criterion, Likelihood Equivalence, Minimal

Sufficient Statistic, Exponential families and Pitman Families, Fisher information for one and

several parameters models. Minimum variance unbiased estimators, Rao - Blackwell Theorem,

completeness, Lehmann - Scheffe theorem, necessary and sufficient conditions for MVUE, Cramer

– Rao lower bound approach. One parameter exponential family. (15)

Interval estimation: confidence level, construction of confidence interval using pivots, confidence

intervals based on CAN estimators shortest expected length confidence interval, uniformly most

accurate one sided confidence interval (5)

Methods of estimation :

Method of maximum likelihood, Likelihood Function, Examples from standard discrete and continuous models (such as Bernoulli, Poisson, Normal, exponential, Gamma, Pareto etc.) Solution of likelihood equations, Method of scoring, Newton - Raphson and other iterative procedures, MLE in Pitman family and Double

Exponential Distribution, Properties of M.L. estimators. Other methods of estimation: Methods of

moments and percentiles, (15)

CAN property of estimators obtained by methods of moments ,percentiles and MLE method in one parameter exponential family, Cramer family, Choice of estimators based on unbiasedness, minimum variance, mean squared error, (5)

REFERENCES

Kale, B. K. (1999) A first Course on Parametric Inference, Narosa Publishing House.

Rohatgi V. (1988). An Introduction to Probability and Mathematical Statistics. Wiley Eastern Ltd.

New.Delhi (Student Edition)

ADDITIONAL REFERENCES

Lehmann E. L. (1986) - (Latest) Theory of Point.Estimation (Student Edition) Rao, C. R. (1 973) : Linear Statistical Inference.

Dudewicz, E. J. and Mishra, S. N. (1988). Modern Mathematical Statistics. Wiley Series in Prob. Math. Stat., John Wiley and Sons, New York (Internatioai Student Editinn)

Zacks, S. (1971). Theory of Statistical Inference, John Wiley and Sons, New York.

Practicals: Finding Estimators using M.L.method, method of moments, Confidence intervals, Comparison of efficiency of estimators

ST-204 Word Processing Though MS-Word and Introduction to spreadsheets:

INTRODUCTION TO SPREADUCTION TO

SPREADSHEET: MS EXCEL Worksheet basics

Getting started ,Entering information in a worksheet , Enter the heading information as text

Entering data , Entering text , Entering dates, Saving worksheet ,Quitting a worksheet , Closing a worksheet

Opening a worksheet and moving around, Steps to select cells in a worksheet, Steps to select multiple cells in a worksheet

Range: Selecting, naming and using data ranges in a

worksheet Toolbars: Standard and formatting toolbar

Using toolbars, Changing font size and style, displaying

the current format Using menus, Using keyboard shortcuts

Worksheet Functions :

Arrays (10 L) (Matrix operations, Frequency distribution from raw data, Fitting of commonly used

statistical distributions, correlation, etc)

Editing data in a cell: Copying entries, Using shortcuts menus

Editing and copying formulae .Absolute and relative cell

references. Creating, Labeling, Editing,, formatting and

printing a work sheet.

Creating and editing graph from worksheet, changing scales, adding background grids, Fitting of least squares curve, Managing use of more than one worksheet, workbook.

Use of spreadsheets for statistical analysis : Presentation, graphical analysis, and regression analysis. Pivot Tables ,tests of statistical hypotheses (10 L)

Word Processing Package MS-Word (Latest Version)

Basics :

Introduction to word Processing : Creating Documents , Saving documents , Quitting

Documents Printing a document, Editing , formatting ,merging documents. Mail Merge.

Microsoft OFFICE 2000—GINI COUMRTER and Annette Marquis, BPB publications

MS WORD-2000 Thumbrules and Details — S. Banerjee, New Age International Publishers

ST- 205: MULTIVARIATE ANALYSIS

Multivariate normal distribution, marginal, conditional distributions, properties, characteristic function. Random sampling from a multivariate normal distribution. Maximum likelihood estimators of parameters. Distribution of sample mean vector. `(10 L)

Wishart Matrix-Its distribution and properties. Distribution of sample generalized variance. Null and non-null distribution of simple correlation coefficient. Null distribution of partial and multiple correlation coefficients. Distribution of sample regression coefficients. Application in testing arid interval estimation. Application in testing and interval estimation. (10 L)

