FIRST MEETING OF THE BOARD OF STUDIES OF STATISTICS

DEPARTMENT OF STATISTICS

UNIVERSITY OF MALAKAND

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FIRST MEETING OF THE BOARD OF STUDIES OF STATISTICS

WORKING PAPER

DEPARTMENT OF STATISTICS

UNIVERSITY OF MALAKAND

AGENDA FOR THE 1ST MEETING OF THE BOARD OF STUDIES OF STATISTICS

Venue: **Department of Statistics, University of Malakand**

Date: **27/03/2013**

Time: **11:30 am**

Item NO.	Description	Page
1	List of Members of the Board of Studies of Statistics	
2	**(Postgraduate studies in Statistics)** Scheme of Studies for Ph.D, M.Phil leading to PhD, and M.Phil Degree Programs in Statistics	
3	**(Postgraduate courses in Statistics)** Courses for PhD, M.Phil leading to PhD and M.Phil programs in Statistics	
4	**Graduate studies in Statistics)** Scheme of Studies for M.Sc Degree Programs in Statistics	
5	**(Graduate courses in Statistics)** Courses of Studies for M.Sc Degree Programs in Statistics	
6	**(Undergraduate studies in Statistics)** Scheme of Study for BS program	
7	**(Undergraduate courses in Statistics)** Courses for BS Statistics program	

MEMBERS OF THE BOARD OF STUDIES OF STATISTICS

	Name and address	Status
1.	Asst: Prf. Dr. Sohail Akhtar Chairman Department of Statistics University of Malakand	Chairman/ Convener
2.	Prof. Dr. Salahudin Professor Department of Statistics University of Peshawar	Member
3.	Dr. Qamruz Zaman Associate Professor Department of Statistics University of Peshawar	Member
4.	Mr. Zahid Khan Lecturer, Department of Statistics University of Malakand.	Member
5.	Mr. Rihayash Shah Assistant Prfoessor Govt. Degree College Gulabad	Member
6.	Mr. Gohar Ali Lecturer in Statistics GDC Samar Bagh, Dir Lower	Member
7.	Mr. Safdar Sahib, Govt. Degree College Thana Lecturer in Statisitcs GGDC Thana, Malakand Agency	Member

AGE NDA OF THE 1ST MEETING OF THE BOARD OF STUDIES OF STATISTICS

Item No. 1   Postgraduate Studies

(Schemes of Studies for PhD, MPhil leading to PhD, and Mphil Degree Programs in Statistics)

Schemes of Study for Ph.D, Mphil leading to PhD and Mphil programs

The board is requested for consideration and approval of these schemes.

Item No.2   (Postgraduate Courses)

(Courses for PhD, MPhil leading to PhD, and Mphil Degree programs)

The board is requested for consideration and approval of these courses.

Item No. 3   (Postgraduate Studies)

(Scheme of Study for M.Sc Statistics (2-Years) Program)

The board is requested for consideration and approval of the scheme.

Item No.4   (Graduate Courses)

(Courses for M.Sc Degree programs)

The board is requested for consideration and approval of these courses.

Item No. 5   (Undergraduate Studies)

(Scheme of Study for BS Statistics (4-Years) Program)

The board is requested for consideration and approval of the scheme

Item No.6   (Undergraduate Courses)

(Courses for BS Statistics (4-Years) Program)

The board is requested for consideration and approval of these courses.

Eligibility Criterion for Admission for Mphil and PhD

According to HEC and Malakand University Standard

Eligibility Criterion for Admission for M.Sc Statistics

BA / BSc or Equivalent at least second division from any recognized University along with the major of Statistics.

Eligibility Criterion for Admission for BS Statistics 4-year Program

FA/F.Sc or Equivalent with at least 45 % marks both in SSC and HSSC or Equivalent.

DEPARTMENT OF STATISTISTICS

UNIVERSITY OF MALAKAND

M.Phil/ Ph.D. COURSES

REVISED AND PROPOSED COURSES AS REQUIRED UNDER THE REVISED STATUTES AND REGULATIONS RELATING TO M.Phil/Ph.D. DEGREE IN STATISTICS

Course No.	Title	Credit Hours
MINOR COURSES		
STAT-701	Data Processing and Computer Programming	3
STAT-702	Logical Reasoning and Social Research Methods	3
STAT-703	Theory of Linear Model	3
STAT-704	Measure Theory	3
MAJOR COURSES		
STAT-711	Statistical Inference	3
STAT-712	Advance Experimental Designs	3
STAT-713	Regression Analysis	3
STAT-714	Applied Multivariate Analysis	3
STAT-715	Survey Sampling	3
STAT-716	Categorical Data Analysis	3
STAT-717	Survival Data Analysis	3
STAT-718	Applied Stochastic Models	3
STAT-719	Modeling and Simulation	3
STAT-720	Spatial Data Analysis	3
STAT-721	Operation Research	3

STAT-722	Ecological Statistics	3
STAT-723	Discrete Event Simulation	3
STAT-724	Advance Programming	3
STAT-725	Visual Basic Oracle	3
STAT-726	Statistical Quality Control	4
STAT-727	Computational Statistics	4
STAT-801	Robust Statistics	3
STAT-802	Time series Analysis and Forecasting	3
STAT-803	Advance Econometrics	4
STAT-804	Advance Statistical Theory	4
STAT-805	Performance Modeling	4
STAT-806	Statistical Signal Processing	4

STAT-701   DATA PROCESSING AND COMPUTER PROGRAMMING (3Cr.Hrs.)

EDP Concept: Generation and Categories of Computers, Hardware, Structure of Digital Computers, I/O Concepts & Devices, Auxiliary Storage Concepts and Devices, Software, Operating systems: DOS & WINDOWS, Programming Languages & Compilers, Application Software, Program Development, Problem Analysis, Logic and Debugging, Documentation.

Any Advanced Programming Language: Programming, Data Type, Assignment Statements, List Directed I/O, Control Statements, Loops, Arrays, Functions, Formatted I/O, Subroutines, Data Files, Sequential & Direct Files, File I/O.

Problem Solving with Programming Language: Matrices Manipulation, Moments, Regression and correlation, Random Number Generation, Probability Distribution, Analysis of Variance, Solution of one variable equation, Solution of Simultaneous equations, Numerical Differentiation & Integration, Plotting and fitting procedures.

Working Manipulation: Ms Excel, WordPerfect, Ms Word Statistical Packages (any two):SPSS, SAS, MINITAB, GLIM

Recommended Books:

1. Davis, G.B. (1981). *Computer Data Processing*. 2nd Edition, McGraw-Hill International book company, New York.
2. Hughes, C.E., Pfleeger, C.P. and Ross, L.L. (1978). *Advance Programming Techniques: A Second Course in Programming Using FORTRAN*. John Wiley and Sons.
3. James, M.L., Smith, G.M. and Wolford, J.C. (1979). *Applied Numerical Methods for Digital Computation with FORTRAN*. 2nd Edition. Harper International Edition, New York.

STAT-702   LOGICAL REASONING AND RESEARCH METHODS (3Cr.Hrs.)

Propositions and Arguments, Recognizing Arguments, Validity and Invalidity, Fallacies, Definitions and its Types, Symbolizing Arguments, Truth Functions, Truth Tables, Proving Validity and Invalidity.

Science and Scientific Attitude, Theory and Fact, Sources and Properties of Hypothesis, Formation of Research Problem and its Significance, Preparation of Research Design, Components of Research Design, Questionnaires and Interviews, Preparation of Research Report.

Recommended Books:

1. Copi, I.M. (1986). *Introduction to Logic*. 7th Edition. Mac Millan Publishing Company.
2. Goodde, & Hatt. (1991). *Methods in Social Research*. McGraw-Hill.
3. Hurley, P.J. (1988). *A Concise Introduction to Logic*. 3rd Edition. Wadsworth Publishing Company.

STAT-703   **THEORY OF LINEAR MODEL**   **(3Cr.Hrs.)**

Euclidean Space, Orthogonality, Norm, Projection Operator, Inverses, Least Squares Estimation, Best Linear Unbiased Estimation, Parameterization, Multivariate Normal Distribution of Quadratic Forms, Testing Linear Hypothesis, Simultaneous Confidence Intervals.

Recommended Books:

1.   Graybill, F.A. (1976). *Theory and Application of Linear Model*. Duxbury, New York.
2.   Guttman, I. (1982). *Linear Models: An Introduction*. John Wiley & Sons.
3.   Kshirsagar, A.M. (1983). *A Course in Linear Models*. Marcel Dekker, New York.
4.   Searle, S.R. (1971). *Linear Models*. John Wiley & Sons.

STAT-704   **MEASURE THEORY**   **(3Cr.Hrs.)**

Length of open and closed sets. Inner and outer measures. Properties of measurable sets. Measurable functions. Lebesgue integral and its properties for bounded and unbounded measurable functions. Some fundamental theorems. Relationship of Riemann and Lebesgue integrals.

Recommended Books:

1.   Billingsley, Patrick (1986). *Probability and Measure*. 2nd Ed. John Wiley & Sons.
2.   Burkill, C.J. (1971). *The Lebesque Integral.* Cambridge University Press.
3.   Goldberg, R.R. (9170). *Methods of Real Analysis*. Oxford and IBH Publishing Company.
4.   Royden, H.L. (9168). *Real Analysis*. The MacMillan Co. Collier MacMillan Limited, London.
5.   Saxena,C.S. & Shah, S.M. (9180). *Introduction to Real Variable Theory*. Prentice-Hall of India (Pvt.), New Delhi.
6.   Spiegel, R.M. (1969). *Real Analysis*. Schaum's Outline Series. McGraw Hill Book Company.

STAT-711   **STATISTICAL INFERENCE**   **(3Cr.Hrs.)**

Theory of Point Estimation, Cramer-Rao Lower Bound and Its Extension, Bias Reduction by Jackknifing, Rao-Blackwellization, Ancillariy and Basu's Theorem, Methods of Estimation, Maximum Likelihood Estimation and their Optimal Properties, Least Squares Estimation and their Optimal Properties, Estimation Using Ordered Observations Bayes and minimax Estimators. Neyman-Pearson theory of Hypothesis Testing, Testing of Simple and Composite Hypotheses, Similar Regions, Unbiased Tests, Invariant Tests, Likelihood Ratio Tests and their Asymptotic Properties, Confidence Estimation, Methods of Confidence Intervals, Confidence Regions, Robustness and Distribution Free Procedures, Non-Parametric Tests, Comparison of Testing Procedures, Pitman's Asymptotic Relative Efficiency.

Recommended Books:

1.   Cox, D.R. And Hinkley, D.V. (1974). *Theoretical Statistics*. Chapman and Hall, London.
2.   Lehmann, E.L. (1983). *Theory of Point Estimation*. John Wiley & Sons.

3. Lehmann, E.L. (1986). *Testing of Statistical Hypotheses*. 2nd Edition, John Wiley & Sons.
4. Rohatgi, V.K. (1984). *Statistical Inference*. John Wiley & Sons.
5. Silvey, S.D.(1975). *Statistical Inference*. Chapman & Hall.
6. Stauat, A. and Ord, J.K. and Arnold, S. (1999). *Kendall's Advanced Theory of Statistics: Classical Inference and Linear Model*. 6th Edition, Vol-2A,. Arnold Oxford University Press Inc., New York.

STAT-712   **ADVANCE EXPERIMENTAL DESIGN**   **(3Cr. Hrs.)**

Resolution of the Factorial Experiments, Confounding and Fractionalization, Incomplete Block Design, Incidence Matrix, Lattice Design, Youden Squares, Split Plots, Strip Plots, Split-Split Plots, Strip-Split Plots, Response Surfaces, Change-Over Design, Repeated Measure, Analysis of Unbalanced Data.

Recommended Books:

1. Box, G.E.P., Hunter, W.G. & Hunter, J.S. (1978). *Statistics for Experimenters: and Introduction to Design, Data Analysis and Model Building*. John Wiley & Sons.
2. Cochran, W.G. and Cox, G.M. (1957). *Experimental Design*. 2nd Edition. John Wiley & Sons.
3. Das, M.N. and Giri, N.C. (1986). *Design and Analysis of Experiments*. 2nd Edition. Wiley Eastern Ltd.
4. Gomez, K.A. and Gomez, A.A. (1984). *Statistical Procedures for Agricultural Research*. John Wiley & Sons.
5. Kempthorne, O. (1973). *Design and Analysis of Experiments*. John Wiley & Sons.
6. Kendall, M., Stuart, A and Ord, J.K. (91983). *Kendal's Advanced Theory of Statistics: Design and Analysis and Time Series*. Vol-3. Charles Griffin & Co. Ltd.
7. Milliken, G. & Johnson, D. (1984). *Analysis of Messy Data*. Chapman and Hall, London.

STAT-713   **REGRESSION ANALYSIS**   **(3Cr.Hrs.)**

Multiple Regression Analysis, Various Approaches Of Subset Selection Procedures, Branch and Bound Technique, Stepwise Regression, Multicollinearity, Ridge Regression, Robust Regression, Outliers, Diagnostics, Jackknifing, Bootstrapping, Identification.

Recommended Books:

1. Draper, N.R. & Smith, H. (1981). *Applied Regression Analysis*. 2nd Edition, John Wiley & Sons.
2. Miller, A.J. (1990). *Subset Selection in Regression*. Chapman & Hall, London.
3. Rewlings, J.O. (1988). *Applied Regression Analysis: A Research Tool*. Wadsworth & Brook/Cole, Pacific Grove, California.
4. Rousseew, P.J. (1987). *Robust Regression and Outlier Detection*. John Wiley & Sons.
5. Wesburg, S. (1980). *Applied Linear Regression*. John Wiley & Sons.
6. Wetherill, G.B. (1986). *Regression Analysis with Application*. John Wiley & Sons

STAT-714   **APPLIED MULTIVARIATE ANALYSIS**   **(3Cr.Hrs.)**

Review of Multivariate Normal Distribution and Matrix Algebra Results, Principal Components Analysis and their Sampling Properties, the Factor Model, Principal Factor Analysis, Maximum Likelihood Factor Loadings, Cluster Analysis, Visual Approaches to Finding a Partition, Hierarchical Methods, Distances and Similarities, Single-Link Clustering, Discriminant Analysis, Discrimination Under Estimation, Probabilities of Misclassification, Discarding of Variables, Canonical Correlations, Mathematical Development, Qualitative and Quantitative Data, Multidimensional Scaling, Measure of Similarity and Dis-Similarity, Classical Scaling, Ordinal Scaling.

Recommended Books:

1. Anderson, T.W. (1984). *An Introduction to Multivariate Statistical Analysis*. John Wiley & Sons, New York.
2. Chatfield, C. and Collins, A.J. (1980). *Introduction to Multivariate Analysis*. Chapman & Hall, London.
3. Everitt, B.S. (1974). *Cluster Analysis*. Heinemann, London.
4. Hawkins, D.M. (1982). *Topics in Applied Multivariate Analysis*. Cambridge University Press.
5. Johnson, R.A. and Wichern, D.W. (1992). *Applied Multivariate Statistical Analysis.* 3rd Edition. Prentice-Hall International.
6. Lawley, D.N. and Maxwell, A.E. (1971). *Factor Analysis as a Statistical Method.* 2nd Edition. Butterworth, London.
7. Mardia, K.V., Kent, J.T. and Bibby, J. (1979). *Multivariate Analysis*. Academic Press.
8. Morrison, D.F. (1976). *Multivariate Statistical Methods*. 2nd Edition. McGraw-Hill.

STAT-715   **SURVEY SAMPLING**   **(3Cr.Hrs.)**

Non-Sampling Error, Observational Errors, Incomplete Sampling, Non-Response, Effect of Non-Response, Response and Response Variance, Sources of Response Error, Detection, Control and Measurement of Response Error, Scaling Methods, Types of Scales, General Procedure in Attitude Scaling, Rating Scales, Likest Scales, Guttman Scales, Sematic Differential, A Survey of Superpopulation Models, Optimal Design-Unbiased Strategies Model G_T, Optimal Design-Unbiased Model E_T, Predicting the Population Mean, Results on Optimal Unbiased Prediction, Prediction Without Auxiliary Information, Model G_R, Juging the Uncertainty of the Estimation, Prediction Using Auxiliary Information, Model $G_{MR,}$, Regression Analysis for Complex Survey Design on Regression Analysis, Effect of Two-Stage Sampling on OLS Methods, Comparison of Domain Means in Two-Stage Sampling.

Recommended Books:

1. Cassel, C.M., Sarndal, C.E. and Wretmen, J.H.(1977). *Foundation of Inference in Survey Sampling.* John Wiley & Sons.
2. David, H.A. (   ). *Contribution to Survey Sampling and Applied Statistics*. Academic Press.
3. Holt, D. and Scott, A.J. (1981). *Regression Analysis Using Survey Data*. The Statistician, 30, 169-178.
4. Holt, D., Smith, T.M.E. and Winter, P.D. (1980). *Regression Analysis of Data from Complex Surveys*. JRSS, A, 143, 474-487.
5. Kish, L. (1965). *Survey Sampling*. John Wiley & Sons.

6.   Kish, L. and Frankel, M.R. (1947). *Inference from Complex Samples*. JRSS, B, 13, 1037.
7.   Krewshi, D., Plateki, R. & Rao. (1981). *Current Topics in Survey Sampling*. Academic Press.
8.   Lessler, J.T. and Kalskeek, W.D. (1992). Non-Sampling Error in Surveys. John Wiley & Sons.
9.   Moser, C.R. & Kalton, G. (1971). *Survey Methods in Social Investigation*. H.E.B.
10.   Namoodiri, N.K. (1978). *Survey Sampling and Measurement*. Academic Press.

STAT—716   CATEGORICAL DATA ANALYSIS   (3Cr.Hrs.)

Maximum Likelihood Analysis for Frequency Data, Generalized Linear Models, Regression Type Models for Binomial and Poisson Data, Loglinear and Logit Models, Delta Method, Odd Ratio, Mantel-Haenszel Test, Iterative Weighted Least Squares and Maximum Likelihood, Analysis of Deviance and Residuals, Over dispersion, Underdispersion and Quasi likelihood Models, Log Linear Models for Multidimensional Contingency Tables.

