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PART-I

CORE COURSES

Each core courses weightage: 4 + 4 Credit Hours

No. of weeks: 30

STAT-511: (I) STATISTICAL METHODS

Aims and Objectives

1. To revise and introduce some basic principles and standard methods in Probability and Statistics;
2. Complete exercises requiring the fundamental results, properties and tests outlined in the course;
3. Identify any deficiencies in their background knowledge;
4. Appreciate the level of participation expected of M.Sc students in the remaining courses;
5. Approach the remainder of the M.Sc with confidence.

Course Outline

- 1 Applications of standard discrete and continuous distributions: Binomial, Hyper-geometric, Multinomial, Negative Binomial, Geometric, Poisson, Exponential and Normal probability distributions. Basic ideas about sampling distributions with particular reference to chi-square, t and F distributions.
2. Basic ideas of statistical inference, Point and interval estimation, Confidence intervals, testing of hypotheses. Simple and composite hypotheses, Calculation of type I and type II errors, Power of a test, Operating characteristic (OC) function, Inferences about means, proportions and variances, Determination of sample size.
3. Inference about regression coefficient for simple and multiple linear regression up to three regressors. Standard error of estimate. Coefficient of determination. Linear correlation. Multiple and Partial correlation. Confidence intervals for regression and correlation coefficients.
4. Analysis of categorized data. Goodness of fit tests. Homogeneity of variances. Bartlett test and Cochran test. Contingency tables. Test of independence in contingency tables. Fisher's exact test for 2x2 contingency tables.

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5. Non-parametric methods. Chebyshev's inequality. The sign test. Wilcoxon's signed rank test. Mann-Whitney U test. Median test. Run test. Kolmogorov-Smirnov test. Kruskal-Wallis test. Median test for k-samples. Friedman's test.
 6. Sequential test. Test for proportion. Operating characteristic (OC) function. Average sample number (ASN) function. Test for standard deviation.
 7. Finite and divided differences. Newton's formulae for interpolation. Inverse interpolation.

Books Recommended

1. Dixon, W.J., and Massey, F.J., "Introduction to Statistical Analysis" McGraw-Hill Company, New York, Fourth Edition, 1979.
2. Steel, R.G.D. and Torrie, J.H. "Introduction to Statistical Analysis" McGraw-Hill Book Company, New York, Second Edition 1980.

Reference Books

1. Larson, H.J. "Introduction to Probability Theory and Statistical Inference" John Wiley and Sons, New York, Third Edition, 1982.
2. Wilcox, Rand R. "Fundamentals of modern Statistical methods", Springer N.Y. 2001.
3. Vaidyanathan, M. "Latest Statistical Methods", S. Chand and Company, New Delhi, 2001.
4. Aggarwal, Y. P. "Statistical Methods" Sterling publisher, New Delhi, 1998.

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STAT-512: PROBABILITY AND PROBABILITY DISTRIBUTIONS

Aims and Objectives

1. To revise and introduce some basic principles and standard methods in probability.
2. To provide an introduction to the language of distribution theory regarding univariate, bivariate, and multivariate cases.
3. To provide the concepts of joint distribution, conditional distribution and their expectation.
4. To provide the concept of order statistics.

Course Outline

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1. Probability set function. Axioms of probability. Conditional probability and independence. Total probability and Bayes theorem. Random variables. Distribution function, probability function and probability density function. Moment, factorial moments and cumulants. Probability generating function. Moments generating function. Cumulant generating function. Uniqueness theorem. Inversion theorem. Chebyshev's inequality. Central limit theorem. Laws of large numbers.
2. Univariate distributions. Discrete uniform, continuous uniform, binomial, hyper-geometric, multinomial, Poisson, geometric, negative binomial, normal, exponential, gamma, beta, lognormal, Weibull, double exponential, Pareto and Cauchy distributions and their properties.
3. Bivariate distributions. Marginal distribution. Conditional distribution and independence. Conditional expectation and conditional variance. Bivariate normal distribution and its properties.
4. Transformation of variables of discrete and continuous types. Expectations of functions of random variables. Sum, product and quotient of random variables. Cumulative distribution function and moment generating function techniques. Derivations of chi-square, t and F distributions and their properties. Distribution of sample mean and variance.
5. Multivariate normal distribution: its mean vector, covariance matrix and moment generating function. Marginal and Conditional distributions (without derivations). Distribution of the rth order statistics. Distribution of sample range, sample median and sample mid-range. Sample cumulative distribution function.

Books Recommended

1. Hogg, R.V. and Craig, A.T., "Introduction to Mathematical Statistics" Prentice-Hall International, Inc. Engle Wood Cliffs, N.T., Fifth Edition, 1995.
2. Mood, A.M., Graybill, F.A. and Boes, D.C. "Introduction to the Theory of Statistics" McGraw-Hill Book Company, New York, Third Edition, 1974.

Reference Books

1. Dudewicz, E.J. and Misra, S.N. "Modern Mathematical Statistics" John Wiley and Sons, New York, 1988.
2. Hogg, R.V. and Tanis, E.A. "Probability and Statistical Inference" McMillan Publishing Company, New York, Forth Edition, 1993.