Null distribution of Hotelling's T2 statistic. Application in tests on mean vector for one and more multivariate normal populations and also on equality of the components of a mean vector in multivariate normal populations. (8 L)

Multivariate linear regression model -Estimations of parameters, test of hypotheses about regression coefficients. Likelihood ratio test criterion. Multivariate analysis of variance [MANOVA] of one-and

two way classified data. (8 L)Classification and discrimination procedures for discrimination between two multivariate normal

populations – Sample discriminant function, tests associated with discriminant functions, probabilities of misclassification and their estimation, classification into more than two multivariate normal populations. (6 L)

Principal components, dimension reduction, canonical variable and canonical correlation – definition, use estimation and computation. (6 L)

Reference

Anderson, T, W. (1983): An Introduction to Multivariate Statistical Analysis.2nd Ed. Wiley. Giri, N.C. (1977): Multivariate Statistical Inference. Academic Press.

Kshirsagar, A.M. (1972): Multivariate Analysis, Marcel Dekker.

Morrison, D.F. (1976): Multivariate Statistical Methods 2nd edition, McGraw Hill Muirhead, R.J. (1982) Aspects of Multivariate Statistical Theory. J Wiley

Rao, C.R. (1973) Linear Statistical Inference and its application 2nd Edition. Wiley Seber, G.A.F. (1984): Multivariate Observations, Wiley

Sharma, S. (1996): Applied Multivariate Techniques. Wiley

Srivastava, M.S.and Khatri, C.G. (1979): An Introduction To Multivariate Statistics North Holland

Johnson, R.and Wychern (1992): Applied Multivariate Statistical Analysis, Prentice – Hall, 3rd Ed.

Practicals: Fitting of Multivariate normal distribution. Marginal and conditional distributions.

Hotelling's T^2 statistic, , tests associated with discriminant functions, probabilities of misclassification

and their estimation, classification into two and three multivariate normal populations. Principal

components, dimension reduction, canonical variable and canonical correlation

ST 301 Statistical INFERENCE - II

Tests of Hypotheses

Concepts of critical regions, test functions, two kinds of errors, size function, power function, level, MP and UMP test in class of size alpha tests. Connection of test of hypotheses with interval estimation (8 L)

Neyman - Pearson Lemma, MP test for simple null against simple alternative hypothesis. UMP tests for simple null hypothesis against one sided alternatives and for one sided null against one sided alternatives in one parameter exponential family. Extension of these results to Pitman family when only upper or lower end depends on the parameter and to distributions with MLR property, non-existence of UMP test for simple null against two sided alternatives in one parameter exponential family. (14 L)

Likelihood Ratio Test (LRT), Asymptotic distribution of LRT statistic, Wald Test, Rao's score test, Pearson Chi2 test for Goodness of fit, Bartlett's Test for homogeneity of variances.

Variance stabilizing transformation and large sample tests. (10)

Error probabilities, Minimum sample size required to attain given level of accuracy. (4 L)

Non Parametric Tests: .(Emphasis will be more on concepts and applications)

Testing of hypotheses under nonparametric setup. Review of single sampling problems(Tests of randomness, tests of goodness of fit, the problem of location). (8)

Two sample problems: Sign test, Wald Wolfowitz run test. Mann Whitney Wilcoxon test, median

test, K-S test, Kendall's Tau, Rank Correlation, Kruskal Wallis test, Friedman's two way ANOVA by ranks , Asymptotic relative efficiency, (12)

REFERENCES

Kale, B. K. (1999) A first Course on Parametric Inference. Narosa Publishing House.

Rohatgi V. (1988). An Introduction to Probability and Mathematical Statistics. Wiley Eastern Ltd. New Delhi (Student Edition)

Gibbons J.D. (1971) non Parametric Inference, McGraw Hill

Mukhopadhyay, P.(2002) Mathematical Statistics, Books and Allied (P)

ADDITIONAL REFERENCES

Lehmann, E. L. (1986). Testing Statistical hypotheses (Student Edition)

Rao, C. R. (1973) : Linear Statistical Inference.

Dudewicz. E, J. and Mishra, S. N. (1988). Modern Mathematical Statistics,. Wiley Series in Prob.

Math.,Stat , John Wiley and Sons, New York (International Student Edition)

Ferguson, T, S. (1996). A course on Large Sample Theory. Chapman and Hall, London.