Recommended Books:

1.   Agresti, A. (1990). *Categorical Data Analysis*. John Wiley & Sons.
2.   Atkin, M., Anderson, D., Francis, B. and Hinde, J. (1989*). Statistical Modeling in GLIM*. Clarendon Press, Oxford.
3.   Bishop, Y.V.V., Fienberg, S.E. and Holland, P.W. (1975). Discrete Multivariate Analysis. MA: MIT Press, Cambridge.
4.   Cox, D.R. and Snell, E.J. (1989). *The Analysis of Binary Data*. Chapman & Hall, London.
5.   Mccullagh, P. and Nelder, J.A. (1989). *Generalized Linear Model*. 2nd Edition, Chapman & Hall, London.

STAT-717   SURVIVAL DATA ANALYSIS   (3Cr.Hrs.)

Multiparameter Analysis Using Large Sample Likelihood Methods for Response Time Data, Survival Function and Hazard Function, Multiparameter Models, Reparameterization and Regression-Type Models, Likelihood Functions for Censored Data, Kaplan-Meier (Product-Limit) Estimator, Testing Based on Maximum Likelihood Estimators, Likelihood Ratios, and Score Tests, Analysis of Grouped Data.

Recommended Books:

1.   Bain, L.J. (1978). *Statistical Analysis of Reliability and Life-Testing Models.* Marcel Dekker.
2.   Lawless, J.F. (1982). *Statistical Models and Methods for Lifetime Data*. John Wiley & Sons.
3.   Lee, E.T. (   ). *Statistical Methods for Survival Data Analysis*. John Wiley & Sons.

STAT-718   APPLIED STOCHASTIC MODELS   (3Cr.Hrs.)

Probability Generating Functions, Compound Distributions, Simple Random Walk, Branching Processes, Markov Processes, Discrete and Continuous Time Markov Chains, Branching Processes, Poisson Processes, Imbedded Markov Chains, Birth-Death Process, Immigration and Immigration Processes, Immigration-Death-Processes, Queuing Theory, Renewal Processes, Markov Renewal Process, Ergodic Theorem, Gaussian Processes and Brownian Motion.

Recommended Books:

1. Beaument, G.R. (   ). *Introductory Applied Probability*.
2. Cox, D.R. and Millar, H.D. (1965). *The Theory of Stochastic Processes*. Chapman and Hall, London.
3. Strizaker, D.R. (1982). *Probability and Random Processes*. Oxford University Press, London.
4. Medhi, J. (1982). *Stochastic Processes*. Wiley International Ltd.
5. Feller, W. (1968). *An Introduction to Probability Theory and its Application*, V0l-1, 3rd Edition, John Wiley & Sons.

STAT-719   MODELING AND SIMULATION   (3Cr.Hrs.)

Principles and Methodology for Simulation Modeling, Generation of Pseudorandom Numbers, Congruential Generators, Stochastic Deviate Generation, Inverse Transform Methods, Acceptance-Rejection Method, Convolution Method, Alias Method, Building Simulation Models, Variance Reduction Techniques, Statistical Validation Technique.

Recommended Books:

1. Fishman, G.S. (1978). *Principles of Discrete Event Simulation*. John Wiley & Sons.
2. Kleijnen, J.P.C. (1974). *Statistical Techniques in Simulation*. Marcel Dekker, New York.
3. Mood, A.M. Grabill, F.A & Boes, D.C. (1974). *Introduction to the Theory of Statistics.* Mcgraw-Hill International, New York.
4. Pritsker, A.A.B. (1984). *Introduction to Simulation & SIAM.* Halsted Press, New York.
5. Ross, S.M. (1990). *A Course in Simulation*. Macmillan, New York.

STAT-720   SPATIAL DATA ANALYSIS   (3Cr.Hrs.)

Introduction to Spatial Statistics and Data Handling, Eigen function Analysis of Areal Unit Configuration, Spatial Autocorrelation and Spectral Analysis, Models of Spatial Autocorrelation, Higher Order Autoregressive Models, Relationship between Autoregressive and Spectral Models, Kriging.

Recommended Books:

1. Bartlett, M. (1975). *Statistical Analysis of Spatial Pattern*. Chapman and Hall, London.
2. Cressie, N. (1987). *Statistics of Spatial Data*. John Wiley & Sons.
3. Griffith, D. (1988). *Advanced Spatial Statistics*. Kluwer, Boston.
4. Ripley, B. (1988). *Statistical Inference for Spatial Processes*. John Wiley & Sons.
5. Upton, G. and Fingleton, B. (1985). *Spatial Data Analysis by Example*. Vol. I & II. John Wiley & Sons.

STAT-721   OPERATIONS RESEARCH   (3Cr.Hrs.)

Linear Programming: Graphical and Algebraic Solutions. Duality and Sensitivity Analysis. Transportation Model. Integer Programming; Dynamic Programming. Decision Theory and Games. Project Scheduling

(PERT-CPM). Inventory Models. Simulation Techniques. Non-Linear Programming: Classical Optimization Theory and Algorithms.

Recommended Books:

1. Brownson, R. (1983). *Operation Research- Schaum's Outline Series*. McGraw-Hill Book Company.
2. Hadley, G. (1962). *Linear Programming*. Addison Wesley, Reading, Mass.
3. Hillier, F.S. and Lieberman, G.J. (1980). *Introduction to Operation Research*. 3rd Edition, Holden-Day, San Francisco.
4. Luce, R. and Raiffa, H. (1957). *Games and Decisions*. John Wiley & Sons, New York.
5. Taha, H.A. (1997). *Operation Research an Introduction*. 6th Edition, Macmillan Publishing Company, London.
6. Theiranf, R.J. and Klekamp, R.C. (1975). *Decision Making Through Operations Research.* 2nd Edition, John Wiley & Sons, New York.

STAT-722   **ECOLOGICAL STATISTICS**   **(3Cr.Hrs.)**

Techniques for Describing Spatial Variation. Pattern Detection by Quadrat Analysis and Nearest-Neighbour Analysis. Tests for Detecting Non-Randomness of a Spatial Point Pattern. Contagious Distributions for Describing Spatial Patterns. Estimation of the Relative Abundance of Different Species. Concept of Species Diversity. Some Discussion of Diversity Indices.

Recommended Books:

1. Engen, S. (1978). *Stochastic Abundance Models*. Chapman and Hall.
2. Grieg-Smith, P. (1964). *Quantitative Plant Ecology*. Butter Worth.
3. Pielou, E.C. (1975). *Ecological Diversity*. Wiley, New York.
4. Pielou, E.C. (1977). *Mathematical Ecology*. Wiley, New York
5. Ripley, B.D. (1981). *Spatial Statistics. Wiley*, New York.
6. Saber, G.A.F. (1980). *Estimation of Animal Abundance and Related Parameters*. Macmillan, New York.

STAT-723   **DISCRET EVENT SIMULATION**   **(3Cr.Hrs.)**

Introduction: Modeling, Simulation. The Simulation Study, Workloads and Performance Metrics, Choice of Modeling Units and Time Scales, Documentation. Implementation: Simulation Software, Requirements of a General-Purpose Language, Modeling Approaches. Simulation Model Structure. Random Numbers: Randomness, Generating Random Numbers from Probability Distributions, Goodness of Fit, Selecting a Distribution.Entities and Resources:The Scheduler: The Job of the Scheduler, Types of Algorithm, Dynamic Algorithms, Performance Comparison, Implementation Simultaneous Events.

Queues: The Structure of a Queuing System, Basic Queuing Theory, the Implementation of Queues, Queues Behavior.

Gathering Results: Recording Results, Measurements, Outputting Results.

Results Analysis: The Dynamic Behavior of Simulation Models, Transient Effects, Detection of the Steady State, Estimating Accuracy, Realizing Accuracy Goals, Analysis of Transient Behavior.

Recommended Books:

1. Mihram, G.A. (1972). *Simulation: Statistical Foundations and Methodology*, London.
2. Pidd, MC (1989). *Computer Modeling for Discrete Simulations*, U.K.
3. Walking, K. (1993). *Discrete Event Simulation in C.*

STAT-724 **ADVANCE PROGRAMMING** **(3Cr.Hrs.)**

C++ Programming: Basic Structure of C++ Programs. Functions and Procedures. Arrays, Structures and Unions. Using Files & Graphics. Object Oriented Approach.

JAVA: Introduction to Java. Programs, Data, Variables and Calculation. Loops and Logic Arrays and Strings. Defining Classes. Streams Files, and Stream Output. Stream Input and Object Streams. Utility Classes. Handling Events.

Recommended Books:

1. Dietel, H.M. and Dietel, P.J. (1999). *Java 2: How to Programme*. 3rd Edition. BPB Publishers New Delhi.
2. Dietel, H.M. and Dietel, P.J. (1999). *C++: How to Programme*. 3rd Edition. BPB Publishers New Delhi.
3. Herbert Schildt. (1999). *The Complete Reference C++.* McGraw Hill, New York.
4. Samuel, N.K. and Edward, M. (1996) *Programming With Class A C++ Introduction to Computer*. BPB Publisher New Delhi.
5. Yahuda Shiran (2001). *Advanced JavaScript*. BPB Publishers New Delhi.

STAT-725 **VISUAL BASIC & ORACLE** **(3Cr.Hrs.)**

Microsoft Visual Basic:

Visual Basic Fundamentals. Working with Forms and Controls. Use Arrays and User-defined data types. Controlling Program Execution. Using Debug Toolbar, Watch, Immediate and Local Windows. ActiveX controls and insertabe objects.

Oracle-DBA:

Using Oracle, SQL-PL/SQL. Oracle objects, Oracle Data Dictionary. DML, DDL & DCL Statements. Expections & Error Handling. Oracle Architectural Components. Data Dictionary Views and Structure Packages. Types of Failures and Troubleshooting. Utilities and Dynamic Performance Views.

Recommended books:

1. Bradley, J.C. (1990). *Programming In Visual Basic (5.0)* Millspangly.
2. Dietel, H.M., Dietel, P.J. & T.R. Nitro (1999). *V.B.6: How to Programme*. Printice Hall New Jerky.
3. *Introduction To SQL/PLS SQL* By Oricle Press (1998).
4. Ivan Byros (1999). *Desiging Commercial Application Using Oracle*.

STAT-726   STATISTICAL QUALITY CONTROL   (4Cr.Hrs.)

Quality and Quality Improvement, Total Quality Management, Method and Philosophy of

Statistical Process Control, Control Charts for Variables, Cumulative Sum and Exponentially Weighted Moving Average Control Charts, Statistical Process Control for Short Production Runs, Modified and Acceptance Control Charts, Group Control Charts for Multiple-Stream Processes, Multivariate Quality Control, Process Capability Analysis, Probability Plot, Process Capability Ratios, Response Surface Methods and Designs, Evolutionary Operation, Taguchis Contribution to Quality Engineering.

Acceptance Sampling: Some Fundamental Concepts in Acceptance Sampling, The Doge-Roming System for Lot-By-Lot Acceptance Sampling by Attributes, An AQL System for Lot-By-Lot Acceptance Sampling by Attributes, Acceptance Inspection for Continuous Production.

Latest International Certification Methods.

Recommended Books:

1. Douglas C. Montgomery. (1996). *Introduction to Statistical Quality Control*. 3rd Edition, John Wiley & Sons, Inc.
2. Grant E.L. and Richard S.L. (1988). *Statistical Quality Control*. 6th Edition, McGraw-Hill.
3. Gupta R.C. (1983). *Statistical Quality Control*. 3rd Edition, Khanna Publishers, Delhi.
4. Paranthaman D.(1987). *Quality Control*. Tata McGraw-Hill Publishing Company Limited, New Delhi.

STAT-727   COMPUTATIONAL STATISTICS   (4Cr.Hrs.)

Recurrence Relations: Binomial Coefficients, Horner's Methods, Sample Means & Variances, Poisson-Binomial Distribution, an Unstable Recurrence.

Power Series Expansion: Expansion of $P(s)^n$, Expansion of $e^{p(s)}$, Standard Normal Distribution, Incomplete Gamma and Beta Functions, Connections to other Distribution (x^2, Standard Normal, Poisson, Binomial F, Student's –T Etc).

Continued Fraction Expansion: Wallis Algorithms, Equivalence Transformation, Gauss's Expansion of Hyper Geometric Function.

Asymptotic Expansion: Finite Taylor Expansions, Expansions Via Integration by Parts, General Definition of an Asymptotic Expansion, Laplace's Method and its Validations.

Solution of Nonlinear Equations.

Linear Regression and Matrix Inversion.

Eigen Values and Eigen Vectors. Splines. The EM Algorithms. Newton's Method and Scoring. Convergence of Optimization Algorithms.

Recommended Books:

1. Haimmerlin, G. Hoffmann K-H. (1991). *Numerical Mathematics*, Springer-Verlag, New York.
2. Henrici, P. (1982). *Essential of Numerical Analysis with Pockit Calculator DemonstrationS,* Wiley New York.
3. Kenneth, L. (1998). *Numerical Analysis for Statistician*. Springer-Veriag New York.
4. Wilf, H.S. (1986). *Algorithms and Complexity*. Prentice Hall, New York

STAT-801   **ROBUST STATISTICS**   **(3 Cr.Hrs.)**

Introduction to Robust Statistics; the Aims of Robust Statistics, the Main Approaches towards a Theory of Robustness.

The Influence Function and Breakdown Bound; Classes of Estimators: M-Estimators,

L-Estimators, W-Estimators, R-Estimators, P-Estimators and S-Estimators;

Robustness Properties in Linear Models; Robustness Testing in Linear Models.

Recommended Books

1. Hampd, F.R.; Rousseeuw, P.J.; Ronchotti, E.M and Stahal, W.A.(1985). *Robust Statistics:The Approach Based on Influence Function*. John Wiley & Sons, New York.
2. Hoaglin, D.C.; Mosteller, F.; and Tukey, J.W.(1983). *Understanding Robust and Exploratorydata Analysis.* John Wiley and Sons, New York.
3. Rey, W.J.J.(1983). *Introduction to Robust and Quasi Robust Statistical Methods.* Springer-Verlag, Berlin.
4. Rousseeuw, P.J. and Leroy, A.(1987). *Robust Regression and Outlier Deletion*. John Wiley, New York.

STAT-802   **TIME SERIES**   **(3Cr.Hrs.)**

Estimation of Autocorrelation Function, Linear Stationary Models, Estimation of Auto-Regressive Parameters, Linear Non-Stationary Models, The Non-Stationary Auto-Regressive Processes, ARIMA

Models for Non-Stationary Time Series, Different Forms of ARIMA Models, ARMA Models, Minimum Mean Square Error Forecasts, Calculating and Updating Forecasts, the Forecast Function, the Cox-Jenkins, Winner and Ross Approaches to Forecasting, Prediction Versus Forecasting, Objectives and Techniques of Identification.

Recommended Books:

1. Box, G.E.P. and Jenkins, G.M. (1976). *Time Series Analysis, Forcasting and Control*. 2nd Edition, Holden Day, San Francisco.
2. Chatrield, C. (1980). *The Analysis of Time Series: An Introduction*. Chapman & Hall.
3. Diggle, P.J. (1990). *Time Series: A Biostatistics Introduction*. Oxford University Press.
4. Kedall, M. and Ord, J.K. (1976). *Time Series*. 2nd Edition, Hafner, New York.
5. Kedall, M. Stuart, A. and Ord, J.K. (1983). *Kendall's Advance Theory of Statistics: Design and Analysis and Time Series.* Vol-3. Charles Griffin & Co. Ltd.
6. Montgomery, D.C. Johnson, L.A. and Gardiner, J.S. (1990). *Forcasting and Time Series Analysis.* McGraw-Hill International Edition.

STAT-803   **ADVANCE ECONOMETRICS**   (4Cr.Hrs.)

Simultaneous-Equation Models, Methods of Identification, Methods of Estimation, Finite and Infinite Distributed Lag Models, Serial-Correlation Problems, Seasonality, Aggregation Over Time, Computation Of Mean Lags, Weak Parametric Specifications, The Almon Distributed Lag, Shiller's Method and Ridge Estimators, Varying Parameter Models, A Model of Systematically Varying Parameters, Hildreth and Houck Models, Switching Regression Model, Adaptive Regression Models, Stochastically Convergent Parameter Models, Kalman-Filter Models, Random Coefficient Models, Mixed Estimation Methods, Restricted Least-Square, Pooling Cross-Selection and Time-Series Data, Forecasting With A Single-Equation Regression Model, Forecasting With A Multi-Equation Econometric Model, Evaluation of the Forecasting Power, Ranking of the Econometric Technique.

Recommended Books.

1. Desai, M. (1977). *Applied Econometrics.* Philip Allen Publishers Limited, Oxford.
2. Green, W.H. (1991). *Econometric Analysis.* McMillan Publishing Company New York.
3. Gujrati, D. (1983). *Basic Econometrics*. McGraw-Hill Kogakussa Company, Singapore.
4. Johnston, J. (1984). *Econometric Methods*. McGraw-Hill Book Company, Singapore.
5. Judge, G.G. (1985). *The Theory and Practice of Econometrics*. 2nd Edition. John Wiley & Sons.
6. Maddala, G.S. (1977). *Econometrics*. McGraw-Hill Inc.
7. Pakorny, M. (1987). *An Introduction to Econometrics*. Basil Blackwell Ltd.

STAT-804   **ADVANCE THEORY OF STATISTICS**   (4Cr.Hrs.)

Probability Measures, Expectations, Conditioning, Convergence of Random Sequence, Law of Large Numbers, Central Limit Theory, Characteristic Functions, Discrete Distributions, Continuous Distributions, Pearson Systems of Distributions, Chebyshev-Hermite Polynomials, Gram-Charlier Series (Type-A), Polynomial Transformations to Normality, Order Statistics and Their Sampling Characteristics, Distributions of Extreme Values, Non-Central Chi-Square, t and F Distributions.