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3. Stuart, A. and Ord, J.K. "Kendall's Advanced Theory of Statistics Vol.-I" Edward Arnold, London, Sixth Edition, 1994.
 4. Wadsworth, G.P. and Bryan, J.G. "Introduction to Probability and Random Variables" McGraw-Hill Company, New York, 1960.
 5. Chow, Yuan. Chow, "Probability theory" Springer New Jersey 1997.
 6. Chung, Kai Lai, "A course in probability theory" Academic Press, N.Y. 2001.
 7. Williams David, "Weighing the odds" Cambridge press, Cambridge, 2001.
 8. Falmagne, J.C. "Lectures in elementary probability theory and stochastic processes", McGraw-Hill, Boston, 2003.
 9. Hines, W.W. "Montgomery, D.C. "Probability and Statistics in engineering", Wiley N.Y. 2003.

STAT-513: (iii) DESIGN AND ANALYSIS OF EXPERIMENTS

Aims and Objectives

1. To introduce distinctive methodologies specifically related to design of experiment.
2. To build on students' existing knowledge of design of experiments,
3. To develop enough of the theory to allow a proper understanding of what these methods can achieve, while showing how and when these methods are applied to data arising in practical context.
4. To illustrate applications of statistics within agriculture and medical fields.
5. To understand the main ways of improving the accuracy of a designed experiment, and the need for randomization; and understand the importance of designing for the contrasts of interest and the actual experimental situation
6. Compare the efficiencies of different block and row-column designs; and understand the main features of factorial designs;
7. Be able to obtain efficient designs in non-standard situations.

Course Outline

1. Concept of experiment. Planning of experiment. Design of experiment and its terminology. Principles of experimental designs. Analysis of Variance (ANOVA). Inference about means after ANOVA. Multiple comparison tests: LSD test, Duncan's test, Tuckey's test, Scheffe's test, Orthogonal contrast test. Transformations.
2. Layout and analysis of Completely Randomized, Randomized Complete Block, Latin Square and Graeco-Latin Square designs. Estimation of missing observations. Relative efficiency of these designs. Fixed, Random and Mixed effect models. Expected mean squares deviations. Partitioning of treatment and error SS. Orthogonal Polynomials.
3. Covariance analysis for Completely Randomized, Randomized Complete Block and Latin Square designs; single and double covariates.
4. Factorial experiments and its advantages. $p \times q$ Factorial in Randomized Complete Block designs. 2nd series Factorial experiments. Linear and quadratic components of main effects and interactions.
5. Confounding, its types and its advantages. Complete and partial confounding in 2nd series. Fractional replication. Quasi-Latin squares. Split-plot designs.
6. Balanced Incomplete and Partially Balanced Incomplete Block designs. Comparison of Incomplete Block design with Randomized Complete Block design. Youden Squares.

Books Recommended

1. Cochran, W.C. and Cox, G.M. "Experimental Design" John Wiley and Sons New York, Second Edition, 1957.
2. Montgomery, D.C. "The Design and Analysis of Experiments". John Wiley and Sons, New York, Fourth Edition, 1997.
3. John, J.A. and Quenoville M.H. "Experiments Design and Analysis", Second Edition, Charles Griffin & Co. London, 1977.

Reference Books

1. Kempthorne, O. & Hinkelmann, K. "Design and Analysis of Experiments Vol. 1, John Wiley and Sons, New York, 1994.
2. Barker T.B. "Quality by Experimental Design", Second Edition, 1994, Marcel Dekker, Inc. New York.

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3. Boniface D.R., "Experiment Design and Statistical Methods for Behavioural and Social Research", First Edition, 1995, Champman & Hall, London.
 4. Ostle, B. and Mensing, R.W. "Statistics in Research" The Iowa State University Press, Third Edition, 1975.
 5. Winer, B.J. "Statistical Principles in Experimental Design". McGraw-Hill Book Company, New York, Second Edition, 1971.
 6. Federer, W.T. "Experimental Design". Macmillan Company, New York, 1955.
 7. Graybill, F.A. "An Introduction to Linear Statistical Models Vol.-I "McGraw Hill Book Company, New York, 1961.
 8. Heath D. "An Introduction to Experimental Design and Statistics for Biology" Second Edition, 1996, UCI Pres, London.
 9. Clewer, AlanG, "Practical Statistics and Experimental Design for Plant and Crop Scienc", Wiley N.Y., 2001.
 10. Quinn Gerry P, "Experimental Design and Data Analysis for Biologists" Cambridge Press, Cambridge, 2002.
 11. JeffWu, C.F. "Experimental: Planning Analysis" Wiley N.Y., 2002.
 12. Kuehl, R.O. "Design of experiments: Statistical principles of research design and analysis" Duxbury, Boston 2000.

STAT-514: (iv) SAMPLING TECHNIQUES

Aims and Objectives

1. To introduce distinctive methodologies related to sampling designs.
2. To build on students' existing knowledge of sampling techniques.
3. To get the knowledge about the economical use of available resources such as time, money and manpower in connection with the information obtained through sample survey.
4. To apply the sampling tools in real life problems.
5. To theoretically study the impact of various types of errors encountered in a sample survey.