ST 302: DESIGN AND ANALYSIS OF EXPERIMENTS

Introduction to designed experiments; General block design and its information matrix (C), criteria for connectedness, balance and orthogonality; Intrablock analysis (estimability, best point estimates/interval estimates of estimable linear parametric functions and testing of linear hypotheses); BIBD- recovery of interblock information; Youden design - intrablock analysis.

Analysis of covariance in a general Gauss-Markov model, applications to standard designs. Fixed, mixed and random effects models,- Variance components estimation - study of various methods; Tests for variance components; Missing plot technique- general theory and applications.

General factorial experiments, factorial effects; best estimates and testing the significance of factorial effects; study of 2 and 3 factorial experiments in randomized blocks; Complete and partialconfounding. Fractional replication for symmetric factorials. Split plot and split block experiments.

Application areas: Response surface experiments; first order designs and orthogonal designs;

Model validation and use of transformation; Tukey's test for additivity.

REFERENCES

Aloke Dey (1986): Theory of Block Designs, Wiley Eastern.

Angela Dean and Daniel Voss (1999): Design and Analysis of Experiments, Springer.

Das, M.N. and Giri, N.(1979): Design and Analysis of Experiments, Wiley Eastern

Giri,N.(1986): Analysis of Variance, South Asian Publishers

John, RW.M.(1971): Statistical Design and Analysis of Experiments, Macmillan

Joshi,D.D.(1987): Linear Estimation and Design of Experiments, Wiley Eastern

Montgomery,C.D.(1976): Design and Analysis of Experiments, Wiley, New York

Myers, R.H..(1971): Response Surface Methodology, Allyn & Bacon

Pearce,S.C.(1984): Design of Experiments, Wiley, New York

Rao,C.R..and Kleffe, J.(1988): Estimation of Variance Components and applications, North Holland.

Searle, S. R.. Casella, G. and McCulloch, C. E.. (1992): Variance Components, Wiley.

ST 303 OPERATIONS RESEARCH I

Definition and scope of Operational research; phases in Operations Research; models and their solutions. (4 L)

Linear programming problems. Simplex, revised simplex and dual simplex methods, .duality theorem, Post optimality problems and sensitivity analysis transportation and assignment problems;. (15 L)

Analytical structure of inventory problems; EOQ formula of Harris, its sensitivity analysis and

extensions allowing quantity discounts and shortages.. Multi-item inventory subject to constraints. Models with random demand, the static risk model. P and Q-systems with constant and random

lead times. S-s policy for inventory. (12 L)

Queueing models-specifications and effectiveness measures. Steady-state solutions of M/M/1 and M/M/c models with associated distributions of queue-length and waiting time. M/G/1 queue and Pollackzek Khinchine result. Steady-state solutions of M/Ek/l and Ek/M/1 queues. Machine interference problem. (12 L)

REFERENCE:

Taha H.A. (1982) Operational Research: An Introduction; Macmillan.

Gupta P K., D S. Hira: Operations Research: Sultan Chand & Co

Kanti Swarup, Gupta,P.K. and Singh,M.M.. :(1985) Operations Research; Sultan Chand & Sons. Gass, S.I. Linear Programming

Additional REFERENCES

Philips D.T., Ravindran A. and Solberg J.( ) Operations Research, Principles and Practice. Churchman, C. W., Ackoff, R.L., and Arnoff, E.L.(1957) Introduction to Operations Research; John Wiley

Hadley, G. Linear Programming

Sasieni,M,, Yaspan,A, and Friedman,L: Operations Research- Methods and Problems , Wiley International

Gross, D. aid Harris, C.M.,(1974) Fundamentals of Queuing Theory; John Wiley

Kleinrock L. (1 975) Queueing Systems, vol. 1, Theory; John Wiley

Saaty T.L. (1961) Elements of Queueing Theory with Applications; McGraw Hill

Hadley G. and Whitin T.M. (1963) Analysis of Inventory Systems; Prentice HallStarr M.K. and Miller D.W. (1962) Inventory Control-Theory and Practice; Prentice Hall

Murthy K.G. (1976) Linear and Combinatorial Programming; John Wiley

ST- 304 STATISTICAL PROCESS AND QUALITY CONTROL

Basic concept of process monitoring and control, process capability and process optimization.(4 L) General theory and review of control charts for attribute and variable data; O.C. and A.R.L. of control

charts; control by gauging; Moving average and exponentially weighted moving average charts; Cusum charts using V-masks and decision intervals; economic design of X-bar chart. (10 L)

Acceptance: sampling plans for attribute inspection; single, double and sequential sampling plans and their properties; plans for inspection by variables for one-sided and two-sided specifications; Mil Std and IS plans; Continuous sampling plans of Dodge type and Wald-Wolfiwitz type and their properties. Bayesian sampling plans.(12 L)

Capability indictor Cp, Cpk and Cpm; estimation confidence intervals and tests of hypotheses relating to capability indices for Normally distributed characteristics. (4 L).