Recommended Books:

1. Billingsley, P. (1986). *Probability and Measure*. 2nd Edition, John Wiley & Sons.
2. Johnson, N.L. and Kota, S. (1970). *Continuous Univariate Distributions*. Vol-1,2, John Wiley & Sons.
3. Stuart, A and Ord, J.K. (1987). *Kendall's Advance Theory of Statistics: Distribution Theory.* Vol-I, 5th Edition, Charles Griffin and Co. Ltd.

STAT-805   PERFORMANCE MODELLING   (4Cr.Hrs.)

Stochastic Processes: Random Walks, Marko Chains, Markov Processes, Reversibility, Renewal Theory.

Queues: Simple Markovian Queues, the M/G/1 Queues, the G/G/1 Queue.

Single Class Queueing Networks: Introduction, Open Queueing Networks, Mean Value Analysis, Performance Measure for the State-Dependent Case, The Flow Equivalent Server Method.

Multi-Class Queueing Networks: Service Time Distributions, Types of Service Centre, Multi-Class Traffic Model, BCMP Theorem, Computational Algorithms for BCMP networks, Priority Disciplines, Quasi-Reversibility.

Approximate Methods: Decomposition, Fixed Point Method, Diffusion Approximation, Maximum Entropy Methods.

Time Delays: Time Delays in the Single Server Queue, Time Delays in Networks of Queues, Inversion of the Laplace Transforms, Approximate Methods.

Blocking in Queueing Networks: Introduction, Type of Blocking, Two Finite Queues in A Closed Network, Aggregation Markovian States, BAS Blocking, BBS Blocking, Representative Service Blocking.

Switching Network Models: Telephone Networks, Interconnection Networks For Parallel Processing Systems, Models of The Full Crossbar Switch, Multi-Stage Interconnection Networks, Models Of Synchronous MINIS, Models of Asynchronous MINIS, Interconnection Networks in a Queueing Model.

Recommended Books:

1. Cox, D.R. and Miller, H.D. (1965). *The Theory of Stochastic Processes*. Chapman and Hall, London.
2. Peter, G. Harrison and Naresn M.Patel (1993). *Performance Modeling of Communication Networks and Computer Architectures.* Prentice Hall London.
3. Takacs, L. (1962). *Introduction to the Theory of Queues*. Oxford University Press.

STAT-806   STATISTICAL SIGNAL PROCESSING   (4Cr.Hrs.)

Introduction: detection theory in signal processing. The detection problem the mathematical detection problem, Hierarchy of detection problems, Role of asymptotic, Gaussian distribution, Chi-squared (non-central) distribution, F (non central) distribution, Tayleigh and Rician distribution, Quadratic form of Gaussian random variables, Monte Carlo performance evaluation, Normal Probability paper.

Statistical Decision Theory: Neyman-Pearson Theorem, Minimum probability of error, Minimum Bayes Risk detector, composite hypothesis testing, Performance of GLRT for large data records, equivalent large data records tests, Asymptotically equivalent tests-no nuisance parameters.

Determination Signals: Matched filters, Generalized matched filters, multiply signals, Linear model. Signal modeling and detection performance, Unknown amplitude, Sinusoidal detection, Classical linear model.

Random Signals: Incompletely known signal covariance, Large data record approximations, Weak signal detection, Derivation of PDF for periodic Gaussian random process Estimator- correlator, Estimator-correlator fro large data records, general Gaussian detection, Detection performance of the estimator-correlator.

Unknown Noise Parameters: White Gaussian noise, Colored WSS Gaussian noise. Non Gaussian noise characteristics, deterministic signals with unknown parameters.

Detection: Detection approaches, choosing detector. Description of problem, Extensions to the basic problem, Multiple change times, Signals processing examples.

Complex/vector Extensions and Arrays Processing: Known PDFs. Uncorrelated from spatial sample to sample, Detectors for vector observations, Known deterministic signal is CWGN, Known deterministic signal and General noise covariance, Random signal in CWGN.

Recommended Books:

1.   Loren, D.Lutes, S.Shahron (1997). *Stochastic Analysis of Structural and Mechanical Vitrating*. Prentice Hall.
2.   Oppenheim Schafer (1993). *Discrete Time Signal Processing*. Prentice Hall PTR New Jersey.
3.   Stevan M.K. (1998). *Fundamental of Statistical Signal Processing Volume-II Detection Theory.*
4.   Therrien (1992). *Discrete Random Signals and Statistical Signal Processing.*

CURRICULUM IN STATISTICS

AT THE

M. Sc LEVEL

(2013 & Onwards)

DEPARTMENT OF STATISTICS

UNIVERSITY OF MALAKAND

CURRICULUM IN STATISTICS AT THE M.Sc. LEVEL

OBJECTIVES

The objective of teaching Statistics at the M.Sc. Level are:

1.	To provide students with sound background of statistical knowledge and skills and enable them to apply these skills to real world problems.

2.	To prepare students for Statistical based position/field jobs/teaching jobs.

3.	To motivate the students interest for undertaking research and higher education in various areas of Statistics.

4.	To train students in such a manner that they should feel competent to organize experiments and to provide proper guidance to researchers in other fields, involving statistical applications.

5.	To train students to be able to link themselves with information Technology and Computer software's and make use of it for their benefit in day to day work

SCHEME OF STUDIES

M.Sc. Statistics is a two-year course with a University Examination at the end of each year. The total marks for two years are 1200 with each paper carry 100 marks.

M.Sc. Statistics (Previous)

STAT 501 Paper I:	Statistical Methods……………………………	100 marks

STAT 502 Paper II:	Probability and Probability Distribution……...	100 marks

STAT 503 Paper III: Sampling and Survey Methods………………...   100 marks

STAT 504 Paper IV: Linear Algebra and Numerical Analysis………..   100 marks

STAT 505 Paper V: Data Processing and Statistical Computing

Total =   50 marks

Total =   50 marks

Practical- I: Based on Paper I & III…………………………………..   50 marks

Practical- I: Based on Paper II & IV…………………………………..   50 marks

Total: ……….   600 marks

Note: Each practical examination will be of three hour duration.   Five marks are reserved for practical Note Book and another Five marks for Viva-Voce.

M.Sc. Statistics (Final)

STAT 601	Paper-VI:	Design and Analysis of Experiments....................	100 marks
STAT 602	Paper-VII:	Statistical Inference……………………………..	100 marks
STAT 603	Paper-VIII:	Regression Analysis and Econometrics…………	100 marks

Any two of the following options: ………………………………   200 marks

STAT 604	Paper-IX:	Multivariate Analysis
STAT 605	Paper-X:	Operations Research
STAT 606	Paper-XI:	Stochastic Processes
STAT 607	Paper-XII:	Population Studies
STAT 608	Paper-XIII:	Concept of Quality Control and Reliability
STAT 606	Paper-XIV:	Time Series Analysis and Forecasting
STAT 607	Paper-XV:	Non-Parametric and Robust Methods
STAT 608	Paper-XVII:	Survival Analysis
STAT 609	Paper-XVI:	Official Statistics
STAT 610	Paper-XVIII:	Biostatistics and Epidemiology
STAT 611 STAT 501	Paper-XIX:	Statistics and Information Technology

Paper XX: Thesis……………………………………………   100 marks

OR

Practical-I   (Based on Paper-VI)…………………………...   50 marks

Practical –II   (Based on Paper VII & VIII)…………………   50 marks

Total: ………….   600 marks

Note:
  (a)   Optional courses will be offered subject to the availability of the teachers and facilities.

(b) Each practical will examination will be of three hour duration. Five marks are reserved for practical Notebook and another five marks for Viva-Voce examination.

(c) Thesis will be offered to the student who secure at least 60% marks in his/her M.Sc. (Previous) examination (subject to availability of the advisors and facilities). The examiner (advisor must be an M. Phil./Ph.D. degree holder or at least Assistant Professor. The thesis is to be submitted in typed and binded form. The evaluation is to be made by both the internal and external examiners.

(d) The question papers for all the practical shall be set (like the theory papers) by the external examiners and then moderated according toe the rules of University.

M. Sc. Statistics (Previous)

Paper – I: *Statistical Methods*

i. Review of basic concepts of Sampling Procedures and Distributions. Random Numbers and their Generation.

ii. Basic ideas of Inferential Statistics. Simple and Composite hypotheses. Type-I and Type – II Errors, Power of a test, O.C. Curves. Testing of hypotheses and Construction of Confidence Interval for Means, Proportions, and Variances in small and large samples. Determination of the sample size.

iii. Analysis of Categorical Data. Goodness of Fit Tests of commonly used distributions. Testing of Independence in Contingency Tables. Testing of Homogeneity of several Variances. Bartlet's test. Fisher's Exact Test for $2*2$ Contingency Table, Log-Linear Models & their application.

iv. Simple Linear Regression and Correlation. Fitting of Linear and Multiple Regression Model upto two Regressors and Inference about the Model. Inference about the Multiple and Partial Correlation Coefficients, Concept of outliers.

v. Analysis of Variance and the Interpretation of its assumptions. One-way Classification. Two-way Classification with one and several observations per cell. Multiple Comparison Tests.

vi. Nonparametric methods. Sign test. Wilcoxon's Signed Rank Test, Mann-Whitney U test. Kruskul-wallis test, Friedman test. Randomness and Run Tests. Kolmogrov-Smirnov test. Normal Approximations to Nonparametric Test Statistics.

Books Recommended:

1. Snedecor, G.W. and Cochran W.G. (1997). *"Statistical Methods"*, Iowa State
2. University Press.
3. Daniels, H (1988). *"Applied Non-Parametric Statistics",* John Wiley, New York.
4. Steel, R.G.D., Torrie, J.H. and Dickey, D.A. (1996). *"Principles and Procedures*
of Statistics", 3rd Edition, McGraw Hill, New York.
5. Mendenhall, W. and Beaver, R.J (1994). *" Introduction to Probability and Statistics"*, 9th Edition, Duxbury Press, Belmont, California.

6.   Montgomery D. C. and Peck, E. A. (1992). *"Introduction to Linear Regression*

Analysis", John Wiley and Sons, Inc. New York.

7.   Chase, W. and Bowen, F (1992). *"General Statistics"*, 2nd Edition, John Wiley

and Sons, Inc, New York.

8.   Anderson, D.R. Sweeney, D.J and Williams, T.A (1991). *"Introduction to Statistics Concepts and Application"*, 2nd Edition, West Publishing Company, New York.

9.   Dixon, W.J. and Massey, F.J (1983). *"Introduction to Statistical Analysis"*, McGraw Hill. New York.

10.   Walpole, R.E (1990). *"Introduction to Statistics*", 3rd edition, MacMillan. Publishing Co. Inc. New York

Paper II: <u>Probability and Probability Distributions</u>

i.   Nature and Scope of Probability . Algebra of Sets. Sample Space and Events. Axiomatic Development of Probability. Counting Techniques. Discrete and Continuous Sample Spaces. Conditional and Marginal Probabilities. Bays' Theorem.

ii.   Random variable, Distribution function. Probability function and probability density function. Joint distributions and probability density functions of two and more random variables. Marginal and conditional distributions, stochastic independence. Mathematical expectation. Conditional expectation, variance and moments. Probability generating function. Moment generating and characteristic function and their properties. Relation between moments and cumulants.

iii.   Probability distributions: Binomial, geometric, Hypergeomatric, Multinomial, Negative Binomial, Poisson, Uniform, Exponential, Gamma, Beta, Laplace, Normal, Lognormal, Cauchy, Weibull, Rayleigh with moments and cumulants. Bivariate Normal distribution.

iv.   Distributions of Functions of Random Variables. Chi-square, t and F-Distributions, their derivations and properties. Central limit theorem and Chebyshev's inequality.

v.   Order Statistics: Distribution of rth and sth order Statistics. Distribution of Sample Range.

Books Recommended:

1.   Stirzaker, D. (1999). *"Probability and Random Variables"*. Cambridge University Press, Cambridge.

2.   Stuart, A. and Ord, J.K. (1998). *"Kendall's "Advance theory of Statistics"*, Vol.1, Charles Griffin, London.

3.   Hirai, A.S. (1998). *"A Course In Mathematical Statistics"*, Ilmi Kutab Khana, Lahore.

4.   Mood, A.M, Graybill, F.A. and Boss, D.C. (1997).*"Introduction to the Theory of Statistics"*, McGraw Hill, New York.

5.   Hogg, R.M. and Craig, A.T. (1995). *"Introduction to Mathematical Statistics"*. Prentice Hall, Engle Wood Cliffs, New Jersey.

6.   Khan, M.K., (1996). *"Probability with Applications"*, Maktiba Ilmi, Lahore.

7.   Rohatgi, V.K.(1976*).*"An introduction to Probability Theory and Mathematical Statistics"*, John Wiley and Sons.

8.   Ross, S. (1976*). "A First Course in probability"*, Collier Mac Millan. New York.

Paper III: <u>**SAMPLING AND SUVEY METHODS**</u>

i.   Basic concepts advantages of sampling methods, requirements of a good sample, bias and its effects, sampling and non-sampling errors. Steps and problems involved in planning and conduct of census and sample surveys, Precision and Accuracy.

ii.   Selection and estimation procedures. Description and properties of simple random sampling. Sampling for proportions and percentages. Estimation of variances, standard errors and confidence limits. Sample size determination under different condition.

iii.   Description and properties of stratified random sampling. Formation of strata, Different methods of allocation of sample size. Systematic sampling. Ratio and regression estimates in simple and stratified random sampling.

iv.   Cluster sampling. Sub-sampling, PPS-Sampling, Multistage sampling. Comparison of different sample designs.

v.   Critical study of National sample surveys conducted in Pakistan: Census of Agriculture, Household Economic and Demographic Survey (HED), Household Income and Expenditure Survey (HIES), Pakistan Demographic Survey (PDS) and National Population and Housing Census Surveys (NPHCS).

Note: Practical of this course shall include visits of the students to various national statistical organizations and a report submitted to this effect.

Books Recommended
1.   Des Raj & Chandhok, P. (1998). *"Sample Survey Theory".* Narosa Publishing House, Hew Delhi.
2.   Ferguson, T.S. (1996). *"A course in large sample theory",* Chapman & Hall, London.
3.   Cochran, W.G. (1996). *"Sampling Techniques".* John Wiley and Sons New York.
4.   Kish, L. (1992). *"Survey Sampling",* John Wiley, New York.
5.   Sukhatme, P.V. Sukhatme,B., Sukhatme, S., and Asok, A. (1985). *"Sampling Theory of Survey with Application".* Lowa State University Press.
6.   Des Raj, *"Design of Sample Survey".* McGraw Hill, New York.
7.   Singh, R. and Singh N, (1996). *"Elements of Survey Sampling",* Kulwar, Dodrecht.

Paper-IV: <u>**Linear Algebra and Numerical Analysis.**</u>

<u>**Section-I**</u>

i.   Introduction to Vectors. Vector spaces and subspaces. Linear independence and Dependence. Basis and Dimension. Inner product spaces. Orthogonality. Orthonormal set. Gram –Schmidt Orthogonalization process.

ii.   Introduction to matrices. Basic Matrix operations. Elementary Results on Matrix Algebra. Partitioned matrices. Idempotent Matrices. Trace of matrices. Determinant and its properties. Minors and cofactors. Adjoint Matrix Inversion. Rank of Matrices. System of Linear Equations (Homogeneous and Non-homogeneous). Gauss Elimination and Gauss-Jordan Methods. Numerical solution of non-linear solution: iterative methods; Newton Raphson method. Gauss Seidel Method and Jacobi method.

iii.   Introduction to Eigen values and Eigen vectors. Roots of characteristic polynomial. Diagonalization of Symmetric Matrices. Properties of the Eigen values and Eigen vectors of

Symmetric Matrices. Application of Spectral Decomposition Theorem. Quadratic forms and Definiteness. Diagonalization of Quadratic forms.

Section-II

i. Introduction to Interpolation. Finite and Central Difference Operators. Factorial Polynomial. Finite and Divided Differences. Newton-Gregory, Newton Divided Difference and Newton-gauss formulas. Of Interpolation.
ii. Introduction to numerical Integration and Summation. Approximation to a Definite Integral. Euler-Maclaurin Formula and its Application to summation of series and the sum of power of the whole numbers. Remainder Term in the Euler. Maclaurin Expansion. Stirling's Approximation to the factorial. Gregory's formula of Numerical Integration. Trapezoidal, Simpson's one-third and Simpson's three-eights rules.

Books Recommended

1. Mumtaz. K. (2002). *"Numerical Methods"*, 2nd Edition. Engineering University Peshawar.
2. Scheid, F. (1983). *"Numerical Analysis Schaum's Outline Series"*, McGraw Hill Book Company.
3. Watson, W. A., Phlipson, T. and Oates, P. J. (1981). *" Numerical Analysis"*, 2nd Edition. Edward Arnold Limited, London.
4. LIPSCHUTZ,S.(1981). *"Linear Algebra Schaum's Outline Series"*, McGraw-Hill Book Company.
5. Hadley, G. (1980). *"Linear Algebra"*, Addison Wesley Publishing Company.

Paper-V: Data Processing and Statistical Computing

i. Introduction to hardware, CPU, I/O concepts and devices, primary and auxiliary storage concepts, classification of devices, organization of hardware.
ii. Introduction to software, system software, application software.
iii. Computer programming steps, definition of the problem, programme design and flow charting, coding, execution, debugging, testing, documenting, maintenance and updating the programme,. Some of the programming Languages: FORTRAN, C^{++}.
iv. Use of some of the Statistical Packages: SPSS, MINITAB.

Practical (50 Marks)

Each student shall be given statistics-orientated problems to solve on the computer using computer programming in FORTRAN and C^{++}. The examination shall be 3 hours duration. Five marks will be reserved for Viva-Voce examination and another five marks for the note book

Books Recommended

1. Andy F. (2000). *"Discovering statistics using SPSS for Windows"*, SAGE Publications, Londons.
2. Freeze J.T (2000). *"Teach your self Computer Basis"*, 2nd edition, SAMS techmedia New Delhi.
3. Vandwoorde D. (1998). *"C^{++} Solutions"*, Addison Wesley, ENGLAND.