Course Outline

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1. Simple random sampling. Probability and Non-probability samples. Estimation of mean, total, proportion and variance Confidence limits, Determination of sample size.
2. Stratified random sampling. Estimation of mean, total, proportion and variance. Arbitrary, proportional and optimum allocations and their comparisons. . Determination of sample size. Effect of deviation from optimum allocation. Controlled and two way selection. Gain in precision in stratified sampling as compared with simple random sampling. Construct of strata.
3. Systematic sampling. Estimation of mean, total and variance. Systematic sampling under stratification. Comparison of systematic, stratified and random sampling for population with linear trend.
4. Ratio and Regression estimates. Estimation of total, mean square error and bias in classical ratio estimate. Estimation of total and variance in linear regression estimates. Best linear unbiased estimator (BLUE). Lahiri, Midzuno and Hartley-Ross ratio estimators. The Linear regression estimator under the linear model.
5. Cluster sampling. Estimation of mean, total and variance for single-stage cluster sampling. Cost function. Sampling with probability proportional to size (PPS) with and without replacement. Hansen-Hurwitz and Horvitz-Thompson estimators and estimation of variance.
6. Two-stage sampling. Estimation of mean, total and variance. Both stages with equal probability. First stage PPS (with replacement) and second stage with equal probability. Both stages with probability proportional to size and with replacement. Basic concept of double sampling
7. Sampling and non-sampling errors and their sources. Non-response and their sources. Bias and sources of bias.

Books Recommended

1. Cochran, W.G. "Sampling Techniques" John Wiley and Sons, New York, Third Edition, 1977.
2. Raj. D., "Sampling Theory" Mc-Graw-Hill Book Company, New York, 1971.
3. Singh, D. Chaudhry F.S. "Theory and Analysis of Sample Survey Designs", Wiley Eastern Limited, New Dehli, India, 1986.

Reference Books

1. Raj. D. "Design of Sample Survey" Mc-Graw-Hill Book Company, New York, 1972.
2. Kish, L. "Survey Sampling" John Wiley and Sons, New York, 1995.
3. Som, R.K. "A Manual of Sampling Techniques" Heinemaan Educational Books Limited., London, 1973.
4. Sukhatme, P.V. and Sukhatme, B.V., Sukhatme, S. and Asok, C. "Sampling Theory of Surveys with Applications" Iowa State University Press, Ames, IOWA. Third Edition, 1984.
5. Brewer, Ken, "Combined Survey Sampling Inference" Arnold U.K. 2002.
6. Tryfos, Peter, "Sampling Methods for Applied Research" Wiley N.Y. 1996.

PRACTICALS BASED ON CORE COURSES

Each practical weightage: 2 Credit Hours

No. of weeks: 30

STAT-516P: SPSS and Practical based on Statistical Methods

STAT-517P: Practical based on Probability and Probability Distributions

STAT-518P: Practical based on design and Analysis of Experiments

STAT-519P: Practical based on Sampling Techniques

M.Sc STATISTICS**PART-II****CORE COURSES**

Each core courses weightage: 4 + 4 Credit Hours
 (Except STAT- 613 which have
 A: 3 + 3 and B: 3 Credit Hours)

No. of weeks: 30

STAT-611: (I) STATISTICAL INFERENCE**Aims and Objectives**

1. To extend understanding of the practice of statistical inference.
2. To familiarize the students with ideas, techniques and some uses of statistical simulation.
3. To describe computational implementation of moments, likelihood, and likelihood-ratio based analysis
4. To describe the parametric interval estimation, sequentially probability ratio tests and minimum chi-square estimation.
5. To familiarize the students with Bayesian approach to inference.
6. To apply the estimation techniques to the real life problems and systems.

Course Outline

1. Point estimation, problem of estimation. Properties of a good estimator: Unbiasedness, Consistency, Efficiency and Sufficiency. Mean-squared error. Consistency and Best asymptotically normal estimator. Minimal sufficient statistics. Joint sufficiency. Exponential family. Sufficiency and Completeness. Cramer-Rao inequality. Minimum Variance Bound estimators. Bhattacharya bounds. Rao-Blackwell and Lehmann-Sheffe theorems. Uniformly Minimum Variance Unbiased estimators. Joint completeness. Location invariant and scale-invariant estimators. Bayes estimators. Prior and Posterior distributions. Posterior Bayes estimators. Loss function and Risk function. Bayes estimator Minimax. methods of estimation. Method of moments. Maximum likelihood method and its properties. Method of least squares and its properties. Ordered least squares estimation. Minimum chi-square method.

2. Interval estimation. Confidence interval and its interpretation. One-sided confidence intervals. Methods of finding confidence intervals. Pivotal quantity method. Confidence intervals for the mean and variance. Confidence region for the mean and variance. Large-sample confidence intervals. Bayesian interval estimates. Shortest sets of confidence intervals.
3. Tests of Hypotheses. Simple and composite hypotheses. Power function. Size and power of a test. Randomized and Non-randomized tests. Most powerful tests. Neyman-Pearson lemma. Loss function and Risk function. Bayes test. Generalized likelihood-ratio tests. Uniformly most powerful tests. Unbiased test. Uniformly most powerful unbiased test. Monotone likelihood ratio tests of hypotheses. Sequential probability ratio test. Approximate sequential probability ratio test. Approximate expected sample size of sequential probability ratio test.