Use of Design of Experiments in SPC; factorial experiments, fractional factorial designs, construction of such designs and analysis of data. (10 L)

Multivariate quality control; use of control ellipsoid and of utility functions. (4 L)

REFERENCES

Montgomery, D C (1985) Introduction to Statistical Quality
Control; Wiley Montgomery, D C (1985) Design and Analysis of
Experiments; Wiley

Ott, E.R. (1975) Process Quality Control; McGraw Hill

.

ST- 401 Linear Models And Regression Analysis

Gauss Markov set-up, Normal equation and least squares estimates, Error and estimation spaces, Variances and co-variances of least squares estimates, estimation of error variances, estimation with correlated observations, least squares estimates with restriction on parameters, simultaneous estimates of linear parametric functions. (15 L)

Test of hypothesis of for one and more than one linear parametric functions, confidence intervals and regions, ANOVA, Power of F-test, multiple comparison tests due to Tukey and Scheffe, simultaneous confidence intervals. (8 L)

Introduction to one –way random effects linear models and estimation of variance components. (4 L Residuals and their plots as tests for departure from assumptions such as fitness of the model normality, homogeneity of variances of outliers. Remedies. (8 L)

Introduction to nonlinear models. (3 L

Multicollineariy, Ridge regression and principal component regression, subset selection of explanatory variables, Mallow's Cp statistic .(12 L)

REFERENCES

Kshirsagar, A. A course in Linear Models, Marcell Dcker

Cooke, R.D. and Weisberg, S. (1982). Residual and Influence in Regression, Chapman and Hall. Draper, N.R. and Smith, H. (1998). Applied Regression Analysis. 3rd Ed. Wiley.

Gurist, R.F. and Mason, R.L. (1980). Regression Analysis and Its Applications –A Data Oriented

Approach. Marcel and Dekker.Rao, C.R. (1973). Linear Statistical Inference and Its Applications. Wiley Eastern. Weisberg, S.(1985). Applied Linear Regression. Wiley.

Practicals: Test of hypothesis of for one and more than one linear parametric functions, confidence intervals and regions, ANOVA, Power of F-test, multiple comparison tests due to Tukey and Scheffe, simultaneous confidence intervals. Residuals and their plots as tests for departure from assumptions such as fitness of the model normality, homogeneity of variances of outliers.

ST-402 ECONOMETRICS

Nature of econometrics. The general linear model (GLM) and its extensions. Ordinary least squares (OLS) estimation and prediction. Use of dummy variables and seasonal adjustment. Generalized least squares (GLS) estimation and prediction. Heteroscedastic disturbances. Pure and mixed estimation.

Grouping of observations and of equations. (12 L)

Auto correlation, its consequences and tests, Theil BLUS procedure. Estimation and prediction.

Multicollinearity problem, its implications and tools for handling the problem. Ridge regression. (8 L)

Linear regression with stochastic regressors. Instrumental variable estimation. Errors in variables.

Autoregressive linear regression. Distributed lag models. Use of principal components, canonical

correlations and discriminant analyses in econometrics. (8 L)

Simultaneous linear equations model. Examples. Identification problem. Restrictions on variances and covariances.(8 L)

Estimation in simultaneous equations model. Recursive systems. 2 SLS Estimators. Limited information estimators, k-class estimators. 3 SLS estimation. Full information maximum likelihood method. Prediction and simultaneous confidence intervals. Monte Cario studies and simulation.(12 L)

REFERENCES

Apte PG (1990) : Text book of Econometrics. Tata McGraw Hill.

Cramer, J.S. (1971) : Empirical Econometrics, North Holland.

Gujarathi, D (1979) Basic Econometrics, McGraw Hill.

Intrulligator, MD (1980) : Econometric models – Techniques and applications, Prentice Hall of India.

Johnston, J. (1984): Econometric models, Third edition, McGraw Hill.

Klein,L.R. (1962) An Introduction to Econometrics, Prentice Hall of India.

Koutsoyiannis, A. (1979) : Theory of Econometrics, Macmillan Press.