4. Foster J.J (1998). *"Data Analysis Using SPSS for windows",* SAGE publications, London.
5. Hahn, B.D. (1987). *"Problem Solving with FORTRAN 77",* Edward Arnold, London.

M.Sc. Statistics (Final)

Paper-VI   **Design and Analysis of Experiments.**

i.   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. Analysis of transformations.

ii.   Layout and Analysis of Completely Randomized, Randomized Complete Block, Latin Square and Graeco-Latin Square Designs. Estimation of Missing observations. Relative Efficiency of Designs. Fixed, Random and mixed Effect models. Expected Mean Squares Derivations for Basic Design.

iii.   Covariance Analysis for completely Randomized, Randomized complete Block and Latin Square Designs.

iv.   Factorial Experiments. Its Advantages and Disadvantages. 2^n Series Factorial Experiments. Linear and Quadratic Components of Main Effects and Interactions. p x q factorial in Randomized complete Block Designs. Analysis of 3^2 and 3^3 Factorial Experiments.

v.   Confounding and its types. Its Advantages and Disadvantages. The complete confounding and Partial confounding in 2^n series. Fractional Replication. Quasi-Latin Squares. Split-Plot and Split Block designs.
vi.   Balanced Incomplete and Partially Balanced Incomplete Block Designs. Comparison of Incomplete Block Design with Randomized complete Block Design.

Books Recommended

1.   Montgomery D.C. (2000). *"Design and Analysis of Experiments",* John Wiley, New York.
2.   Clark, G.M., and Kempton, R.E. (1997). *"Introduction to the Design and analysis of Experiments"*, Edward Arnold.
3.   Clark, G.M. (1994). *"Statistics and Experimental Design",* Edward Arnold.
4.   Das, M.N. and Giri, N.C, (1986). *"Design and Analysis of Experiments",* John Wiley, New York.
5.   Gomez, K.A., and Gomez, A.A. (1984). *"Statistical Procedures for Agricultural research"* 2nd Edition, John Wiley, New York.
6.   Hicks, C.R. (1982). *"Fundamental Concepts in the Design of Experiments",* 3rd Edition, Holt-Saunders International Edition.
7.   Cochran, W. G. and Cox, G. M. (1957). *" Experimental Design",* 2nd Edition John Wiley and Sons, Inc, New York.

Paper-VII   Statistical Inference

i.   Point Estimation. Introduction. Properties of a good Estimator: Unbiasedness. Consistency, Sufficiency and Efficiency. Completeness and Minimal Sufficiency . Fisher Information. Cramer-Rao Inequality. Minimum Variance Bound Unbiased Estimators. Rao-Blackwell Theorem. Lehmann - Scheffe Theorem. Uniformly Minimum Variance unbiased Estimators.
ii.   Methods of Estimation. Maximum Likelihood Estimation (in Regular and Non-Regular distribution). Properties of Maximum Likelihood Estimators. Moment-Equations Method. Minimum Chi- Square. Method Bayesian Approach: Prior, Posterior and Improper Prior Distributions. Bayes and Minimax Estimators.
iii. Testing of Hypotheses. Introduction. Most Powerful Tests. Neyman Pearson Lemma, Randomized Tests. Uniformly Most powerful Tests. Consistency of Test. Unbiased and Invariant Tests. Similar Regions. Likelihood Ratio Tests and its Properties.
iv.   Interval Estimation. Introduction. Pivotal Method. Large-Sample Approximation. Shortest Confidence Interval. Unbiased confidence Interval. Bayesian Intervals. Interpretation.
v.   Sequential Tests. Introduction. Sequential Probability Ratio Test and its Properties. O.C. Curve. Average Sample Number Sequential Tests of Composite Hypotheses.

Books Recommended

1.   Ley, P.S. and Lemeshow, S. (1999). *"Sampling of Populations: Methods and Applications",* 3rd Edition, John Wiley, New York.
2.   Stuart, A and Ord J.K. (1998). *"Kendall's Advanced Theory of Statistics",* Vo.II Charles Griffen, London.
3.   Lindgren, B.W. (1998). *"Statistical Theory".* Chapman and Hall, New York.
4.   Mood, A.M. Graybill, F.A. and Boss, D.C. (1997). *"Introduction to the Theory of Statistics".* McGraw Hill, New York.

5.   Lehman, E.L. (1997). *"Testing Statistical Hypotheses".* Springler Valag, Hew York.
6.   Hogg, R.V. and Craig, A.T. (1996). *"Introduction to Mathematical Statistics".* Prentice Hall, New Jersey.
7.   H.C Saxena (1985). *"Statistical Inference"*, S.Chaud and Company Limited Ram Nagar, New Delhi.
8.   Rohatgi, V.K. (1976). *"An Introduction to Probability Ratio Test and its Mathematical Statistics".* John Wiley and Sons, Inc. New York.
9.   Hirai, A.S (1973). *" Estimation of Statistical Parameters",* Latest Edition. Ilmi Kitab Khana, Urdu Bazar Lahore.
10. Rao, C.R., (1973). *"Linear Statistical Inference and its Applications",* John Wiley, New York.
11. Wetherill, G. B. and Glaze brook, K. D. (1986). *"Sequential Methods in Statistics"*, 3rd Edition. Chapman and Hall, London.

Paper-VIII   Regression Analysis and Econometrics

1.   Introduction. The Nature and Scope of Econometrics. Relationships among Economic variables. Probabilistic Versus Deterministic Models.
2.   Simple Linear Regression Analysis. The Two-Variable Linear Model and Assumptions. The Ordinary Least Squares Estimators and their Properties. Inference in the Linear Model.
3.   The General Linear Model. Introduction. Assumptions and their Role. The Ordinary Least Squares Estimators. Gauss- Markov's Theorem. Inference in the Ordinary Least Squares Model. Use of Extraneous Information in Linear Regression Model. Least Squares Method Subject to Linear Restrictions. Inference about the set of Linear Hypotheses.
4.   Problems in the General Linear Model: Multi collinearity and its Consequences. Detection and Remedies Ridge Regression. Heteroscedasticity and its Sources. The Generalized Least Squares Estimator and its Properties. Testing for Heteroscedasticity. Autocorrelation and its Consequences for Ordinary Least Squares Estimator. Durbin - Watson Test for Autocorrelation. Estimation with Stochastic Regressors. Independent Stochastic Linear Regression Model. Properties of the Ordinary Least Squares Estimator.
5.   Further Topics in the General Linear Model. Dummy Variables and their Role. Distributed Lag models and Difficulties involved in Estimation. Specification Error. Exclusion of Relevant Variables and Inclusion of Irrelevant Variables. Errors in Variables. The Classical Model. Properties of Ordinary Least Squares. Instrumental Variable Estimators.
6.   System of simultaneous Linear Relationship. Introduction to Simultaneous Equation Systems Problems of Identification. Methods of Estimation: Instrumental Variable, Indirect Least Squares and Two-Stage Least Squares.

Books Recommended

1.   Gujrati. D. (1998). *"Basic Econometrics",* John Wiley, New York.
2.   Draper, N.R. and Smith, H. (1998). *"Applied Regression Analysis",* John Wiley, New York.
3.   Johnston, J. and Di. Nardo, J., (1997). *"Econometric Methods",* 4th Edition, McGraw Hill, New York.
4.   Montgomery, D.C., and Peck E.A. (1992). *"Introduction to linear Regression Analysis"*, 2nd Edition, John Wiley and sons Inc. New York.
5.   Chow, G. C. (1985). *"Econometrics",* McGraw- Hill Book Co.
6.   Madnani, G. M. K. (1986). *"Introduction to Econometrics Principles and Application"*, 3rd Edition Oxford and IBM Publishing Co.
7.   Wonnacot, T.H. and Wonnacot R.J. (1981). *"Econometrics",* John Wiley, New York.
8.   Maddala, G.S. (1977). *"Econometrics",* McGraw Hill. New York.

Optional Papers

Paper-IX   Multivariate Analysis

i.   Preliminaries. Introduction to Multivariate Analysis. Objects and Variables. Data Matrix. Summary Statistics. Some Basic Properties of Random Vectors. Mahalanobis Distances and Angles.
ii.   Multivariate Normal Distribution. Introduction. Distribution of Linear Combinations of Normally Distributed Variates. Basic Properties.
iii.   Estimation. Introduction. Maximum Likelihood Estimation of the Mean Vector and the Covariance Matrix. Maximum Likelihood Estimation under Constraints. Properties of the Estimators.
iv.   Basic Multivariate Sampling Distributions. Distribution of Quadratic Forms Cochran's Theorem. The Wishart Distribution and its properties. The Hotelling T^2 Distribution. Distributions of Sample, Partial and Multiple Correlation Coefficients (Extensive derivations not required).
v.   Inference for the Multivariate normal Distribution. One-Sample Hypotheses on the mean Vector and covariance Matrix. One Sample Hypotheses of Linear Constraint on the Mean Vectors. Two Sample Hypotheses on the Mean Vectors and Covariance Matrices. Test of Homogeneity of Covariance Matrices. Test of Independence (Extensive Derivations not desired). Confidence Regions for the Mean Vectors. Simultaneous Confidence Intervals.
vi.   Principal Component Analysis. Introduction. Definition and Properties of Principal Components. Sampling Properties of Principal Components. Inference about Principal components. Discarding of Variables. Interpretation of the Results.
vii.   Factor Analysis Introduction. The Factor Model. Principal Factor Analysis. Maximum Likelihood Factor Analysis. Goodness of Fit Test. Factors Scores. Relationship between Factor Analysis and Principal Component Analysis.
viii.   Discriminant Analysis. Introduction. Discrimination When the Populations are known. Discrimination under Estimation. Fisher's Linear Discriminant Function. Probabilities of Misclassification.
ix.   Cluster Analysis. Introduction. A Probabilistic Formulation. Hierarchical Methods. Distances and Similarities. Other Methods and Comparative Approach.

Books Recommended
1.   Flury B. (1997). *"A First Course in Multivariate Statistics",* Springler Valerg, New York.
2.   Jhonson, R.A. and Wichern, D.W. (1992). *"Applied Multivariate Statistical Analysis".* Prentice Hall. London.
3.   Morrison, D. F. (1990). *"Multivariate Statistical Methods"*, McGraw Hill, New York.
4.   Anderson, T.W. (1984). *"An Introduction to Multivariate Statistical analysis",* John Wiley, New York.
5.   Sebber.,G.A.F.(1984). *"Multivariate Observations"* John Wiley and Sons, Inc. New York.
6.   Chatfield, C. and Collins, A.J. (1980). *"Introduction to Multivariate Analysis",* Chapman and Hall, London.
7.   Mardia, K.V., Kent, J.T. and Bibby, J.M. (1979). *"Multivariate Analysis"*, Academic Press, London.
8.   Kendall, M.G.(1975). *"Multivariate Analysis"* Charless Griffin and Co. Ltd. London.

Paper-X   Operations Research.

i.	Overview; history and definition of Operation research. Linear programming: Introduction. Feasible and Optimal Solutions. Linear Programming Techniques. Graphical Solution of two Variables Linear Model. Simplex Method. M-Technique. Primal-Dual Problems. Dual Simplex Method. Transportation Type Problem. Transportation Model. North -West corner Rule. Stepping-Stone method. Least-Cost Method. Vogle's Approximation Method. Method of Multipliers. Assignment Model. Simplex and Algorithm.

ii.	Games Theory: Introduction to Game Theory. Strategy Payoff Table or Matrix. Types of Games and Strategies. Rectangular Game. Two-Person Zero-Sum Game. Rectangular Game with Saddle Point. Rules of Game Theory.

iii.	Inventory Models: Introduction. Classification of Inventory Models (Deterministic and Probabilistic). Economic Log size Model. Optimization Procedures. Inventory Model with Production Planning Replacement Simple types of Reliability. Simulation Techniques.

Books Recommended

1.	Taha, H.A. (1998). *"Operations Research"*. MacMillan. London.
2.	Hillier, F.S. and Lieberman G.J. (1996). *"Introduction to Operations Research"*, Holden Day
3.	Gupta, P.K. and Hira, D.S. (1994). *"Operations Research"*. S.Chand and Co., New Delhi.
4.	Brownson, R. (1983). *"Operations Research"*. Schaum's Outline Series McGraw Hill.
5.	Hillier, F. S. and Lieberman, G, J. (1980). *"Introduction to Operations Research"* 3rd Edition, Holden-Day, San Fransisco.

## Paper-XI	Stochastic Processes

i.	Introduction. Generating Functions. Laplace Transforms. Difference Equations. Differential-Difference Equations.
ii.	Introduction to Stochastic Processes. The Random Walk in one and two Dimensions. The Classical Gambler's Ruin Problem. Expected Duration of the Game.
iii.	Markov Chains. Definition. Higher Transition Probabilities. Classification of states and chains.
iv.	Markov Processes with Discrete state space. Poisson Process and its Generalization. Pure Birth and Death Processes. Markov Processes with Discrete State Space (Continuous Time Markov Chains).
v.	Markov Processes with continuous State Space. Introduction to Brownian Motion. The Wiener Process. Diffusion Equations for the Wiener Process. The Kolmogorov equations. First Passage Time Distribution for Wiener Process. The Ornstein-Uhlenbeck Process.
vi.	Renewal Process and Theory. Introduction to Renewal Process. Renewal Theorems. Delayed and Equilibrium Renewal Process. Two-Stage Renewal Processes.
vii.	Branching Process. Introduction. Generating Functions of Branching Process. Probability of Extinction. Distribution of Total Number of Progeny. Continuous Time Markov and Age-Dependant Branching Process.

Books Recommended

1.	Ross, S. (1996). *"Stochastic Process",* 2nd Edition, John Wiley, New York.
2.	Feller, W. (1992). *"An Introduction to Probability Theory and its Applications"*, John Wiley, New York.

3. Srinivasin; S.K. and Mehta, K.M. (1988). *"Stochastic Processes"*. Tata McGraw Hill.
4. Hoel, P.G., Port, S. and Stone, C.L. (1984). *"An Introduction of Stochastic Process"*, John Wiley, New York.
5. Cox D.R. and Miller H.D. (1984). *"The Theory of Stochastic Processes",* Chapman and Hall, London.
6. Medhi, J. (1982). *"Stochastic Processes",* Wiley Eastern Ltd.

7. Feller, W. (1968). *"An Introduction to Probability Theory and its Applications"* Vol-I-Third Edition. John Wiley and Sons, Inc. New York.

Paper-XII   POPULATION STUDIES

i.   Sources of demographic data: The population census Registration of vital events. Housing and Demographic surveys. Components of Population growth, composition of population and vital events.

ii.   Testing the accuracy of demographic data: Types and sources of errors. General testing procedures. Testing the accuracy of age and sex data.

iii.   Basic demographic measures: Fertility and mortality measures. Mortality rates. Total and general fertility rates. Estimation from incomplete Data.

iv.   Life tables: Construction of complete and abridged life tables. Different types of life tables. Graphs of lx, qx and dx. Description and uses of life table columns. Stationary population models.

v.   Population estimates and projections, Inter-censal estimates, Population projections through various methods.

vi.   Population Models: Theory of demographic transition. Stable and stationary population models, their applications and uses. Malthusian and post Malthusian theories of growth. Consequences of world population growth and population explosion.

vii.   State of Population in Pakistan. Development of demographic profile in Pakistan. Recent demographic parameters. Current and future demographic activities in Pakistan.

Books Recommended

1. Govt. of Pakistan (1998). *"National, Provincial and District census reports and other supplementary reports with respect to 1998 census";* PCO, Islamabad.
2. Hind, A., (1998). *"Demographic method",* Arnold.
3. R. Ramakumar. (1986). *"Technical Demography".* Wiley Eastern Limited.
4. Keyfitz N. (1983). *"Applied Mathematical Demography",* Springer Verlag N.Y.
5. Pollard, A.H., Yousaf, F and Pollard, G.M. (1982). *"Demographic Techniques",* Pergamon Press, Sydney.

Paper-XIII: Concept of Quality Control and Reliability

i.   Concept of quality control; Total Quality Management (TQM). Statistical Methods in Quality Improvement. Statistical Process Control (SPC). Statistical Control (SQC).

ii.   Shewhart control charts: philosophy, construction, advantages. CUSUM and moving average control charts: Average Run Length (ARL); Fast Initial Response (FIR). ARL and FIR for X, R and S-charts.

iii. Process capability analysis; designed experiments process improvements using design of experiments. Orthogonal fractional factorial designs. Acceptance sampling for attributes and variable.

iv. Acceptance sampling plans; single, double and multiple plans with their O.C. curves, military standard 105 sampling plans. Introduction to ISO-9000 and ISO-14000 series.

v. Basic concepts of reliability: structural reliability.

vi. Lifetime distributions (Failure models): hazard rate; Gamma, Weibul, Gumbel, Log-Normal and Inverse Gaussian. Stochastic fatique-rate model; point and interval estimation; fatique-life model.

vii. Testing reliability hypothesis. Monte-carlo, distribution-free and bayes methods in reliability. System reliability; series and parallel systems. Failure models, (K-out-of-m) new-better-than used models inferences for these models. Accelerated life testing.

Books recommended
1. Montgomery, D.C.(1998). *"Introduction to Statistical Quality Control".* McGraw Hill, New York
2. Miltag H.J and Rinne H. (1993). *"Statistical Methods of Quality Assurance",* Chapman & Hall.
3. Nelson, W. (1990). *"Accelerated Testing. John Wiley",* New York.
4. Gertsbakh, I.B. (1989). *"Statistical Reliability Theory".* Marcel Dekker, New York.
5. Banks, J.(1989). *"Statistical Methods for quality Improvement".* John wiley, New York.
6. Ryan, T.P.(1989). *"Statistical Methods for quality Improvement".* John wiley, New York.
7. Juran, J.M. and Gryana, F.K. (1988). *"Juran's Quality Control Handbook".* McGraw Hill New York.
8. Feigenbaum, A.V. (1986). *"Total Quality Control".* New York.
9. Cox, D.R and Oakes, D. (1984). *"Analysis of Survival Data".* John Wiley, New York.
10. Lawless, J.F. (1982). *"Statistical Models and Methods for Lifetime Data".* John Wiley, New York.