Books Recommended

1. Hogg, R.V. and Craig, A.T. "Introduction to Mathematical Statistics", Prentice-Hall International, Inc. Engle Wod Cliff, N.J., Fifth Edition, 1995.
2. Mood, A.M. Graybill, F.A. and Boes, D.C., "Introduction to the Theory of Statistics", McGraw-Hill Book Company, New York, Third Edition, 1974.

Reference Books

1. Hogg, R.V. and Tanis E.A., "Probability and Statistical Inference" Macmillan Publishing Company, New York, Fourth Edition, 1993.
2. Lindgrind, B.W. "Statistical Theory" Macmillan Publishing Company, New York, Third Edition, 1976.
3. Stuart, A. and Ord, J.K. "Kendalls Advanced Theory of Statistics, Vol.-2, Edward Arnold, London, Fourth Edition, 1991.
4. Welsh, A. H. "Aspects of statistical Inference". Wiley Series in Probability and Statistics. John Wiley & Sons, Inc. N.Y., 1996.
5. Ganthwaite, Paul H. "Statistical Inference". Oxford University Press, N.Y., 2002.
6. Freund, John E. "Mathematical Statistics". Prentice Hall International, Inc. New Jersey, 1999.
7. Stuart, Alan, "Classical Inference and the Linear Model". Edward Arnold: Arnold, London, 1997.
8. Chib, S, Clyde. M, "Subjective and Objective Baysian Statistics". Wiley N.Y. 2003.

STAT-612: (II) REGRESSION ANALYSIS AND ECONOMETRICS

Aims and Objectives

1. To review and extend the students' knowledge of the standard linear model.
2. To introduce the more general ideas of generalized linear models, heirarichal models and errors in variable models by building on the familiar concepts of the linear models.
3. To develop enough of the theory to allow a proper understanding of what these methods can achieve.
4. To show how these methods are applied to data, and what kind of conclusions are possible
5. To derive minor extensions and applications of the general theory to carry out the straight forward regression analysis.
6. To assess the fit of the model to the data, and make at least some suggestions as to how to improve if it is unsatisfactory.

Course Outline

1. Nature of Econometrics. Simple linear regression, its assumptions and least squares estimators. The General linear regression, its assumptions and least squares estimators. Significance tests and confidence intervals. Tests of linear combinations of regression coefficients. Use of extraneous information in linear regression.
2. Stepwise regression, Ridge regression. Polynomial regression. Orthogonal Polynomials and their use.
3. Multi-collinearity. Heteroscedasticity. Auto-correlator, Model specification. Specification Errors. Stochastic Regressors. Instrumental Variables. Lagged Variables. Dummy Variables. Systems of simultaneous linear equations. Identification and estimation. Income and wealth distribution.

Books Recommended

1. Gujrati, D. "Basic Econometrics" McGraw Hill Book Company, Fourth Edition, 2003.
2. Johnston, J. "Econometric Methods," McGraw-Hill Book Company, Third Edition, 1985.
3. Koutsoyiannis, A "Theory of Econometrics" Macmillan Press Ltd., Hong Kong, 2nd Edition, 1979.

Reference Books

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1. Dutta, M. "Econometric Methods, "South-Western Publishing Company, England, 1975.
2. Goldberger, A.S. "Econometric Theory", John Wiley and Sons, New York, 1964.
3. Wonnacott, T.H. and Wonnacott, R.J. "Econometrics" John Wiley and Sons, New York, 2nd Edition, 1979.
4. Chatterjee, Samprit, "Regression Analysis by Example", Wiley, 2000.
5. Montgomery, Douglas C. "Introduction to Linear Regression Analysis" Wiley N.Y. 2001.

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STAT-613: DATA PROCESSING AND COMPUTER PROGRAMMING

Aims and Objectives

1. To understand the basis concepts of computer architecture.
2. To carry out computer based analysis of different statistical methods and procedures
3. Use of computer literacy for improved employment prospectus.
4. For greater self-sufficiency in every field of life.
5. For speedy works and accuracy attainment in estimation and inferential statistics.
6. To introduce application software and to design the software.

Course Outline

Part-A (Theory 70 marks)

1. Introduction to the Computers: History, Main Computers, Various Input and Output devices and Tips for the computer maintenance.
2. Introduction to Operating Systems, Introduction to DOS: DATE, TIME, COPY, XCOPY, FORMAT, DEL, RENAME etc. Commands.
3. FORTRAN, FORTRAN fundamentals, Constants, Variables and Arithmetic. Input, Output and Format Statements. Decision making in FORTRAN language. Branching and looping Arrays, Functions, sub-programs and sub-routines filing.

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4. Introduction to C-Language, Basic Data types, Input, Output and Format. Decision making in C-Language, Branching and Looping. Arrays, Strings, Pointers, Structure and Union. Functions and Macros, Concepts of Filing. Building of projects and libraries.