Srivastava, V.K. and-Giles D.A.E. (1987) : Seemingly unrelated regression equations models, Marcel Dekker.

Theil, H. (1982): Introduction to the theory and practice of Econometrics, John Wiley.

Walters, A (1970): An introduction to Econometrics, McMillan & Co.

Wetjeroll,G.B. (1986) : Regression analysis with applications, Chapman Hall.

ST 403 OPERATIONS RESEARCH II

Mutti-stage decision processes and Dynamic Programming. Bellman's principle of optimality, general formulation, computational methods and application of dynamic programming. (6)

Integer programming-branch and bound algorithm and cutting plane algorithm. Branch and bound method for solving travelling salesman problem. Multi-criterion and goal programming. (6)

Decision-making in the face of competition, two-person games, pure and mixed strategies, existence of solution and uniqueness of value in zero-sum games, finding solutions in 2x2, 2xm and mxn games (10)

Non- linear programming-Kuhn Tucker conditions, Wolfe's and Beale's algorithms for solving quadratic programming problems.(6)

Replacement problems; block and age replacement policies; dynamic programming approach for maintenance problems; replacement of items with long. life. (10)

Project management; PERT and CPM; probability of project completion, PERT-crashing. (8L)

Monte-Carlos techniques.(6)

REFERENCES

Taha H.A. (1982) Operational Research: An Introduction; Macmillan.

Sasieni,M,, Yaspan,A, and Friedman,L: Operations Research- Methods and Problems ,

Wiley International

Kanti Swarup, Gupta,P.K. and Singh,M.M.. (1985) Operations Research; Sultan Chand & Sons.

Gupta,P.K. and Hira,D.S. Operations Research, S. Chand & Co.

Hadley G. (1 964) Non-linear and Dynamic programming; Addison Wesley

Mckinsey J.C.C. (1952) Introduction to the Theory of Games; McGraw Hi

ST-404: PLANNING AND ANALYSIS OF INDUSTRIAL EXPERIMENTS

Analysis of single replicate of 2k Full Factorial Experiment total and artial confounding in 2k full Factorial m E>periment, Resolution III, IV and V fractions of 2k experiments. (10 L)

Criteria in selecting factorial designs: Criteria based on the Spectrum of the information matrix-A and D optimality Criteria based on alias matrix. (8 L)

Construction of layouts of orthogonal array experiments and associated linear graphs to study some of the main effects and first order interactions of 2^K designs which need not be resolution 3 designs, (designs known as Taguchi designs) with special cases of L_8 and L_16. (12 L)

3^K Full factorial designs, Total and confounding in 3^ K Factorial experiments. Construction of Orthogonal array experiments involving three level factors, with special cases of L_9, and L_18. (12 L) Roll of Center Composite Designs (CCD) as alternative to 3k designs, probability of CCD, Linear and quadratic Response surfaces, contour plots. (8 L)

Role of non normality, Box-Cox transformation, Generalized linear models (GLIM), for exponential family of distributions.(8 L)

REFERENCES

D. C. Montgomery: Design and Analysis of Experiments, J. Wiley and Sons (Asia) 5th edition (2001). R.H. Myers & D. C. Montgomery: Response Surface Methodology, J, Wiley and Sons.

J. Fox : Quality through Design, McGraw-Hill Book Company, 1993. J.A. Nelder and P. McCullagh : Generalized Linear Models, 2nd edition.

B. L. Raktoe, A. Hedayat and W.T. Federer, Factorial Designs, J, Wiley and Sons. 1981.

ST-405 Analysis:

Elementary set theory, finite, countable and uncountable sets, Real number system as a complete ordered field, Archimedean property, supremum, infimum. Sequences and series, convergence, limsup, liminf.

Bolzano Weierstrass theorem, Heine Borel theorem. Continuity, uniform continuity, differentiability, mean value theorem. Sequences and series of functions, uniform convergence, Riemann sums and Riemann integral, Improper Integrals. Monotonic functions, types of discontinuity, functions of bounded variation, Lebesgue measure, Lebesgue integral. Functions of several variables, directional derivative, partial derivative, derivative as a linear transformation, inverse and implicit function theorems.

Metric spaces, compactness, connectedness. Normed linear Spaces. Spaces of continuous functions as examples.