Paper-XIV: Time Series Analysis and Forecasting

i. Time Series Analysis: Concept (Stochastic process, mean & covariance functions. Parsimony, Stationary). Importance of Good Forecasts. Classification of Forecast Methods. Framework of a Forecast. Forecast Criteria. Regression and its application in Forecasting, Regression and Exponential Smoothing Methods to Forecast. Modelling seasonality with trigonometric Function.

ii. Introduction to Stochastic Time Series Models, especially ARMA and ARIMA models.

iii. Some Econometric models of Time Series. Identification, Estimation and diagnostic technique for ARMA and ARIMA models. Seasonal ARIMA models. Exponential smoothing and ARIMA models.

iv. Introduction to spectral analysis. Transfer function models. State space models and kalman filters. Design of feed forward and feed backward control schemes.

Books Recommended

1. Sturat A and Ord J.K. (1998). *"Kendall's: The Advanced theory of statistics"*. Charles Griffin.
2. Cox D.R., Hinckley D.V. and Nielsen O.E.B (1996). *"Time series Models in Econometrics, Finances and other fields"*, Chapman & Hall, London
3. Chatfield, C. (1996). *"The Analysis of Time Series: and Introduction",* Chapman and Hall London.
4. Andy, P, West M. and Harrison, P.J. (1994). *"Applied Bayesian forecasting and time series analysis"*, Chapman & Hall New York.
5. Brockwell P.J. and Davis R.A. (1991). *"Time series theory and methods",* Springer Verlag New York.
6. Harvey A.C. (1990). *"Forecasting structural time series models and the kalmanter"*, Cambridge university press, Cambridge.
7. Diggle, P.J. (1990). *"Time series: A Bio-statistical Introduction"*, Clarendon press, Oxford.
8. Bovas, A and Johannes, L (1983). *"Statistical methods for forecasting",* John Wiley, New York.
9. Priestley, M.B. (1981). *"Spectral Analysis and Time series",* Academic Press, London.
10. Box, G.E.P and Jenkins G.M. (1976). *"Time Series Analysis Forecasting and Control",* San Francisco.

Paper-XV: Non-Parametric and Robust Methods

      i.   Introduction, nonparametric and robust methods; location estimates for single samples; the sign test, modified sign test, Wilcoxon signed rank test, confidence interval based on these tests. Runs test for randomness. Distribution tests and rank transformation. Kolmogrov' test. Lilliefor's test and Shapiro-Wilks test for norality. Tests and estimation for two independent samples; the median test, Wilcoxon-Mann-Whitney test. The Siegel-Tukey test, the squared rank test for variance, Smirnov test. Tests for paired samples. Kruskal-Wallis test, Friedman test, multiple comparison with the Friedman test, Cochran's test for binary responses. Spearman's rank correlation coefficient, Kendall's rank correlation coefficient. Theil's regression methods.

      ii.   Introduction to robustness. Objective function, M-Estimator of location, E-Estimator and W-estimator, Redescending M-Estimators. The breakdown point and Robust estimator, influence function. M-Estimator for scale. Outliers and influential observation. Outliers in regression analysis, the least median of square line.

Books Recommended

1. Conover, W.J. (1999). *"Practical Nonparametric Statistics",* 3rd Edition, John Wiley and Sons, New York.
2. Maritz, J.S. (1995). *"Distribution-Free Statistical Methods"*. Chapman & Hall London
3. Gibbons, J.D. and Chakraborti, S. (1992). *"Nonparametric Statistical Inference",* Marcel Decker, New York.
4. Sprent, P. (1989). *"Applied Nonparametric Statistical Methods"*. Chapman & Hall London.
5. Rousseeuw, P.J. and Leory, A.M. (1987). *"Robust Regression and outliers detection"*, John Wiley, New York.

6. Hample, T.R. Ronchetti, E.M. Rousseeuw, P.J. and Stahel, W.A. (1986). *"Robust Statistics, The approach Based on influence functions",* John Wiley New York.
7. Huber, P.J. (1981). *"Robust Statistics",* John Wiley, New York.
8. Lehman, EL. (1973). *"Nonparametric Statistical Methods, based on Ranks",* Holden-Day San Francesco.

Paper-XVI: <u>**Official Statistics**</u>

  i.   Design and planning of a Statistical Investigation. Data collection-approach and operation; Role of sampling in generation of Statistics, Sampling plans and survey Designs. Sources of Errors, Types of Errors, methods of their control. Data processing, presentation, and publication of Statistics. Different modes of Data Dissemination.

  ii. Official Statistics, Statistical systems and standards, Sources of official statistics, their role, working and publication. Role of Official Statistics, Official Publications. Setup of official organizations in Pakistan their role, working & publication, Statistics Division, Federal Bureau of Statistics, Agricultural Census Organization, Population Census Organization, Ministry of Food, Agriculture and Livestock; National Data Base and Registration Authority (NADRA). Provincial Bureaus of Statistics. Financial Statistics: Ministry of Finance, State Bank of Pakistan-Department of Statistics, their working, publications and responsibilities. Other Organization's Statistical output, National and International series, classification and standards.

  iii. Use of Statistics in administration and planning. Concepts and evaluation of GDP, GNP, NNP, Balance of Trade and payments. Measurement of Income Distribution, use of Index Numbers. and time series. Deflation and Inflation of series. National sample surveys and censuses conducted in Pakistan. Assignment: Visit of major Statistical Organizations will be a part of the course.

Assignment:

Visit of major statistical organizations will have be a part of the course. An assignment will have to be submitted on any topic given by the course incharge.

Books Recommended

1. Kish, L. (1992). *"Survey Sampling",* John Wiley, New York.

2. Statistics Division, *"Activity Report"* (1988-89). Government of Pakistan, Islamabad.

3. Statistical Institute for Asia & Pacific SlAP (1984). *"Training of Trainers in Statistical Operations and Procedures"* Part-I, II UNDP, Tokyo.

4. Hansen M.H. (1980*). "Progress and Problems in Survey Methods and Theory". Illustrated by the work of U.S. Bureau of the Census, U.S. Department of Commerce; A Monograph.*

5. Murthy, MN. (1979). *"Quality of Data, Country Course on Sample Surveys",* Karachi.

6. Statistics Division (1979). *"Retrospect, Perspective and Prospect",* Islamabad.

7. State Bank of Pakistan (1966). *"Department of Statistics-A Chronicle".*

8. Zarkovich S.S. (1966). *"Quality of Statistical Data, Food and Agricultural Organization"*, The U.N. Rome.

9. NIPA (1962). *"Administrative uses of Statistics"*, NIPA Res. Sr.No.2 Karachi.

10. Yates F. (1960). *"Sampling Methods for Census and Surveys",* Charles Griffin. FAO Year Books.

11. *FAO year Books.*

12. Various Publications of FBS, P00, ACO, *"State bank of Pakistan, Ministry of Finance"* etc.

Paper-XVII: <u>Survival Analysis</u>

i.   Special features of Survival data: Patient time and study time, Survival function and hazard function, Time dependent and censored survival data. Non-parametric procedures: Estimation of Survival function hazard function, median and percentiles of Survival times. Confidence interval and comparison of group; stratified and log-rank tests for trend.

ii.   Modeling of Survival data; hazard function modeling; its tests and confidence interval. The Waybill model for survival data. Exploratory data analysis and other models. Sample size requirement for survival study.

iii.   SPSS SAS, and GLIM.

Books Recommended

1. Lee, E.T. (1997). *"Applied Survival Analysis",* John Wiley and Sons, New York.

2. Muller, R.G. and Xian Zhou (1996). *"Survival Analysis with long-term Survivors*", John Wiley. New York.

3. Burkett, M. (1995). *"Analyzing Survival Data from Clinical Trials and Observational Studies",* John Wiley New York.

4. Parmer M.K.B. & Mackim D. (1995). *"Survival Analysis: A Practical Approach"*; John Wiley New York.

5. Collett, D. (1994). *"Modeling Survival Data in Medical Research".* Chapman & Hall, London.

6. Lee, E.T. (1992). *"Statistical Methods for Survival Data Analysis";* John Wiley. New York.

7. Eland Johnson, R. C. and Johnson N. L. (1989). *"Survival Models & Data Analysis".* John Wiley New York.

8. Tukey, J. (1987). *"Exploratory Data Analysis",* John Wiley, New York.

9. Cox, D.R. and Oakes, D. (1984). *"Analysis of Survival Data"*; Chapman & Hall London.

Paper-XVIII: **Biostatistics and Epidemology**

    i.   Definition of Biostatistics, viz-a-viz the type of variables and observations in biological, health and medical sciences, Uniqueness in terms of behaviour of variables their domain, and units; Categorical, numerical and censored data. Populations, Target populations and samples; Role of sampling in biostatistics, Size of samples of various types of studies, Proportions, rates and ratios; incidence, prevalence and odds.

    ii.   Distributional behaviour of biological variables (Binomial, Poisson and Normal), Role of transformation for analysis of biological variables. Probit and Logit transformations and their analysis, p values, its importance and role. Confidence Interval in simple and composite hypothesis testing.

    iii.   Definitions of Epidemiology & etiology, role of statistics in epidemiologic research, Types of epidemiological studies; experimental and non-experimental studies.

    iv.   Sampling design for epidemiological studies, Prospective (cohort), Retrospective (Case-Control), Cross-Sectional studies (Simple and Stratified Analysis). Clinical Trial.

    v.   Multivariate Models; Binary logistic regression, Multiple Logistic Regression. Proportional Hazard Model.

    vi.   Methods of Survival data analysis, Actuarial analysis, Kaplan-Maier Estimates, Comparison of Survival curves.

Books Recommended

1. Zar, J. (2000). "*Bio-statistical Analysis*", 5th Edition, John Wiley and Sons.

2. Woodward, M. (1999). *"Epidemiology; study design and data analysis"*. Chapman and Hall, London.

3. Shoukri, M. M & Pause, C. A. (1998). *"Statistical Methods for Health Sciences"*. 2nd Edition, CRC Press, Florida.

4. Daniel, W.W. (1996). *"Biostatistics: A Foundation for the Health Sciences"*, 6th Edition, John Wiley, New York.

5. Sahai, H. and Khurshid, A. (1996). *"Statistics in Epidemiology: Methods, Techniques and Applications"*. CRC Press, Florida.

6. Diggle, J. P., Liang, Kung-Yee and Zeger, S. L. (1996). *"Analysis of Longitudinal Data"*, Clarendon Press, Oxford.

7. Dunn, G. and Event, B. (1995). *"Clinical Biostatistics"*, Edward Arnold, London.

8. Lillienfeld A.M. and Stolley P.D. (1994). *"Foundation of Epidemiology"*, 3rd edition, oxford University Press, New York.

9. Rosner, B. (1994). *"Fundamentals of Biostatistics"*, 4th Edition, Duxbury Press.

10. Zolman, J.F. (1993). *"Biostatistics: Experimental Design and Statistical Inference"*, Oxford University Press, New York.

11. Ahlbom, A. (1993). *"Biostatistics foe Epidemilogistics"*. Lewis Publishers, Florida.

12. Lee, E.T. (1992). *"Statistical Methods for Survival Data Analysis"*, 2nd Edition, John Wiley, New York.

13. Harris, E. K. and Albert, A. (1991). *"Survivorship Analysis for Clinical Studies"*. Marcel Decker, New York.

14. Selvin, S. (1991). *"Statistical Analysis of Epidemiologic Data"*, Oxford University Press, New York.

15. Altman, G. (1991). *"Practical Statistics for Medical Research"*. Chapman & Hall, London.

16. Kahu H.A and Sempos, C.T (1989). *"Statistical Methods in Epidemiology"*. Oxford University Press New York.

17. Kleinbaum, D.G, L.L Kupper and H. Morgenstern (1982). *"Epidemiologic research; Principles and Quantitative Methods"*. Life time Learning Publication, Clifornia.

Paper-XIX: Statistics and Information Technology

41

i. General Perception of Statistics and their databases, their origin, Utilities and uses as information. Problems in obtaining, generation, collection, collation and production of statistics. Error in statistical indicators, common social indicators their comparative analysis.

ii. Modes of dissemination of statistical information, print and electronic media. Utility and drawback of these media. Role of computers in statistical dissemination.

iii. Modern methods of information transfer, Internet, Intranet, E-mail, Website. Uses of these methods in control of errors in production of Statistics, use of information Technology in daily life. Data mining methods.

iv. Leaning statistics through Technology. Computer graphics and interactive learning of the statistical concepts. Designing of ICT material for classroom teaching of statistics.

Books Recommended

1. CSA (2001). *"Internal; computer and information system abstracts".*

2. Adelsberger (2001). *"Handbook on information technologies for education and training"*, Springer Verlag.

3. Silverman B.W. (2000). *"SAVELETS (The key to intermittent information)",* Oxford University Press.

4. Harris, R.L. (2000). *"Information Graphics",* Oxford University Press.

5. Blazewics J. (2000). *"Handbook on data Management in Information System"*, Springer Verlag.

6. Thuraisingham (2000). *"WEB data management and Electronic Commerce",* Springer Verlag.

7. Fuller R. (2000). *"Introduction to neuro Fuzzy System",* Springer Verlag.

STATISTICS BS
(4–YEAR)

Compulsory Requirements (the student has no choice)		General Courses to be chosen from other departments		Discipline Specific Foundation Courses	
9 courses		7-8 courses		9-10 courses	
25 Credit hours		21-24 Cr. Hours		30-33 Credit hours	
Subject	Cr. hr	Subject	Cr. Hr	Subject	Cr. hr
1. ENGLISH I	3	1. Psychology	3	1. Introductory Statistics	3
2. ENGLISH II	3	2. Philosophy	3	2. Introduction to Probability Distributions	3
3. ENGLISH III	3	3. Economics	3		
4. COMMUNICATION SKILL	3	4. International Relations	3	3. Basic Statistical Inference	3
5. PAKISTAN STUDIES	2	5. Mass Communications	3	4. Linear Algebra	3
6. ISLAMIC STUDIES / ETHICS	2	6. Sociology	3	5. Introduction to Regression Analysis & Experimental Design	3
7. CALCULUS-I	3	7. Business Administration (Entrepreneurship)	3	6. Applied Statistics	3
8. CALCULUS-II	3			7. Probability & Probability Distribution-1	3
9. INTRODUCTION TO COMPUTER	3	OR			
		* from the list of general courses		8. Sampling Technique-I	4
				9. Statistical Packages	3
	25		21		28

Major courses including research project/internship		Elective Courses within the major	
11-13 courses		4 courses	
36-42 Credit hours		12 Credit Hours	
Subject	Cr. hr	Subject	Cr. hr

1.	Regression Analysis	4	1.	Operation Research	3
2.	Design & Analysis of Experiment-I	4	2.	Stochastic Process	3
3.	Probability and Probability Distribution-II	3	3.	Reliability Analysis	3
4.	Sampling Techniques-II	4	4.	Time Series and Forecasting	3
5.	Econometrics	4			
6.	Design & Analysis of Experiment-II	4	OR		
7.	Non Parametric Methods	3	** from the list of elective courses.		
8.	Statistical Inference-1	3			
9.	Applied Multivariate Analysis	4			
10.	Research Methods / Internship	3			
11.	Population Studies	4			
12.	Statistical Inference-II	3			
13.	Project	3			
		46			**12**

MODEL SCHEME OF STUDIES FOR BS (4-YEAR) IN STATISTICS

Semester / Year	Name of Subject	Credits
First	English-I	3
	Pakistan Studies	2
	Calculus-I	3
	General-I	3
	General-II	3
	Introductory Statistics (F-1) STAT-101	3
		17
Second	English-II	3
	Islamic Studies/Ethics	2
	Calculus-II	3
	General-III	3
	General-IV	3
	Introduction to Probability Distributions (F-2) STAT-102	3
		17
Third	English-III	3
	Introduction to Computer	3
	General-V	3
	General-VI	3
	Basic Statistical Inference (F-3) STAT-201	3
		15
Fourth	Communication Skill	3
	General-VIII	3
	Linear Algebra (F-9)	3
	Introduction to Regression Analysis & Experimental Design (F-4) STAT-202	3
	Applied Statistics (F-5) STAT-203	3
		15

Fifth	Probability & Probability Distribution-1 (F-6) STAT-301	3	
	Sampling Technique-I (F-7) STAT-303	4	
	Design & Analysis of Experiment-I (M-2) STAT-305	4	
	Regression Analysis (M-1) STAT-307	4	
	Statistical Packages (F-8) STAT-313	3	
		18	
Sixth	Probability and Probability Distribution-II (M-3) STAT-302	3	
	Sampling Techniques-II (M-4) STAT-304	4	
	Design & Analysis of Experiment-II (M-6) STAT-306	4	
	Econometrics (M-5) STAT-308	4	
	Non Parametric Methods (M-7) STAT-310	3	
		18	
Seventh	Statistical Inference-1 (M-8) STAT-401	3	
	Applied Multivariate Analysis (M-9) STAT-403	4	
	Research Methods / Internship (M-10) STAT-405	3	
	Elective-I	3	
	Elective-II	3	
		16	
Eight	Statistical Inference-II (M-12) STAT-402	3	
	Population Studies (M-11) STAT-404	4	
	Project (M-13) STAT-424	3	
	Elective-III	3	
	Elective-IV	3	
		16	
	Total	**132**	

F for Foundation Courses   M for Major Courses
4 credit hours must include Lab./Practical

Aims and Objectives

The major aims and objectives of the curriculum of Statistics are to adapt the international standard in the curriculum.

1. To provide a sound footing of the subject matter of statistical theory with applications, so that they can pursue higher degrees and research in the field of statistics.

2. To upgrade the graduates with the knowledge of statistical theory with applications, statistical software and techniques of data collection and analysis so that they can compete in the job market.

3. To enhance and involve the graduates with the participation of project based activities so that they can be better trained in the field of published research.