Part-B: Practical based on Part-A on Data Processing & Computer Programming (Marks 30)

Books Recommended

1. Lipschutz, M.M. Lipschutz S. "Theory and Problems of Data Processing". Schaum's outline series. McGraw Hill Book Company, New York, 1982.
2. Lipschutz., AS. And Poc., A. "Theory and Problems of Programming with FORTRAN". Schaum's out line series, McGraw Hill Book Company, New York, 1982.
3. Salaria R.S. "Programming in Microsoft FORTRAN 77", BPB Publications, New Delhi, India, 1994.
4. Herold H. and Unger W. "C Complete Manual", Second revised edition, 1992, Galgotia Publications Pvt., New Delhi, India.
5. Kernighan B.W. Ritchie D.M. "The C Programming Language", Second Edition, Prentice Hall of India Pvt. Lt., New Delhi, India.

Reference Books

1. Fouri, W.M. Gaughran, S.L and Fouri, M. "IBM FORTRAN 77: Elements of Programming Style" 1986, Hayden Book Company.
2. Zwoss, V. "Introduction to Computer Science" 1931, Braves and Noble Books, New York.
3. Tizzard, K. "C for Professional Programmers", Second Edition, 1992, Ellis Horwood, London
4. Hancock L. Krieger M. "C The Primer" Second Edition 1985, McGraw Hill Book Company,
5. Schildt H. "C Made Easy", 1987, McGraw Hill Book Co.
6. Kochan S.G. "Programming in C" Revised Edition, 1990, Hayden Books, USA.
7. Tan, H.H, "C Programming for Engineering and Computer Science", McGraw Hill, Singapore, 1999.

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8. Dale. N, Weams. C, Headington. M. "Programming & Problem Solving with C++", Jones & Bartlett Pub. Boston, 1997.
 9. Deitel H.M, Deital PJ. "C++ How to Program" 3rd Ed., Pearson Edu. Asia, 2001.
 10. Cohoon, James. P, Jack W. David Son, "C++ Program Design", 2nd Ed. McGraw Hill, New Delhi 2000.
 11. Lawrence, Norman, "Compaq Visual Fortan" Digital Press N.Y., 2002.
 12. Press, William H., "Numerical Recipes in Fortran" Cambridge University Press, Cambridge, 1998.
 13. Kenethar Y.P. "Let us C++", BPB, Pub. New Delhi, 2003.

PRACTICALS BASED ON CORE COURSES

Each practical weightage: 02 Credit Hours

No. of weeks: 30

STAT-614P: Practical based on Statistical Inference

STAT-615P: Practical based on Regression Analysis and Econometrics

STAT-616P: Practical based on Data Processing and Computer Programming

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SPECIALIZATIONS:

SPECIALIZATION-1

Each Specialization-I Course have 4 + 4 Credit Hours
except STAT-621 which is of 3.5 + 3.5 Credit Hours

STAT-621: $\sqrt{1(i)}$ STATISTICAL QUALITY CONTROL

Aims and Objectives

1. To introduce the students to the use of mathematical and statistical ideas in optimal decision making in quality control.
2. To familiarize students with much of the terminology used by practitioners in the field of quality control.
3. To understand and implement the procedure for finding sample size and sentencing rule in batch attribute sampling schemes.
4. To understand and implement sampling by variable schemes.
5. To construct control charts and investigate and compare their properties.

Course Outline

(Part-A Theory 75 marks)

1. Characteristics of controlled quality. Definition of Control. Problems of control and nature of control. Scientific basis for Control. Three important postulates. Criteria for detecting assignable causes of variation. Role of statistical theory in controlling the quality. Advantages of statistical quality control.
2. Methods and Philosophy of Statistical Process Control

Meaning of Process Control. Chance and Assignable causes of quality variation. Statistical basis of control charts. Basic principles, Choice of Control Limits, Sample size and Sampling frequency, Rational sub-groups. Analysis of patterns of control charts.
3. Control Charts for Variables

Types of control charts for variables. Statistical Basis of the control charts for variables. Development and use of \bar{X} and R; \bar{X} and s charts with constant and variable sample size. Chart for variables. OC function average run length for \bar{X} chart. Effect of non-normality on \bar{X} and R charts. Choice between attributes and variables control charts. \bar{X} and R charts for

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short production runs. Modified control limits for X charts. Acceptance control charts.

4. Control Charts for Attributes

The control chart for fraction non-conforming. Development and operations of the control chart for attributes. Charts with variable sample size. The OC function and average run length calculation. Control charts for non-conformities. Procedures for defects, Charts with constant and variable sample size. OC function. Dealing with low-defect levels.

5. Acceptance Sampling

Lot-by-lot Acceptance sampling for attributes. Types of sampling plans. Single sampling plans for attributes. Double sampling, Multiple and Sequential sampling. Lot-Sensitive compliance (ITPD) Sampling plan, Dodge-Romig Sampling Plans. AOQL, LTPD. Estimation of process average. Acceptance sampling by variables, Types of such plans. Caution in the use of variable sampling. Designing a variable sampling plan with specified OC curve.