Reference:

Walter Rudin, Principles of Mathematical Analysis(3rd edition), McGraw-Hill international editions

T.M. Apostol, Mathematical Analysis(2nd edition), Narosa Publishing House, New Delhi, H.L. Royden, Real Analysis(4th edition), Macmillan Publishing Company

School of Statistics,
D.A.V.V., Indore

M.PHIL - STATISTICS (FULL-TIME) –2009- 2010 and ONWARDS

SCHEME OF EXAMINATION

M.Phil. Statistics

M.Phil. Semester I

CODE	SUBJECT	L	S	C
SMP 1	Review of Basic Statistical Techniques and Applications to Data Mining.	4	2	6
SMP 2	**Stochastic Models and Simulation**	4	2	6
SMP 5	**Term Paper**		6	6
SMP 6	Live Data Analysis		12	6
	1 Seminar			2
	Viva-Voce			4

Contact hours : 24
Credits : 30
L : Lecture
S : Self Study
C : Credits

M.Phil. Semester II

CODE	SUBJECT	L	S	C
SMP	**Elective Paper**	4	2	6
	Dissertation			10
	5 Seminars			2 each
	Viva-Voce			4

Contact hours : 06
Credits : 30
L : Lecture
S : Self Study
C : Credits

SYLLABUS

1. **Objectives:**
To provide course of study to postgraduates in Statistics with a view to strengthen their foundations for undertaking Ph. D./Teaching /consultancy work in both theoretical and Applied Statistics.

2. **Course Structure**
The M. Phil. Course will consist of two parts:

(i) M. Phil. Part I: Semester I--- Three papers + Live Data Analysis
(ii) **M. Phil Part II: Semester II---One Paper and Dissertation**

Every M. Phil. student will write a dissertation on a topic pertaining to one of the theory courses or Term paper assigned by the M. Phil. Committee subject to the condition that, as far as possible, at most Three candidates will be allowed under any supervisor. In assigning the topic for dissertation, the M. Phil. Committee will be guided by the preferences of the candidate coupled with his/ her performance in M. Phil. part I Examination.

Papers :

Paper 1: SMP 1 Review of Basic Statistical Techniques and Applications to Data Mining.
Paper 2: SMP 2 Stochastic Models and Simulation.

Electives:
SMP 3(EL) Reliability Theory, Survival Analysis and Elements of Risk Analysis.
SMP 4(EL) Applied Time series and Forecasting.

SMP 5 Term paper
SMP 6 Live data Analysis

M. Phil Part I :
Four of the papers mentioned above .

M. Phil 2:
One of the elective papers (EL) mentioned above
and
Dissertation

SMP 1 Review of Basic Statistical Techniques and applications to Data Mining

This paper will be concerned with problem solving and applications, so as to enhance the knowledge based on the post graduate course.

Unit 1:Review of Basic Statistics:
Prob, Distributions: Exponential Family, Pitman Family, Pearson family: Distributions under them and their important properties. (10 L)

Unit 2: Techniques of Multivariate Analysis for Data Mining:
Principal Components analysis, Factor analysis, Canonical Correlation, Discriminant Analysis.(10 L)

Unit 3: Parametric Inference I:
Review of estimation and Testing procedures and their properties. (10 L)

Unit 4: Nonparametric Inference : Binomial test – Wilcoxon signed rank test –Mann Whitney U test- Rank sum test –Rank correlation, Fisher-Irwin test, McNemar test , Kruskal-Wallis Test.(15 L)

References:
Dudevicz, Edward J. and Mishra : Introduction to Statistics and Probability. N.Y., Holt, Rinehart and Winston,

Rohtagi, V.K.: An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern Limited, New Delhi

Hair,Black,Babin,Anderson,Tatham , *Multivariate data analysis* Sixth edition, Pearson Prentice Hall,

Robert F.Woolson and William R.Clarke ,Alvin C. Rencher *Statistical methods for the analysis of biomedical data* Second edition, Wiley series in prob. and statistics,

Alvin C. Rencher, *Methods of multivariate analysis* .Wiley series in prob. and mathematical statistics,

T W Anderson *An introduction to multivariate statistical analysis* Wiley

C.Chatfield and A.J.Collins *Introduction to multivariate analysis* Chapman and Hall

Richard A. Johnson and Dean W.Wiche :*Applied multivariate statistical analysis* Pearson Education,

SMP 2 **Stochastic Models and Simulation**

(a) **Stochastic Models:**
Overview of Basic Stochastic Models like Markov Chains, Random Walk, Poisson Process, Birth and death processes, (20 L)