4. To develop a solid foundation for the effective operational and strategic decisions using statistical theory in almost every discipline.

* LIST OF GENERAL COURSES FOR STATISTICS

Seven courses are to be selected from the following list of courses, according to available facilities and faculty of the Universities.

1.	Psychology	3 credit hrs
2.	Philosophy	"
3.	Economics	"
4.	International Relations	"
5.	Mass Communications	"
6.	Sociology	"
7.	Business Administration (Entrepreneurship)	"
8.	Human Resource Management	"
9.	Environmental Sciences	"
10.	Principles of Management & Marketing	"
11.	Basic Financial Management	"
12.	History of Human Civilization	"
13.	Introduction to Biology	"
14.	Foreign Language other than English (Like French, German, Chinese etc).	
15.	Introduction to Physics	"
16.	Advanced Calculus	"

Any other subject depending upon the expertise available.

** Elective Courses for BS (4-Year) Programme for Statistics

1.	Operation Research	STAT-406
2.	Stochastic Process	STAT-407
3.	Reliability Analysis	STAT-408
4.	Time Series and Forecasting	STAT-409
5.	Decision Theory	STAT-410
6.	Robust Methods	STAT-411
7.	Official Statistics	STAT-412
8.	Survival Analysis	STAT-413
9.	Bio-Statistics	STAT-414
10.	Data Mining	STAT-415
11.	Actuarial Statistics-I	STAT-416
12.	Actuarial Statistics-II	STAT-417
13.	Mathematical Models and Simulation	STAT-418
14.	Categorical Data Analysis	STAT-419
15.	Numerical Methods	STAT-421
16.	Bayesian Statistics	STAT-422
17.	Statistical Quality Control	STAT-423

DETAILS OF THE COURSES

The proposed outlines of the BS (4-YEAR) programme in Statistics are as follows:

STAT-101

Introductory Statistics

The nature and scope of the Statistics. Organizing of Data, classification of data, Graphs and Charts: Stem-and leaf diagram, Box and Whisker plots and their interpretation. Measures of Central Tendency and Dispersion: Their properties, usage, limitations and comparison. Calculations for the ungrouped and grouped data. Measures of Skewness and Kurtosis and Distribution shapes. Probability Concepts, Addition and Multiplication rules, Bivariate frequency tables, joint and marginal probabilities, onditional probability and independence, Bayes' rule.

Books Recommended

1.Spiegel, M.R., Schiller, J.L. and Sirinivasan, R.L. (2000) "Probability and Statistics", 2nd ed. Schaums utlines Series. McGraw Hill. NY.

2. Clark, G.M and Cooke, D. (1998), "A Basic Course in Statistics" 4th ed, Arnold, London.

3.Walpole, R.E., Myers, R.H and Myers, S.L. (1998), "Probability and Statistics for Engineers and Scientist" 6th edition, Prentice Hall, NY.

4. Mclave, J.T., Benson, P.G. and Snitch, T. (2005) "Statistics for Business & Economics" 9th ed. Prentice Hall, New Jersey.

5. Weiss, N.A.(1997), "Introductory Statistics" 4th ed. Addison-Wesley Pub. Company, Inc.

6. Chaudhry, S.M.and Kamal, S. (1996), "Introduction to Statistical Theory" Parts I & II, 6th ed, Ilmi Kitab Khana, Lahore, Pakistan.

 (Text Book)

STAT-102

Introduction to Probability Distributions

Discrete Random Variables, Probability Distribution, Mean and Variance of a discrete random variable. Bernoulli trials. Proerties, applications and fitting of Binomial, Poisson, ypergeometric, Negative Binomial and Geometric distributions. Continuous Random Variable, probability density function and its properties. Normal Distribution and its properties, Standard Normal Curve, Normal approximation to inomial and Poisson distributions.

Pre-requisite: STAT-101

Books Recommended

 1. Spiegel, M.R., Schiller, J.L. and Sirinivasan, R.L. (2000) "Probability and Statistics", 2nd ed. Schaums Outlines Series. McGraw Hill. NY.

2. Clark, G.M. and Cooke, D. (1998), "A Basic Course in Statistics" 4th ed, Arnold, London.

3. Walpole, R.E., Myers, R.H and Myers, S.L. (1998), "Probability and Statistics for Engineers and Scientist" 6th edition, Prentice Hall, NY.

4. Mclave, J.T., Benson, P.G. and Snitch, T. (2005) "Statistics for Business & Economics" 9th ed. Prentice Hall, New Jersey.

5. Weiss, N.A.(1997), "Introductory Statistics" 4th ed. Addison-Wesley Pub. Company, Inc.

6. Chaudhry, S.M.and Kamal, S. (1996), "Introduction to Statistical Theory" Parts I & II, 6th ed, Ilmi Kitab Khana, Lahore, Pakistan. (Text Book)

STAT-201

Basic Statistical Inference

Distribution of sample mean and central limit theorem. Estimation: Point Estimation. Desirable Properties of a Good Estimator. Interval Estimation. Interval Estimation of population mean. Large and small sample confidence intervals for Population Mean. Nature of Hypothesis Testing and Types of errors. Hypothesis Testing for Population Mean and variance. Inferences for Two Population Means. Large-sample inferences for Two Populations using Independent Samples. Inferences for the Mean of Two

Normal Populations using Independent Samples (variances are assumed Equal/Not Equal). Inference for Two Populations Mean using Paired Samples. Inferences for Population Proportions. Confidence Intervals and hypothesis Testing for Population Proportion. Inferences for Two Populations Proportions using Independent Samples, Estimation of sample size. Chi-Square Procedure. Chi-Square Goodness-of fit Test. Chi-Square Independence Tests.

Pre-Requisite- STAT-102

Books Recommended

1. Spiegel, M.R., Schiller, J.L. and Sirinivasan, R.L. (2000) "Probability and Statistics", 2nd ed. Schaums Outlines Series. McGraw Hill. NY.

2. Clark, G.M. and Cooke, D. (1998), "A Basic Course in Statistics" 4th ed, Arnold, London.

3. Mclave, J.T., Benson P.G. and Snitch, T. (2005) "Statistics for Business & Economics" 9th Prentice Hall New Jersey.

4. * Walpole, R.E., Myers, R.H. and Myers, S.L. (1998), "Probability and Statistics for Engineers and Scientist" 6th edition, Prentice Hall, NY.

5. Weiss, N.A. (1997), "Introductory Statistics" 4th ed. Addison-Wesley Pub. Company, Inc.

6. Chaudhry, S.M. and Kamal, S. (1996), "Introduction to Statistical Theory" Part I, II, 6th ed, Ilmi Kitab Khana, Lahore, Pakistan.*   (Text Book)

STAT-202

Introduction to Regression Analysis andExperimental Design

Concepts of Regression and Correlation, Simple Linear regression, Inference regarding regression parameters, Linear correlation: simple, partial and multiple correlation. Inference regarding correlation

coefficient. Coefficient of determination. One-Way and Two-Way Analysis of Variance Design of Experiments, Basic Principles of Design of Experiments, Description, Layout and Analysis of Completely Randomized Design, Randomized Complete Block Design and Latin Square Design. Multiple

Comparisons (LSD and Duncan's test). Introduction to Non-Parametric Statistical Methods,

Pre-Requisite: STAT-101

Books Recommended

1. * Clark, G. M. and Kempson, R. E. (1997), "Introduction to the Design & Analysis of Experiment" Arnold London.

2. * Walpole, P.E., Myers R.H., Myers S.L. (1998), "Probability and Statistics for Engineers and Scientists", 7th ed.Prentice Hall.

3. Weiss, N.A, (1997), "Introductory Statistics" 4th ed. Addison-Wesley Pub. Company, Inc.

4. Chaudhry, S.M., and Kamal, S., (1996), "Introduction to Statistical Theory" Part I, II, 6th ed, Ilmi Kitab Khana, Lahore, Pakistan. *   (Text Book)

STAT-203

Applied Statistics

Sampling: Need of sampling, Sample versus population, Random and non-random sampling, concepts of statistic and population parameter. Sampling techniques: Simple Random, Stratified and Systematic random sampling. Census and survey problem, raming of questionnaire. Sampling and Non-Sampling Errors.Index numbers: construction and uses of index numbers, un-weighted index numbers (simple aggregative index, average of relative price index numbers). Weighted index numbers (Laspayers, Paaches and Fishers ideal index numbers). Consumer price index (CPI) and Sensitive Price Indicators. Time Series Analysis: Components of time series and their isolation. Vital Statistics: Meaning of vital statistics, registrations of Birth and death in Pakistan. Uses of vital statistics, short comings of vital statistics, rates and ratios (Sex ratio, child women ratio, birth and death ratio, population growth rate, classification of natal rates, death rates or mortality rates, crude death rate, specific death rate, infant mortality rate, case fatality rate, fertility rates, crude birth rate, specific birth rate, standardized death rate, reproduction rates, gross reproduction rate, net reproduction rate, morbidity or sickness rates, marriage rates, divorce rates etc. general; fertility rate, total fertility rate.)

 Pre-Requisite: STAT-101

Books Recommended

1. Clark, G.M. and Cooke, D. (1998), "A Basic Course in Statistics" 4th ed, Arnold, London.

2. * Mclave, J.T. Benson, P.G. and Snitch, T. (2005) "Statistics for Business & Economics" 9th Prentice Hall New Jersey.

3. Walpole, P.E. Myers, R.H., Myers S.L. (1998), "Probability and Statistics for Engineers and Scientists", Prentice Hall.

 4. Chaudhry, S.M. and S. Kamal, (1996), "Introduction to Statistical Theory" Part I, II, 6th Ed, IImi Kitab Khana, Lahore, Pakistan.

5. * Cochran, W.G. "Sampling Techniques".3rd Ed.

6. * Pollard, A.H.. Yousuf, F. and Pollard G.M. (1982), "Demographic Techniques", Pergamon Press, Sydney. *   (Text Book)

STAT-204

Statistical Packages

Introduction to Minitab, data manipulation in Minitab, graphical representation in Minitab, Qualitatively and Quantitative data presentation and analyzing data in Minitab, Programming in Minitab introduction of SPSS, data manipulation in SPSS, simple arithmetic in SPSS, SPSS function related to probability distributions, SPSS modules, simple graphing in SPSS. Analysis using SPSS syntax programming. (Use of SPSS, Minitab, Matlab, Statistica is based upon the availability of Software)

Pre-Requisite: STAT-201

Books Recommended

1. Ryan, Barbara F.; Joiner, Brian L. and Cryer, Jonathan D.(2005) MINITAB Handbook, 5th Edition, Duxbury Press, California.

2. Delwiche, Lora D. and Slaughter Susan J. (1998) The Little SAS Book : A Primer, Second Edition, SAS institute, North Carolina.

3. Norusis, Marija(2006) SPSS 14.0 Guide to Data Analysis, Prentice Hall, New Jersey.

4. SPSS (2006) SPSS 14.0 Base User's Guide, , Prentice Hall, New Jersey.

5 Marques de Sá, Joaquim P.(2003) Applied Statistics using SPSS, STATISTICA and MATLAB

STAT-301

Probability and Probability Distributions-I

Probability as a set function. Conditional probability and Bayes' theorem. Random variables, Distribution function, Probability mass function and probability density function. Joint and conditional distributions for two and more random variables. Marginal and conditional distributions, stochastic independence. Mathematical expectation and its properties Conditional expectation, variance and moments. Probability generating function. Moment generating and characteristic functions and their properties. Relation between moments and cumulants. Probability distributions: Hypergeometric, Binomial, Multinomial, Negative Binomial, Geometric, Poisson, Normal and Lognormal distributions with moments and

commulants.   Pre-Requisite: STAT-102

Books Recommended

1. Stirzaker, D. (1999). "Probability and Random Variables". Cambridge University Press, Cambridge.

2. Stuart, A. and Ord, J .K. Kendall's' (1998), "Advanced Theory of Statistics", Vol. I, Charles Griffin, London.

3. Hirai, A.S. (1998), "A Course in Mathematical Statistics", Ilmi Kutab Khana, Lahore.

4. Fridett, B. & Gray, L. (1997). "A Modern Approach to Probability Theory" Birkhallser, Boston.

5. Freund, J. E. (1997). "Mathematical Statistics", Prentice Hall, New Jersey 6th edition.

6. * Mood, A.M, Graybill, F.A. and Boss, D.C. (1997), "Introduction to the Theory of Statistics", cGraw   Hill, New York.

7. Khan, M. K., (1996). "Probability with Applications", Maktiba Ilmi, Lahore.

8. * Hogg, R.M. and Craig, A.T. (1995), "Introduction to Mathematical Statistics". Prentice Hall, Engle wood Cliffs, New Jersey.

9. Haq, M. (1984). Foundation of Probability and Statistics, Tahir sons, Urdu Bazar, Karachi. * (Text Book)

STAT-303

Sampling Techniques-I

Basic concepts, advantages of sampling methods, requirements of a good sample, bias, sampling and non-sampling errors. Steps and problems involved in planning and conduct of census and sample surveys. Selection and estimation procedures. Description and properties of simple random sampling. Sampling for proportions and percentages. Estimation of variances, standard errors and confidence limits. Sample size determination under different conditions. Description and properties of stratified random sampling. Formation of strata, Different methods of allocation of sample size. Systematic sampling. Ratio and regression estimates in simple and stratified random sampling. Note: Practicals of this course shall include visits of the students to various national statistical organizations and a report submitted to this

effect. Pre-Requisite: STAT-203

Books Recommended

1. Raj, D. & Chandhok, P. (1998), "Sample Survey Theory". Narosa Publishing House, New Delhi.

2. Ferguson, T.S. (1996), "A Course in large SampleTtheory, Chapman & Hall, London.

3. Singh, R. and Singh N, (1996), "Elements of Survey Sampling", Kulwar Academic Publisher, Dodrecht.

4. Kish, L. (1992). "Survey Sampling", John Wiley, New York.

5. Sukhatme, P.V, Sukhatme, B., Sukhatme, S., and Asok, A. (1985), "Sampling Theory of Survey with Application". Iowa State University Press.

6. * Cochran, W.G. (1977), "Sampling Techniques", 3rd ed, John Wiley and Sons, New York.

7. Raj, D. (1971) "Design of Sample Survey". McGraw Hill, New York.* (Text Book)

STAT-307

Regression Analysis

General linear model and its assumptions, Least squares estimators,MLE, Least squares estimators, tests of hypothesis, tests of significance of a single and complete regression, tests of significance of subset of

coefficients. Significance tests and confidence intervals. Test of linearity of regression. Use of extraneous information in linear regression model. Residual analysis, Detection and study of outliers. Polynomial

regression, orthogonal polynomial, orthogonal regression analysis. Specification of models. Pre-equisite: STAT-203

Books Recommended

1. *Draper, N.R. and Smith, H. (2004).” Applied Regression Analysis”, John Wiley. New York.

2. Baltagi, B. H. (1999). “Econometrics”, 2nd Edition, Springer Varlog.

3. Gujrati, D. (1998). “Econometrics”, John Wiley, New York.

4. Wonnacott, T.H. and Wonnacott R.J. (1998). “Econometrics”, John Wiley, New -York.

5. Johnston, J. and Di. Nardo, J., (1997). “Econometric Method”, 4th Edition, McGraw Hill, New York.

6. Ryan, P. T. (1996) “Modern Regression Methods”, John Wiley and

sons Inc. New York.

7. Montgomery, D.C., and Peck E.A. (1992).”Introduction to linear Regression Analysis”, 2nd Edition, John Wiley and sons Inc. New York.

8. Guttmann, I, (1980); “Linear Models: An Introduction”, John Wiley, New York.

9. Koutsoyiannis, A. (1980), “Theory of Econometrics”, Macmillan. N.Y.

10. Maddela, G.S. (1977). “Econometrics”, McGraw Hill. New York.

11. Searle, S. R. (1971), “Linear Models”, John Wiley, New York. * (Text Book)

STAT-305

Design and Analysis of Experiments-I

Principles of Design of Experiments. Analysis of variance and its assumptions. Cochran theorem. Fixed, random and mixed effect models. Effect of violation of assumptions and transformations. Completely Randomized, Randomized Complete Block, Latin square, Graeco-Latin square and cross-over designs. Missing observations.Relative efficiency of designs. Estimation of mean squares and their expectations. Multiple Comparisons. Analysis of covariance in CR, RCB designs. Estimation of missing values in analysis of covariance. Pre-Requisite: STAT-202

Books Recommended

1. * Montgomery, D.C. (2000). "Design and Analysis of Experiments", John Wiley, New York.

2. Clarke, G.M., and Kempton, R.E. (1997), "Introduction to the Design & Analysis of Experiments", Edward Arnold.

3. Steel, Robert, G. D., Terrie James H., and Dickey David A. (1997). "Principles and Procedures of Statistics: A Biometrical Approach" 3rd Edition, McGraw Hill, New York.

4. Boniface, D.R. (1995). "Experiment Design & Statistical Methods", Chapman & Hall.

5. Myers, R.H. and Montgomery, D.C. (1995). "Response Surface Methodology; Process & Product Optimization Using Design", John Wiley.

6. Clarke, G.M. (1994). "Statistics & Experimental Design". Edward Arnold.

7. Harold, R. L (1992). "Analysis of Variance in Experimental Design". Springer Verlag:

8. Maxwell, S.E. and Delaney, H.D. (1990). "Designing Experiments and Analysis of Data". A model comparison perspective. Belment and Wadeson.

9. Mead, R. (1988). "The Design of Experiments". Cambridge University Press, Cambridge.

10. Das, M.N.and Geri, N.C, (1986). "Design and Analysis of Experiments", John Wiley, New York.

11. Gomez, K.A., and Gomez, A.A. (1984)."Statistical Procedures for Agricultural Research", 2nd Edition, John Wiley, New York.