6. Life testing and reliability. Conventional model of the probability of equipment failure. Definition of reliability. Failure with reference to life testing. Constant failure rate and mean life. OC curve for an acceptance sampling plan based on stipulated maximum number of test hours. Producer's Risk and Consumer's Risk in acceptance sampling plans used in life testing.

7. Introduction to ISO 9000 series.

Part-B Practical/Project based on Stat-621 (25 marks)

Books Recommended

1. Douglas C; Montgomery; "Statistical Quality Control" John Wiley & Sons, Third Edition, New York, 1996.
2. Grant, E.L. and Leaven-Worth, R.S. "Statistical Quality Control Handbook" McGraw Hill Book Company, New York, Seventh Edition, 1996.
3. Wetherial, G.B. and Brown, D.W. "Statistical Process Control Theory and Methods" Chapman and hall, London, 1991.

Reference Books

1. Jurdn, J.M., A. Blanton Godfref, J. M. Sender, L.A. Gryna, F.M. "Quality Control Handbook". McGraw Hill Book Company, New York, Fifth Edition, 1999.

2. Shewhart W.A. "Economic Control of Quality of Manufactured Product: D-Van Nostrand Company, New York, 1931.
3. Simmons, D.A. "Practical Quality Control". Addison Wesley Publishing Company, London, 1970.
4. Gupta, R.C. "Statistical quality control", 6th Edi. Khanna Pub. New Delhi, 2001.

STAT-622: VI(II) POPULATION AND DEMOGRAPHIC METHOD

Aims and Objectives

1. To introduce the sources of demographic data and the techniques used in the collection of demographic data.
2. Testing the accuracy of demographic data.
3. To study the influence of social and economic factor on the population.
4. To have a knowledge about construction of life tables.

Course Outline

1. Sources of demographic data. Components of population growth. Composition of population and vital events. The population census. Registration of vital events. Use of sampling in collection of demographic data. Demographic surveys and other sources.
2. Testing the accuracy of demographic data. Types of sources of errors. General testing procedures. Testing the accuracy of age and sex data. Checking the accuracy of graphs of single-year are distributions. Checking the accuracy graphed age data.
3. Basic demographic measures. Fertility and mortality measures. Mortality rates. Total and general fertility rates. Standardized death and birth rates. Gross and net reproduction rates. Infant and maternal mortality rates. Intrinsic rate.
4. Life tables. Construction of complete and abridged life tables. Graphs of $1x$, qx , and dx , Description and uses of life tables columns. Stationary population. Model life tables.
5. Population estimates and projections. Intercensal estimates and postcensal estimates. Components and mathematical methods for intercensal and postcensal estimates. Population projections component method for population projections. Mortality basis for population projections. Fertility and migration basis for population projections.

Books Recommended

1. Barclay G.W. "Techniques of Population Analysis". John Wiley and Sons, New York, 1958.
2. Speigleman, M. "Introduction to Demography". Oxford University Press London, Revised Edition, 1969.
3. Shryock, H.S. Siegel J.S. et all "Methods and Materials of Demography". U.S. Department of Commerce, Bureau of Census. Washington, 1971.

Reference Books

1. Pollard A.H., Yusuf, F. and Pollard G.N. "Demographic Techniques" Pergaman Press, Oxford Second Edition, 1981.
2. Sriwastava, O.S., "Demography and Population Studies" Vikas, New Delhi, 1998.

STAT-623: $\sqrt{1(iii)}$ OPERATIONS RESEARCH

Aims and Objectives

1. To apply Quantitative Techniques for decision making.
2. To provide rational basis for decision making by seeking to understand and structure complex situations.
3. To predict system behaviour and improve its performance.

Course Outline

1. Definition and nature of Operations Research (OR) Major Phases of an OR study.
2. Linear Programming, Feasible and Optimal Solutions Linear Programming Techniques, Graphical Solution of two-variable linear model, Simplex method. Duality Theory.
3. The Transportation model, Assignment model.
4. Network Analysis, CPM and PERT model.
5. Decision Analysis, Decision making without & with experimentation, Decision trees, Utility Analysis.
6. Game theory, the formulation of two-person zero-sum games, Games with mixed strategies, Graphical solution procedure, solving by linear programming.

7. Queuing Theory, Single channel and Multi-channel problems, Single server waiting time models.
8. Inventory theory, Inventory model with production planning and simulation techniques.

Books Recommended

1. Hillier, F.A. and Lieberman, G.J. "Introduction to Operations Research". Holden-day, San Francisco. Seventh Edition, 2001.
2. Taha, H.A. "Operations Research. An Introduction". Macmillan Publishing Company, New York, Sixth Edition, 2002.

Reference Books

1. Bronson, R. "Theory and Problems of Operations Research." Schaum's Outlines Series. McGraw Hill Book Company, New York, 1983.
2. Sasjeni, M. "Operations Research methods, and Problems". John Wiley and Sons, New York, 1995.
3. Shamblin, J.E. "Operations Research, A Fundamental Approach". McGraw Hill Book Company, New York, 1974.
4. Chase R.B, "Operation Management for Competitive Advanctage" McGraw Hill, Boston, 2004.
5. Buffa E.S, "Modern Production/ Operation Management" 8th Ed., Wiley, Singapore, 2003.
6. Mohanty, R.P, Desmukh S.G, "Advanced Operation Management" Pearson Edu. New Delhi, 2003.