Stochastic models in queues and queuing networks, Markov models in: communication and information systems, business management Applications in: biology: Epidemic models, Population growth models, Competition between species: prey- predator model, (15 L)

(b) Simulation : Applications of Monte Carlos and Markov chain Monte Carlos(MCMC) techniques to problems in various fields. (15 L)

Suggested Readings:
1. N.T.J. Bailey: The. Elements of Stochastic Processes.
2. S. Biswas: Applied Stochastic Processes, New Age International Publishers
3. A.T. Bharucha Reid: Elements of the Theory of Markov Processes and their Applications, McGraw Hill.
4. J.Medhi: Bulk Queues..
6 S M. Ross: Stochastic Processes.
7. J. Medhi Stochastic Processes, New Age international Publishers
8. B.R. Bhat: Stochastic Models, Analysis and Applications, New Age international Publishers
9. U.N. Bhat: Elements of Applied Stochastic Processes, John Wiley and sons
10. K.S. Trivedi: Probability and Statistics with Reliability, Queueing and Computer Science Applications, Prentice Hall of India
11. H.S. Migon and D. Gamerman , Statistical Inference An Integrated Approach, Arnold Publishers
12. B.M.Ayyub and R.H. McCuen, Probability , Statistics & Reliability for Engineers CRC press, Boca Raton, New York

Smp 3 (El) Reliability Theory And Survival Analysis

Basic concepts in Reliability: Hazard-rate, Mean Residual Life and Mean time to failure and their interrelationships. Censoring. Exponential failure models, estimation of mean life , reliability. Maximum likelihood estimation and uniformly minimum variance unbiased estimation for the parameter and reliability function. Reliability and Risk Analysis.(12 L)

Gamma and Weibull distributions, Estimation of parameters and reliability function with complete and censored samples. Tests of hypotheses and confidence intervals for the reliability function of exponential, gamma and Weibull distributions.(10 L)

Bayes estimation for the parameters and reliability function (under different losses) of exponential, and Weibull distributions. Bayesian credible intervals for the parameters and reliability function for exponential and Weibull distributions.(10 L)

Introduction to Survival Analysis, Various types of censoring in survival data, survival distributions and their applications viz. exponential, gamma, Weibull, Rayleigh, Lognormal, Pareto. Various types of censoring in survival data , Estimation.Tests of goodness of fit for survival distributions, parametric methods for comparing two survival distributions viz. L.R test.(20 L)

Non-parametric methods for estimating survival function and variance of the estimator: Single sample: Actuarial method, Product Limit (Kaplan –Meier)Estimator, Robust Estimators, Bayes estimators. Nonparametric Methods for (a) two samples: Gehan test, Mantel Haenzel Test, Tarone –Ware Class of tests, Efron Test (b) Regression: Cox Proportional Hazards Model, Linear Models. (12 L)

References:

1. Bain, L.J. and Engelhardt, M. (1991): Statistical Analysis of Reliability and Life- Testing Models. Marcel Dekker Inc., U.S.A. -
2. Cox, D.R. and Oakes, D. (1984) : Analysis of Survival Data, Chapman and Hall.
3. Kalbfleisch, J.D. and Prentice, R.L. (1980): The Statistical Analysis of Failure Time Data. John Wiley and Sons, New York.
4. R.G. Miller : Survival analysis, Wiley Interscience
5. Sinha, S.K: Reliability and Life-Testing. Wiley Eastern Ltd., New Delhi.
6. J. Medhi: Stochastic Processes, New Age international Publishers
7. B.M.Ayyub and R.H. McCuen, Probability , Statistics & Reliability for Engineers CRC press, Boca Raton, New York

SMP 4 (EL) Applied Time series and Forecasting

Introduction to Time series and forecasting, decomposition, (6 L)
Exponential smoothing methods, AR models, MA models, ARMA models, ACF and PACF functions, (20 L)
Box- Jenkins Techniques for ARIMA, ACF, PACF, Model identification and diagnostics checking. Forecasts based on these.(14 L)

References:
S. Makridakis, S.C. Wheelwright,R.J.Hyndman: Forecasting - Methods and Applications, John Wiley and Sons
T.M.J.A. Cooray: Applied Time Series, Analysis and Forecasting, Narosa Publishing House.
G.E.P.Box and G.M. Jenkins: Time series Analysis, Forecasting and Control, Holden Day

SMP 5 Term Paper (4 contact hours per week for the student under guidance of the teacher)

SMP 6 Live Data Analysis : (4 contact hours per week for the student under guidance of the teacher)

This paper will involve practical applications of one or more of:

Statistical techniques, Operations research techniques, Statistical packages, Programming , teaching and communication skills and applications to field problems.