12. Hicks, C.R. (1982). "Fundamental Concepts in Design and Analysis of Experiments" Saunders

13. Cochran, W.G. and Cox, G.M. (1957). "Experimental Design", John Wiley, New York. *(Text Book)

STAT-310

Non-Parametric Methods

Location estimates for single samples: The sign test, modified sign test, Wilcoxon signed rank test, onfidence interval based on these tests. Runs test for randomness. Distribution tests and rank ransformation. Kolmogrov's test, Lilliefor's test and Shapiro-Wilks test for normality. Tests and estimation for two independent samples; the median test, Wilcoxon Mann – Whitney test. The Siegel – Turkey test, the squared rank test for variance, Smirnov test. Tests for paired samples. Kruskal – Wallis test, Friedman test, multiple comparison with the Friedman test, Cochran's test for binary responses. Spearman's rank correlation coefficient, Kendall's rank correlation coefficient. Theil's regression method. Pre-Requisite: STAT-202,301

Books Recommended

1. * Conover, W.J. (1999), Practical Nonparametric Statistics, 3rd Edition, John Wiley and Sons, New York.

2. Maritz, J.S. (1995). Distribution-Free Statistical Methods. Chapman & Hall London.

 3. Gibbons, J.D. and Chakraborti, S.(1992), Nonparametric Statistical Inference, Marcel Decker, New York.

4. Sprint, P. (1989). Applied Nonparametric Statistical Methods. Chapman & Hall London.

5. Lehman, E.L. (1973), Nonparametric Statistical Methods, based on Ranks, Holden-Day San Francesco. * (Text Book)

STAT-302

Probability and Probability Distributions-II

Probability Distributions: Uniform, Exponential, Gamma, Laplace, Rayleigh with moments and cumulates Distributions of functions of random variables; Chi-square, t and F distributions, their derivations and properties. Central limit and Chebyshev's theorems and other inequalities. Weak and Strong Laws and their applications. Order statistics. Distributions of rth and sth order statistics. Bivariate Normal distribution. Pre-Requisite: STAT-301

Books Recommended

1. Stirzaker, D. (1999). "Probability and Random Variables". Cambridge University Press, Cambridge.

2. Stuart, A. and Ord, J .K. Kendall's (1998), "Advanced Theory of Statistics", Vol. I, Charles Griffin, London.

3. Hirai, A.S. (1998), "A Course in Mathematical Statistics", Ilmi Kutab Khana, Lahore.

4. Fridett, B. & Gray, L. (1997). "A Modern Approach to Probability Theory" Birkhallser, Boston.

5. * Freund, J. E. (1997). "Mathematical Statistics", Prentice Hall, New Jersey.

6. * Mood, A.M, Graybill, F.A. and Boss, D.C. (1997), "Introduction to the Theory of Statistics", McGraw Hill, New York.

7. Hogg, R.M. and Craig, A.T. (1995), "Introduction to Mathematical Statistics". Prentice Hall, Engle wood Cliffs, New Jersey.

8. Khan, M. K., (1996). "Probability with Applications", Maktiba Ilmi, Lahore.

9. Haq, M. (1984). "Foundation of Probability and Statistics", Tahir sons, Urdu Bazar, Karachi.
*   (Text Books)

STAT-304

Sampling Techniques-II

Cluster Sampling, Sub sampling, PPS-Sampling. Double Sampling, Multistage and Multiphase sampling. Thomson Hurwitz estimator. Comparison of different sample designs. Sampling and non sampling errors and their sources. non-response, their sources and bias. Randomized response. Critical study of National sample surveys conducted in Pakistan: Census of Agriculture, Household Income and Expenditure Survey (HIES), Pakistan Demographic Survey (PDS) and National Population and Housing Census and Surveys (NPHCS). Pre-Requisite: STAT-303

Books Recommended

1. Des Raj & Chandhok, P. (1998), "Sample Survey Theory". Narosa Publishing House, New Delhi.

2. Ferguson, T.S. (1996), "A Course in Large Sample Theory", Chapman & Hall, London.

3.Singh, R. and Singh N, (1996), "Elements of Survey Sampling", Kulwar, Dodrecht.

4. Kish, L. (1992), "Survey Sampling", John Wiley, New York.

5. Sukhatme, P.V, Sukhatme, B., Sukhatme, S., and Asok, A. (1985), "Sampling Theory of Survey with Application". Iowa State University Press.

6. * Cochran, W.G. (1977), "Sampling Techniques", John Wiley and Sons, 3rd ed, New York.

7. Des Raj, (1971), Design of Sample Survey. McGraw Hill, New York.

8. Various publications of FBS, ACO and PCO. * (Text Book)

STAT-308

Econometrics

Errors in Variables. Problems of autocorrelation, multicollinearity, heteroscedasticity and their solution. Ridge regression. Lagged variables. Dummy variables. System of simultaneous linear equations, Identification-Estimation method, indirect and two-stage least squares methods, restricted least squares. Test of identifying restrictions. Estimation with stochastic regressor, generalized least squares

estimators. Pre-Requisite: STAT-307

Books Recommended

1. Draper, N.R. and Smith, H. (2004). "Applied Regression Analysis", John Wiley, New York.

2. Baltagi, B. H. (1999). "Econometrics", 2nd Edition, Springer Varlog.

3. Gujrati, D. (1998). "Econometrics", John Wiley, New York.

4. Wonnacot, T.H. and Wonnacot R.J. (1998). "Econometrics", John Wiley, New York.

5. * Johnston, J. and Di. Nardo, J., (1997). "Econometric Method", 4th Edition, McGraw Hill, New York.

6. Montgomery, D.C., and Peck E.A. (1992). "Introduction to Linear Regression Analysis", 2nd Edition, John Wiley and sons Inc. New York.

7. Guttmann, I. (1980); "Linear Models: An Introduction", John Wiley, New York.

8. Koutsoyiannis, A. (1980), "Theory of Econometrics", Macmillan.

9. Maddela, G.S. (1977). "Econometrics", McGraw Hill. New York.

10.   Searle, S. R. (1971), "Linear Models", John Wiley, New York

.* (Text Book)

STAT-306

Design and Analysis of Experiments-II

Factorial Experiments: 2k, 3k series and mixed level factorial experiments and their analyses.

Confounding in factorial experiments, Complete and partial confounding, Confounding in Fractional replications, Quasi-Latin square designs. Split-plot, split block, split-split plot, strip plot and nested designs. Missing observations in Split plot design. Incomplete block designs: BIBD - Lattice designs, lattice square and Youden squares, PBIBD with recovery of intra-block information. Introduction of response surface methods: First and Second order designs. Central composite designs. Fitting of response surface models and estimation of optimum/maximum response. Pre-Requisite: STAT-305

Books Recommended

1. * Montgomery, D.C. (2000). "Design and Analysis of Experiments", John Wiley, New York.

2. Clarke, G.M., and Kempton, R.E. (1997), "Introduction to the Design & Analysis of Experiments", Edward Arnold.

3. Steel, G. D., Terrie, and Dickey A. (1997). "Principles and Procedures of Statistics: A Biometrical Approach" 3rd Edition, McGraw Hill, New York.

4. Boniface, D.R. (1995). Experimental Design & Statistical Methods, Chapman & Hall.

5.   Myers, R.H. and Montgomery, D.C. (1995). "Response Surface Methodology; Process & Product Optimization Using Design", John Wiley.

6. Clarke, G.M. (1994). "Statistics & Experimental Design". Edward Arnold.

7. Harold, R. L (1992). "Analysis of Variance in Experimental Design". Springer Verlag:

8.   Maxwell, S.E. and Delaney, H.D. (1990). Designing Experiments and Analysis of Data. A Model Comparison Perspective. Belmont and Wadeson.

9. Mead, R. (1988). "The Design of Experiments". Cambridge University Press, Cambridge.

10. Das, M.N.and Giri, N.C, (1986). "Design and Analysis of Experiments", John Wiley, New York.

11. Gomez, K.A., and Gomez, A.A. (1984). "Statistical Procedures for Agricultural Research", 2nd Edition, John Wiley, New York.

12. Hicks, C.R. (1982). "Fundamental Concepts in Design and Analysis of Experiments"; Saunders

13. Cochran, W.G. and Cox, G.M. (1957). "Experimental Design", John Wiley, New York.

* (Text Book)

STAT-311

Population Studies

The population and housing census Registration of vital events. Demographic surveys. Components of population growth, composition of population and vital events. Types and sources of errors. General testing procedures. Testing the accuracy of age and sex data. Fertility and mortality measures. Total and general fertility rates. Estimation from incomplete Data. Construction of complete and abridged life tables. Different types of life tables. Graphs of Ix, qx and ex. Description and uses of life table columns. Stationary population models. Population estimates and projections, Inter-censual estimates, Population

projections through various methods. Theory of demographic transition. Stable and stationary population models, their applications and uses. Malthusian and post Malthusian theories of growth. Consequences of

world population growth & population explosion. State of Population in Pakistan. Development of emographic profile in Pakistan. Recent demographic parameters. Current and future demographic activities in Pakistan. Pre-Requisite: STAT-201 & 202

Books Recommended

1. * Jay Weinstein, Vijayan, K. Pillai, (2001) "Demography: The Science of Population". Allyn & Bacon.

2. Hind, A., (1998). "Demographic Method", Arnold

3. United Nations (1998), "World Population Assessment", UNFPA; New York.

4.   Govt. of Pakistan (1998), National, Provincial and District census reports and other supplementary reports with respect to 1998 census; PCO, Islamabad.

5. United Nations (1996), "Added years of Life in Asia", ESCAP; U.N., Thailand.

6.   Palmore, J.A; Gardner, R.W. (1994), "Measuring Mortality Increase"; East West Centre, Honolulu.

7.   Bogue, D.J. Arriagu, E.E., Anderson, D.L. (1993), "Readings in Population Research Methodology", Vol. I-VIII, United Nations Fund; Social Development Centre, Chicago.

8. Impagliazo, J. (1993), Deterministic Aspects of Mathematical Demography, Springer Verlag New York.

9. United Nations (1990), "World Population Monitoring 1989", UNFPA.

10.   Rukanuddin A.R. and Farooqi, M.N.I.., (1988), "The State of Population in Pakistan – 1987", NIPS, Islamabad.

11. Keyfitz, N. (1983) "Applied Mathematical Demography", Springer Verlag N.Y.

12. * Pollard, A.H., Yousaf, F & Pollard, G.M. (1982), "Demographic Techniques", Pergamon Press, Sydney.

13. Pakistan Demographic Survey, Govt. of Pakistan, Federal Bureau of Statistics.

14. Publications of population census organizations.

*   (Text Book)

STAT-401

Statistical Inference-I

Estimation of Parameters. Properties of Estimators: unbiasedness, consistency, sufficiency,efficiency, completeness. Cramer-Rao inequality, Rao-Blackwell and Lehmann - Scheffe Theorems. Methods of

Estimation: Moments, Maximum likelihood, least-squares, minimum Chi- square and Bayes' method. Pre-Requisite: STAT-302

Books Recommended

1. * Mood, A.M., Graybill, F.A. and Boss, D.C. (1997). "Introduction to the Theory of Statistics". McGraw Hill, New York.

2. * Hogg, R.V. and Craig, A.T. (1996). "Introduction to Mathematical Statistics". Prentice Hall, New Jersey.

3. Lindgren, B.W. (1998). "Statistical Theory". Chapman and Hall, New York.

4. Stuart, A. and Ord, J.K. (1998). Kendall's' "Advanced Theory of Statistics" Vol. II. Charles Griffin, London.

5. Zacks, S. (1973), "Parametric Statistical Inference", John Wiley, New York.

6. Rao, C.R., (1973). "Linear Statistical Inference and its Applications", John Wiley, New York.

7. * Bickel, P.J., and Docksum, K.A. (2001), Mathematical Statistics, Vol I, Prentice Hall, N.J., 2nd ed.

*   (Text Book)

STAT-403

Applied Multivariate Analysis

Introduction to Multivariate Normal Distribution. Estimation of the mean vector and covariance matrix. Multivariate analysis of variance (MANOVA). Principal components analysis, Factor analysis, scriminate

analysis, Canonical Correlation Cluster analysis. Multidimensional scaling.

Pre-Requisite: STAT-302

Books Recommended

1. Anderson, T.W. (2003). "An Introduction to Multivariate Statistical Analysis", John Wiley, New York.

2. Afifi, A. A. and Clark Virginia (2000). "Computer Aided Multivariate Analysis", Lifetime learning publications, Belmont California.

3. Flurry B. (1997). "A First Course in Multivariate Statistics", Springer Valerg, New York.

4. Manly, B.F.J. (1994). "Multivariate Statistical Methods, A Primer" 2nd Edition, Chapman and Hall, London.

5. * Johnson, R.A. and Wincher, D.W. (1992). "Applied Multivariate StatisticalAnalysis". Prentice Hall. London.

6. * Morrison, F. (1990). "Multivariate Statistical Methods", McGraw Hill, New York.

7. Chatfield, C. and Collins, A.J. (1980). "Introduction to Multivariate Analysis", Chapman and Hall, London.

9. Mardia, K.V., Kent, J.T. and Bobby, J.M. (1979). "Multivariate Analysis",Academic Press, London.

10. Everett, B.J. (1974). "Cluster Analysis", McGraw Hill, New York.

*   (Text Book)

STAT-405

Survey and Research Methods

Definition of Research, Types of Research, Selection of Problem, Search of References, Formation of Hypothesis and Procedure for its Testing, Research Methodology, Planning of Experiments to Test Hypothesis Objectivity, Principals of Experimental Design, Steps in Experimentation, Collection of Data, Data Analysis to Determine Functional Relationship

Between Variables, Levels of Significance, Interpretation of Results, Components of Scientific Reports and Various Methods of Data Presentation, Preparation of Scientific Reports, Publication Procedures.

PRACTICAL:

Survey of Literature on a Given Topic, Collection of References from Various Sources Including SD-ROM Data Base. Collection of Primary and Secondary Data, Arrangement of Primary and Secondary Data, Preparation of Scientific Report for Publication, if Possible .Pre-Requisite: STAT-304

Books Recommended

1. Andrew, C.O. and P.E. Hildebrand. (1993) "Applied Agricultural Research", Foundations and Methodology, Western Press.

2. Hashmi, N. (1989) "Style Manual of Technical Writings", USAID/NARC, Islamabad.

3. Gimbaled, J. and W.S. Acuter (1988) "MLA handbook for Writers of Research Papers", McGraw The Modern Language Association of America.

4. Little, T.M. and F.J. Hills (1978) "Agricultural Experimentation", John Wiley & Sons.

STAT-402

Statistical Inference-II

Interval Estimation: Pivotal and other methods of finding confidence interval, confidence interval in large samples, shortest confidence interval, optimum confidence interval. Bayes' Interval estimation.

Tests of Hypotheses: Simple and composite hypotheses, critical regions. Neyman-Pearson Lemma, power functions, uniformly most powerful tests. Deriving tests of Hypothesis concerning parameters in normal,

exponential, gamma and uniform distributions. Randomized Tests. Unbiased tests, Likelihood ratio tests and their asymptotic properties. Sequential Tests: SPRT and its properties, A.S.N. and O.C. functions.

Pre-Requisite: STAT-401

Books Recommended

1.Stuart, A and Ord, J.K. (1998). Kendall's' "Advanced Theory of Statistics" Vol. II. Charles Griffin, London.

2. Lindgren, B.W. (1998). "Statistical Theory". Chapman and Hall, New York.

3. * Mood, A.M. Gray Bill, F.A. and Boss, D.C. (1997). "Introduction to the Theory of Statistics". McGraw Hill, New York.

4. Lehman, E.L. (1997). "Testing Statistical Hypotheses". Springler - Volga, New York.

5. * Hogg, R.V. and Craig, A.T. (1996). "Introduction to Mathematical Statistics". Prentice Hall, New Jersey.

6. Zacks, S. (1973), "Parametric Statistical Inference", John Wiley, New York.

7. Rao, C.R., (1973). "Linear Statistical Inference and its Applications", John Wiley, New York.

*   (Text Book)

STAT-422

PROJECT

ELECTIVE COURSES

STAT-406

Operations Research

History and definition of O.R. Introduction to linear programming. Formulation of LP model. Graphical solution of two variables. Standard Form. Simplex method. Duality theory; Sensitivity

Analysis, Primal and dual form. Gaussian elimination. Transportation Problem, Assignment problem. Introduction to CPM and PERT techniques. Queuing Models, Inventory models, Dynamic programming and simulation models.

Books Recommended:

1. ***** Taha, H.A. (1998). "*Operations Research*". Macmillan. London.

2. Hillier, F.S. and Lieberman G. J. (1996). "*Introduction to Operations Research*," Holden Day.

3. Gupta, P.K. & Hira, D.S. (1994). "*Operations Research*". S. Chand & Co., New Delhi.

4. Bazarra, N.M., Jarvis J.J. and Sherali, H.D. (1990) "*Linear Programming and Network Flows*", John Wiley & Sons, 2nd ed.

5. Ravindran, A., Philips, D.J and Sillerg, J.J. (1987). "*Operations Research: Principles and Practice*" John Wiley.

6. Bronson, R. (1983). "*Operations Research* – Schaums' Outline Series" – McGraw Hill.

* (Text Book)

STAT-407 Stochastic Processes

Introduction. Generating Functions. Laplace Transforms. Difference Equations. Differential - Difference Equations. Introduction to Stochastic Processes. The Random Walk in one and two Dimensions. The Classical Gambler's Ruin Problem. Expected Duration of the Game.

Markov Chains: Definition. Higher Transition Probabilities. Classification of States and Chains. Markov processes with Discrete State Space. Poisson Process and its Generalization. Pure Birth and Death Processes. Markov Processes with Discrete State Space (Continuous Time Markov Chains). Markov Processes with Continuous State Space. Introduction to Brownian Motion. The Wiener Process. Diffusion Equations for the Wiener Process.

Books Recommended

1. ***** Ross, S. (1996). "*Stochastic Process*", 2nd Edition, John Wiley, New York.