STAT-624: VI(IV) SURVEY AND REPORT WRITING

Aims and Objectives

1. To give first hand knowledge of data collection to the students
2. To develop the research aptitude in students
3. To trained the students for report writing

Course Outline

1. Introduction: Census and Survey, Sampling frame, Types of errors in surveys (coverage, non-response, measurement, errors etc.) and methods of control of such errors, Steps for successful surveys.
2. Types of Surveys: Qualitative and Quantitative survey, Assessments survey, Marketing survey, Evaluation of a survey.

3. Methods for conducting a Survey: Mail surveys, telephone surveys, face to face surveys, and drop off surveys.
4. Sample size: Various methods of sample selection, sample size and its practical difficulties.
5. Constructing a questionnaire for different types of surveys.
6. Scaling Techniques.
7. The analysis of Data.
8. Style and Format of report writing.
9. Preparing the report.

Books Recommended

1. Salant, P. and Dillaman, D.A. "How to conduct your own survey", John Wiley and Sons, Inc. 1994.
2. Goode, W. J. and Hatt, P. K. "Methods in Social Research", McGraw-Hill Book Company, Inc.
3. Gupta, S. "Research Methodology and Statistical Techniques", Deep & Deep Publication, New Delhi, 1997.
4. Dalemus T. "Elements of Survey Sampling" SAREC, Stockholm, 1985.

Reference Books

1. Grosh, Margaret, "Designing Household Survey (Questionnaires for Developing Countries)", World Bank, New Age Int. 1999
2. Kish, Leslie, "Survey sampling", Wiley 1995.
3. Barnett Vic, "Sample Survey", Arnold London, 2002.
4. Gupta S. "Research Methodology and Statistical techniques" Deep & Deep Pub. New Delhi 2003.

STAT-624 Part-B (Dissertation)

Students are expected to conduct sample survey and dissertation on the findings of the survey.

25

SPECIALIZATION-II:

Each Specialization-II course have 3.5+3.5 Credit Hours except STAT-633 & STAT-634 which are of 4+4 Credit Hours.

STAT-631: VIII(i) TIME SERIES ANALYSIS AND FORECASTING

Aims and Objectives

1. To familiarize the students with ideas, techniques and uses of time series analysis.
2. To describe the various decomposition methods.
3. To make the students understand the various time series models and the procedure of model building.
4. To familiarize the students with concept of forecasting from naïve techniques to the advanced mathematical techniques.
5. To familiarize the students with time series analysis using computer software.

Course Outline

(Part-A theory 75 marks)

1. Introduction to time series, time series analysis, Objectives of time series analysis, Components of time series, time series plots, time series and stochastic processes, special features of time series data, means, variance, auto-covariance, auto-correlation and partial auto-correlation for sample time series data.
2. Simple Descriptive Techniques: Stationary time series, transformations, Analyzing the secular trend, Filtering, Differencing, Analyzing Seasonal Variations, Analyzing Cyclical Variations, Analyzing Irregular Variations, Auto-correlation (correlogram) and other tests of randomness.
3. Probability Models for Time Series: Stochastic processes and stationary processes, useful stochastic processes, purely random process, random walk, moving average process, Stationarity and Invertibility of moving average models, auto-regressive process, Stationarity and invertibility of auto-regressive models, Duality between moving average and auto-regressive models, Principle of parsimony, Recursion rule for ACVF and ACF of auto-regressive process, Yule-Walker equations for auto-regressive process, Mixed ARMA models, moving average and auto-

- regressive representations of mixed ARMA models, Models for Non-stationary Time series, Box-Jenkins Integrated ARIMA models, Stationarity through differencing, other transformations. General linear processes and continuous processes.
4. Model Building, various stages of model building, Identification of model from sample time series, steps for model identification, estimating the auto-covariance, auto-correlation function and partial auto-correlation function, pattern of theoretical ACF and PACF as a tool of model identification.
 5. Estimating the parameters of an auto-regressive model, estimating the parameters of moving average, Back casting, dual estimation, mixed ARMA model and integrated model. The Box-Jenkins seasonal model. Model diagnostics; Residual analysis, over fitting and parameter redundancy, Model selection criteria, Characteristics of a good model.
 6. Forecasting: Univariate procedures, Minimum mean square estimate of forecast, forecast weights, mean, variance and forecast limits for forecast, forecast error, minimum mean square forecast error, structure of minimum mean square forecast error. Multivariate procedures, comparison of forecasting procedures. Prediction theory.

(Part B: 25 marks Practical/Project on the basis of Part-A)

Books Recommended

1. Chatfield C. "The Analysis of Time Series: An Introduction", Fifth Edition, 1996, Chapman and Hill, London.
2. Wei, W. "Time Series Analysis: Univariate and Multivariate methods" 1989, Addison-Wesley Publishing Company, Inc.
3. Brockwell, P.J. and Davis, R.A. "Introduction to time series and forecasting" Second Edition, 2002, Springer, New York.
4. Gyer J.D. "Time Series Analysis", 1990, Duxbury Press, Boston.