Syllabus

Ph.D. Course work

Study centre : School of Statistics

Plan of Examination

The course work will be of 16 credits

S.No.	Nomenclature	Code	Credits
1.	Research Methodology	Stat_PhD_1	4
2.	Review of Published Research in the relevant field	Stat_PhD _2	3
3.	Computer Applications	Stat_PhD_3	3
4.	Advance course in the relevant subject	Stat_PhD_4	3
5.	Comprehensive Viva - Voce	Stat_PhD_5	3

The requirement of pass marks, attendance and other examination related matters will be as per ordinance 18 of DAVV.

Paper I

STAT_PhD_1

Research methodology (4 credits)

Unit I:

Research Methodology (Number of Lectures=15)

1) Meaning of Research Methodology; Difference (s) between Methods of Research & Research Methodology; Motivation for Research, Research approaches and Related Tools, Conditions and criteria for good research.

2) Choosing the research area, Factors leading to the choice, Defining the concrete research problem and focusing on it.

3) Importance of communication skill in research-Development of power of expression in both speaking and writing, Good presentation techniques. Progress report writing on the research topic(s).

4) Objectivity, Reality and Ethics in research the Dilemmas and the Decision –Makings vis-à-vis the Reality.

Unit II:

Research Methodology in Mathematics

Research tools, Searching Google, MathSciNet, Scopus impact factor, h-index, Google Scholar, ORCID, JStor, Online and open access journals, virtual Library if various countries Scientific writing and presentation writing a research paper, Survey article, thesis writing;

Unit III: Probability Theory: Overview of someimportant results in commonly used distributions and their properties:

Unit I V Overview of the following families of distribution and their properties: Exponential family, Pitaman Family, Pearson Family.

References:

An Outline of statistical theory Vol I and Vol II: Goon, A.M., Gupta, MK Dasgupta, B. world Press .

A first course on Parametric Inference: Kale, B.K. , Narasa Publisher .

Paper II

STAT_PhD_2

Review of Published Research in the relevant field (3 Credits)

Review of published literature in the relevant field

Review of topics related to area of research using internet, hard copies of papers, w ebsites, cross referencing etc.

Paper II I

STAT_PhD_3

Computer Applications (3 Credits)

Unit I: C programming for exploratory statistical analysis and optimization techniques. (12 L)

Unit II: Use of MS Excel and/ or SPSS for descriptive and analytical stati stical (10 L)

Unit III:

Use of ICT: Presentation of research work though PPT (5 L) Introduction to R

programming/ Matlab/ Mathematical/ Minitab (6 L) **References:**

Let us C Kanetkar, Y.P. BPB Publications

The C Programming Language: Brian W, Kernighan Dennis Ritchie, Prentice Hall

Computer Programming in C: V. Rajaraman, PH

Paper I V

STAT_PhD_ IV

Advance course in the relevant subject

Unit I : Overview of results in Gauss - Markov models, estimability of parameters, best linear unbiased estimators.

Unit II: Over view of results in Optimization Techniques (a) Introduction, classification of optimization problems, overview or Linear Programming.

(b) Diffevent optimality Criterion using information matrix (C) matrix of Block designs i.e. A, D and E optimal designs. Efficiency and Vaviance Balanced Block designs.

Unit III: Overview of Results in Nonlinear opt imization techniques. Unconstrained and constrained optimization techniques: Kuhn - Tucker conditions, sensitivity analysis (ll L)

References:

Modern Mathematical Statistics: Dudewicz E.J. and Mishra S.N. (Wiley Series in Probability and Statistics)

An Introduction to Probabilit y and Stat istics: Rohat gi, V.K. and Ehsanes Saleh, A.K. MD., John Wiley & Sons,.

A course in linear Models: Kshirsagar, A.M., M. Dekker

Optimization Theory and Applications: S.S. Rao, Wiley Eastern

Nonlinear Programming Theory and Algorithms: Bazaraa, M.S.and Shetty, C.M. and Shetty, John Wiley Sons

Operation Research: Gupta PK, DS Hira, Sultan Chand & Co

Operation Research: Kanti Swaroop, P.K. Gupta & Manmohan, Sultan Chand & Co..

Theory of Block Designs: Aloke Dey, Wiley Eastem Limited.