Reference Books

1. Box, G.E.P and Jenkins, G.M. "Time Series Analysis: forecasting and control", 1969, Holden-dayk, San Francisco.
2. Gottman, J.M. "Time-series analysis" 1981, Cambridge University Press, Cambridge.
3. Connel, O. and Bowerman, "Time Series Forecasting", Second Edition, 1987. Duxbury Press, Boston.
4. Diggle P. "Time Series", 1990, London.

5. Montgomery D.C. "Forecasting and Time Series Analysis", Second Edition, 1990, McGraw Hill Book Company, New York.
6. Anderson. T.W, "Statistical Analysis of Time Series" Wiley N.Y, 1994.
7. Janacek, Gbareth, "Practical Time Series", Arnold Co., UK, 2001.
8. Akaike, H., Kitagawa, G. "the practice of time series analysis" Springer N.Y. 1999.

STAT-632: \sqrt{ii} MULTIVARIATE ANALYSIS

Aims and Objectives

1. To revise and introduce some basic principles of Multivariate Analysis.
2. To make the students aware to carry out the research at a large scale.
3. To give the students an idea to conduct a research based study including a large group of variables independent or mutually related.
4. To introduce the students with data reduction techniques.

Course Outline

(Part-A theory 75 marks)

1. Review of matrix algebra, Notions of multivariate distributions. The multivariate normal distribution and its properties. Linear compound and linear combinations. Estimation of the mean vector and the covariance matrix. The Wishart distribution and its properties. The joint distribution of the sample mean vector and the sample covariance matrix. The Hotelling's T distribution. The linear discriminant function, Mahalanobis distances. Tests of hypotheses and confidence intervals for mean vectors. One sample and two-sample procedures. Multivariate statistical procedures: Discriminant analysis, Principal component analysis, Factor analysis, and Canonical correlation analysis.

(Part-B: 25 marks Practical/Project based on Stat-632)

Books Recommended

1. Anderson, T.W. "Introduction to Multivariate Statistical Analysis". John Wiley and Sons, New York, second edition, 1984.
2. Chatfield, C. and Collins, A.J. "Introduction to Multivariate Analysis". Chapman and Hall, London, 1980.

- 3 Morrison, D.F. "Multivariate Statistical Methods" McGraw Hill Publishing Co. New York, Third Edition, 1990.
- 4 Johnson, R. A. Wichern. D.W, "Applied Multivariate Statistical Analysis", 4th Ed., Prentice Hall, Inc., USA, 1998.

Reference Books

- 1 Kandall, M.G. and Stuart, A. "The Advanced Theory of Statistics" Vol.-III Charles Griffin and Company, London, Fourth Edition, 1983.
- 2 Rao, C.R. "Linear Statistical Inference and its Applications", John Wiley and Sons, New York, Second Edition, 1973.
- 3 Hougaard, Philip, "Analysis of Multivariate Survival Data", Springer Co. N.Y, 2000
- 4 Tinsley, Howard E.A, "Handbook of Applied Multivariate Statistics and Mathematics" Academic Press, London 2000.
- 5 Fahrmeir, L, Tutz, G., "Multivariate statistical modeling based on generalized linear models", 2nd Ed. Springer N.Y. 2001.

STAT-633: STOCHASTIC PROCESS

Aims and Objectives

1. To trained the students to carry out advanced level of probability and probability models
2. To give the students an idea of Stochastic errors and a process to control them

Course Outline

1. Introduction to stochastic processes. Markov chains, Transition and absolute probability, Calculation of K-step transition probabilities. Chapman-Kolmogorov equations. Classification of states. Classification of Markov chains. The ergodic property. The random walk. Gambler's ruin and expected duration of game.
2. Markov process. Poisson process. Pure death process. Pure birth process. Renewal process. Branching process. The Winer process. Non-Markovian process. Stationary process. Queuing theory. Characteristics of queuing system. Simple queues. Multiple service channels. Optimization of queuing systems.

Books Recommended

1. Bailey, N.T. J. "The Elements of Stochastic Processes with Applications to Natural Science", John Wiley and Sons, New York, 1964.
2. Karlin, A.S. "A First Course in Stochastic Processes" Academic Press, London, 1967.
3. Srinivasan, S.K. and Mehata, K.M. "Stochastic Processes". Tata McGraw Hill Publishing Company, New Delhi, India, Second Edition, 1988.

Reference Books

1. Jones, Pow, "Stochastic Processes", Arnold Co. London, 2001
2. Papoulis, Athanasios, "Probability, Random Variables and Stochastic Processes" McGraw Hill, N.Y. 2002.
3. Gross, D. Harris, C. M. "Fundamental of queueing theory", John Wiley N.Y. 2002.

AUXILIARY NON-CREDIT COURSES

STAT-641: COMPUTER BASED ANALYSIS

SUPPORTING COURSES

STAT-651: ENGLISH SPOKEN AND WRITING SKILLS

STAT-652: ISLAMIC STUDIES

STAT-653: PAKISTAN STUDIES