2. Feller, W. (1992). "An *Introduction to Probability Theory and its Applications*," John Wiley, New York.

3. Srinivasin, S.K. and Mehta, K.M. (1988). "*Stochastic Processes*". Tata McGraw Hill.

4. Karlin, S.A. and Taylor H.M. (1984). *"A first course in Stochastic Process"*, Academic Press London.

5. Hole, P.G., Port, S. and Stone, C.L. (1984). "*An Introduction to Stochastic Process*," John Wiley, New York.

6. Cox, D.R.and Miller H.D. (1984). "*The Theory of Stochastic*

7. Medhi, J. (1982), "*Stochastic Processes",* Wiley Eastern Ltd.
* (Text Book)
STAT-408 Reliability Analysis
Basic concepts of reliability. Structural reliability. Lifetime distributions (Failure models): Hazard rate; Gamma, Weibill, Gumball, Log-Normal and Inverse Gaussian Distribution. Stochastic fatigue-rate models. Point and interval estimation. Fatigue-life model.
Testing reliability hypothesis. Monte-Carlo, distribution-free and Bayes' methods in reliability. System reliability; series and parallel systems. Failure models, (k-out-of-m) New-better-than used models. Inferences for these models. Accelerated life testing.
Books Recommended
1. Achintya Haldar, Sankaran Mahadevan (2000). *Reliability Assessment Using Stochastic Finite Element Analysis*".
2. Crowder, M.J. (1994). "*Statistical Analysis of Reliability Data*".
3. Lee, J. Bain, Bain Bain, (1991). "*Statistical Analysis of Reliability and Life-Testing Models*".
4. Gertsbakh, I.B. (1989). "*Statistical Reliability Theory*". Marcel Decker. New York.
5. ***** Lawless, J.F. (1982). "*Statistical Model and Methods for Lifetime Data*".
6. Gertsbakh, I.B. (1988). "*Statistical Reliability Theory*".
7. Mann, N.R., Scheefer, R.E. and Singapoor wel, N.D. (1974). *Methods for Statistical Analysis of Reliability*, John Wiley & Sons.

* (Text Book)
STAT-409 Time Series Analysis and Forecasting
Stochastic Process, Stationary Time-Series, Exponential smoothing techniques, auto-correlation and auto-covariance, estimates functions and standard error of the auto-correlation function (ACF) and PACF, Periodogram, spectral density functions, comparison with ACF, Linear stationary models: Auto regressive, Moving Average and mixed models, Non-stationary models, general ARIMA notation and models, minimum mean square forecasting. ARIMA Seasonal Models.

Books Recommended
1. Cox, D. R., Hinckley D.V. and Nielsen O.E.B. (1996). *"Time Series Models - In Econometrics, finances and other fields"*; Chapman & Hall, London.
2. ***** Chatfield, C. (1996). *"The Analysis of Time Series: An Introduction"*, Chapman and Hall, London.
3. Andy, P, West M. and Harrison, P. J. (1994). *"Applied Bayesian Forecasting and Time Series Analysis",* Chapman & Hall New York.
4. Brock well P.J. and Davis R.A. (1991). *"Time Series Theory and Methods",* Springer Verlag New York.
5. Harvey, A.C. (1990). *"Forecasting Structural Time Series Models and the Calamander",* Cambridge University Press, Cambridge.
6. Daggle, P.J. (1990), *"Time Series: A Biostatistical Introduction"*, Clarendon Press, Oxford.
7. Bovas, A. and Johannes, L. (1983), *"Statistical Methods for Forecasting",* John Wiley. New York
8. Priestley, M.B. (1981), *"Spectral Analysis and Time Series",* Academic Press, London.
9. ***** Box, G.E.P. and Jenkins, G.M. (1999). *"Time Series Analysis*: *Forecasting and Control",* San Francisco.

* (Text Book)
STAT-410 Decision Theory
The nature and concept of loss functions, parameters, decisions and sample spaces. Risk and average loss. Admissibility and the class of admissible decisions. Minimax principle and its application to simple decision problems, linear and quadratic losses and their uses in problems of estimation and testing hypotheses. Asymptotically minimax procedure. A prior distributions and conjugate priors. Bayes' decision procedure, admissibility of Bayes' and minimax procedures.
Books Recommended
1. Berger, J. O. (1985). "*Statistical Decision Theory & Bayesian Analysis*", Springer Verlag.
2. ***** Lindgren, B.W. (1971). "*Elements of Decision Theory*, Macmillan", New York.
3. Blackwell, D. and Graphic, M.A. (1966). "*Theory of Games and Statistical Decision"*, John Wiley, New York.
* (Text Book)

STAT-411 Robust Methods
Introduction to Robustness. Objective function. M-estimator of location. E-estimator, R-estimator and W-estimator, Redesending M-estimator's The Breakdown point of Robust estimator Influence function. M-estimator for scale. Outliers and influential observations. Outliers in Regression analysis.
Books Recommended
1. Rousseau, P.J. and Leroy, A.M. (1987). "*Robust Regression and outlier detection"*, John Wiley. New York.
2. Hamper, T.R. Brochette, E.M. Rousseau, P.J. and Satchel, W.A. (1986). "*Robust Statistics"*, *"The approach Based on Influence functions"*, John Wiley New York.
3. ***** Huber, P.J. (1981). "*Robust Statistics"*, John Wiley, New York.

* (Text Book)
STAT-412 Official Statistics
Design and planning of a Statistical Investigation. Data collection-approach and operation; Role of sampling in generation of Statistics, Sampling plans and survey Designs. Sources of Errors, Types of Errors, methods of their control. Data processing, presentation, and publication of

Statistics. Different modes of Data Dissemination. Official Statistics, Statistical systems and standards, Sources of official statistics, their role, working and publication. Role of Official Statistics, Official Publications.

Setup of official organizations in Pakistan their role, working & publication, Statistics Division, Federal Bureau of Statistics, Agricultural Census Organization, Population Census Organization, Ministry of Food, Agriculture and Livestock; National Data Base and Registration Authority (NADRA). Provincial Bureaus of Statistics. Financial Statistics: Ministry of Finance, State Bank of Pakistan-Department of Statistics, their working, publications and responsibilities. Other Organization's Statistical output, National and International series, classification and standards.

Use of Statistics in administration and planning. Concepts and evaluation of GDP, GNP, NNP, Balance of Trade and payments. Measurement of Income Distribution, use of Index Numbers. and time series. Deflation and Inflation of series. National sample surveys and censuses conducted in Pakistan.

Assignment: Visit of major Statistical Organizations will be a part of the course. An assignment will have to be submitted on any topic given by the course incharge.

Books Recommended:
1. Kish, L. (1992). "*Survey Sampling*", John Wiley, New York.
2. Statistics Division, "*Activity Report*" (1988-89).*Government of Pakistan*, Islamabad.
3. Statistical Institute for Asia & Pacific SIAP (1984). "*Training of Trainers in Statistical Operations and Procedures*" Part-I, II UNDP, Tokyo.
4. Hansen M.H. (1980). "*Progress and Problems in Survey Methods and Theory*". IIIustrated by the work of U.S. Bureau of the Census, U.S. Department of Commerce; A Monograph.
5. Murthy, M.N. (1979). "*Quality of Data, Country Course on Sample Surveys*", Karachi.
6. Statistics Division (1979). "*Retrospect, Perspective and Prospect*", Islamabad.
7. State Bank of Pakistan (1966). "*Deptt. of Statistics-A Chronicle*".
8. Zarkovich S.S. (1966) "*Quality of Statistical Data, Food and Agricultural Organization*", The U.N. Rome.
9. NIPA (1962) "*Administrative uses of Statistics*", NIPA Res. Sr.No.2 Karachi.
10. Yates F. (1960), "*Sampling Methods for Census and Surveys*", Charles Griffin. FAO Year Books.
11. Various Publications of FBS, PCO, ACO, "*State bank of Pakistan, Ministry of Finance*" etc.

STAT-413 Survival Analysis
Special features of Survival data: Patient time and study time, Survival function and hazard function, Time dependent and censored survival data. Nonparametric procedures: Estimation of Survival function, hazard function, median and percentiles of Survival times. Confidence interval and comparison of group; stratified and log-rank tests for trend. Modeling of Survival data; hazard function modeling; its tests and confidence interval. The Waybill model for survival data. Exploratory data analysis and other models. Sample size requirement for survival study. Computer software for Survival analysis; any available software like SAS, BMDP, SPSS, GLIM, GENSTAT or S-plus.

Books Recommended
1. * Lee, E.T. (1997). "*Applied Survival Analysis*", John Wiley and Sons, New York.
2. Muller, R.G. and Xian Zhou (1996). "*Survival Analysis with long-term Survivors*," John Wiley. New York.

3. Burkett, M. (1995). *"Analyzing Survival Data from Clinical Trials and Observational Studies"*; John Wiley New York.
4. Parmer M.K.B. & Macklin D. (1995). *"Survival Analysis: A Practical Approach"*; John Wiley New York.
5. Collett, D. (1994). *"Modeling Survival Data in Medical Research"*. Chapman & Hall, London.
6. Lee, E.T. (1992). *"Statistical Methods for Survival Data Analysis"*; John Wiley. N.Y.
7. Eland Johnson, R. C. and Johnson N. L. (1989), *"Survival Models & Data Analysis"*. John Wiley N.Y.
8. Turkey, J. (1987). *"Exploratory Data Analysis"*, John Wiley, New York.
9. Cox, DR. and Oakes, D. (1984). *"Analysis of Survival Data"*; Chapman & Hall London.
* (Text Book)

STAT-414 Biostatistics

Definition of Biostatistics, viz-a-viz the type of variables and observations in biological, health and medical sciences, Uniqueness in terms of behaviour of variables their domain, and units; Categorical, numerical and censored data. Populations, Target populations and samples; Role of sampling in biostatistics, Size of samples of various types of studies, Proportions, rates and ratios; incidence, prevalence and odds. Distributional behaviour of biological variables (Binomial, Poisson and Normal), Role of transformation for analysis of biological variables. Probit and Logit transformations and their analysis, p values, its importance and role. Confidence Interval in simple and composite hypothesis testing.

Books Recommended
1. Zar, J. (2000). *"Biostatistical Analysis"*, 5th Edition, John Wiley and Sons.
2. Shoukri, M. M. & Pause, C. A. (1998). *"Statistical Methods for Health Sciences"*. 2nd Edition, CRC Press, Florida.
3. ***** Daniel, W.W. (1996). *"Biostatistics: A Foundation for the Health Sciences"*, 6th Edition, John Wiley, New York.
4. Diggle, J. P., Liang, Kung-Yee and Zeger, S. L. (1996). *"Analysis of Longitudinal Data"*, Clarendon Press, Oxford.
5. Dunn, G. and Everit, B. (1995). *"Clinical Biostatistics"*, Edward Arnold, London.
6. ***** Rosner, B. (1994). *"Fundamentals of Biostatistics"*, 4th Edition, Duxbury Press.
7. Zolman, J.F. (1993). *"Biostatistics: Experimental Design and Statistical Inference"*, Oxford University Press, New York.
8. Lee, E.T. (1992). *"Statistical Methods for Survival Data Analysis"*, 2nd Edition, John Wiley, New York.
9. Harris, E. K. and Albert, A. (1991). *"Survivorship Analysis for Clinical"*
10. *"Studies"*. Marcel Decker, New York.
11. Altman, G. (1991). *"Practical Statistics for Medical Research"*. Chapman & Hall, London.
12. Lawless, J. F. (1982). *Statistical Models and Methods for Life Time Data*. John Wiley, New York.

* (Text Book)

STAT-415 Data Mining

Introduction to databases, including simple and relational databases; data warehouses. Review of classification methods from multivariate analysis; classification and decision trees. Clustering methods from both statistical and data mining viewpoints; vector quantization. Unsupervised learning from univariate and multivariate data; dimension reduction and feature selection. Supervised learning from moderate to high dimensional input spaces; artificial neural networks

and extensions of regression models, regression trees. Association rules and prediction; applications to electronic commerce.

Books Recommended

1. * Han, J. and Camber, M. (2000). Data Mining; "*Concepts and Techniques*". Morgan Gaufmann.
2. Benson and Smith, S.J. (1997). "*Data Warehousing, Data Mining'*, and OLAP. McGraw-Hill.
3. Mitchell, T.M. (1997). *"Machine Learning"*. McGraw-Hill.
4. Ripley, B.D. (1996). "*Pattern Recognition and Neural Networks*". Cambridge University Press.
5. Breiman, L. Friedman, J.H. Olshen, R.A. and Stone, C.J. (1984). "*Classification and Regression Trees"* Wadsworth and Brooks/Cole.

* (Text Book)
STAT-416 Actuarial Statistics-I

Utility theory, insurance and utility theory, models for individual claims and their sums, survival function, curate future lifetime, force of mortality. Life table and its relation with survival function, examples, assumptions for fractional ages, some analytical laws of mortality, select and ultimate tables.

Multiple life functions, joint life and last survivor status, insurance and annuity benefits through multiple life functions evaluation for special mortality laws.

Multiple decrement models, deterministic and random survivorship groups, associated single decrement tables, central rates of multiple decrement, net single premiums and their numerical evaluations.

Distribution of aggregate claims, compound Poisson distribution and its applications.

Books Recommended

1. Bowers, N.L. Gerber, H.U. Hickman, J.C. Jones, D.A. and Nesbitt, C.J. (1986). "*Actuarial Mathematics"*, Society of Actuarial, Ithaca, Illinois, U.S.A. Second Edition (1997).
2. Neill, A. (1977). "*Life Contingencies*", Heineman.
3. Spurgeon, E.T. (1972), "*Life Contingencies*", Cambridge University Press.

STAT-417 Actuarial Statistics-II

Principles of compound interest: Nominal and effective rates of interest and discount, force of interest and discount, compound interest, accumulation factor, continuous compounding.

Life insurance: Insurance payable at the moment of death and at the end of the year of death-level benefit insurance, endowment insurance, deferred insurance and varying benefit insurance, recursions, commutation functions.

Life annuities: Single payment, continuous life annuities, discrete life annuities, life annuities with monthly payments, commutation functions, varying annuities, recursions, complete annuities-immediate and apportionable annuities-due.

Net premiums: Continuous and discrete premiums, true monthly payment premiums, apportionable premiums, commutation functions, accumulation type benefits.

Payment premiums, apportionable premiums, commutation functions, accumulation type benefits.

Net premium reserves : Continuous and discrete net premium reserve, reserves on a semi-continuous basis, reserves based on true monthly premiums, reserves on an apportionable or discounted continuous basis, reserves at fractional durations, allocations of loss to policy years, recursive formulas and differential equations for reserves, commutation functions.

Some practical considerations: Premiums that include expenses-general expenses types of expenses, per policy expenses.

Claim amount distributions, approximating the individual model, stop-loss insurance.

Books Recommended

1. Bowers, N.L. Gerber, H.U. Hickman, J.C. Jones, D.A. and Nesbitt, C.J. (1986) "*Actuarial Mathematics*", Society of Actuaries, Ithaca, Illinois, U.S.A. Second Edition (1997).
2. Spurgeon, E.T. (1972). "*Life Contingencies*", Cambridge University Press.
3. Neill, A. (1977). "*Life Contingencies*", Heinemann.

STAT-418 Mathematical Modeling and Simulation

Monte Carlo methods: Different methods of generating random variables, generation of random numbers, acceptance and rejection techniques from various distributions. Comparison of algorithms to generate random variables. Generating random variables from failure rates.

Generation from multinomial distribution / Monte Carlo integration. Gibbs sampling and other techniques. Variance reduction techniques: importance sampling for integration, control variates and antithetic variables.

Books Recommended:

1. * Ross, S.M.(2002). "*Simulation*" (Third Edition) (Academic)
2. Fishman, G.S. (1996). Monte Carlo: *"Concepts, Algorithms, and Applications*", (Springer).
3. Rubinstein, R.Y. (1981). "*Simulation and the Monte Carlo Method",* (Wiley).

4. Ripley, B.D. (1987) "*Stochastic Simulations*" (Wiley)

* (Text Book)
STAT-419 Categorical Data Analysis
Introduction, describing two way contingency tables, inference for two way contingency tables, models for binary response variables, Log linear models, fitting Log linear and Logit models, building and applying Log linear models, Log linear Logit models for ordinal variables, multinomial response models for matched pairs, analyzing repeated categorical response data, logistic regression models and their analysis.
Books Recommended
1. ***** Agresti, A. (1990), "*Categorical Data Analysis*", John Wiley and Sons.
2. Bishop, Y.V.V., Fienberg, S.E. and Holland, P.W. (1975). "*Discrete Multivariate Analysis*", MA: MIT Press Cambridge.
3. Cox, D.R. and Snell, E.J.(1989). "*The Analysis of Binary Data*", Chapman and Hall, London.
4. David, W.H., Leweshow, S.L. (1989). "*Applied Logistic Regression*".
5. Mc Gullah, P. and Nelder, J.A. (1989). "*Generalized Linear Models*", 2nd ed. Chapman and Hall, London.

STAT-422 Bayesian Statistics
Prior information, Prior distributions, Methods of elicitation of prior distributions, Posterior distributions: The posterior means, medians (Bayes estimators under loss functions) and variances of univariate and bivariate posterior distributions, Noninformative priors: Methods of elicitation of noninformative priors, Bayesian Hypotheses Testing: Bayes factor; The highest density region; Posterior probability of the hypothesis.
Books Recommended
1. O.Hagan A. Kendall's Advanced Theory of Statistics (Vol.2B), Bayesian Inference, Cambridge, The University Press (1994).
2. Bernardo, J. M. & Smith, A.F.M., Bayesian Theory, John Wiley, New York (1994).
3. Lee, P.M. Bayesian Statistics, An Introduction, Oxford University Press, New York (1991).

4. Berger, J.O., Statistical Decision Theory and Bayesian Analysis (2nd Ed.), New York, Springer Verlag (1985).

5. Box, G.E. P & Tiao, G. C. Bayesian Inference in Statistical Analysis, Reading Addison-Wesley (1973).

STAT-423 Statistical Quality Management

Concept of quality control, total control and Total Quality Management (TQM) Statistical Methods in Quality Improvement. Statistical Process Control (SPC). Statistical Quality Control (SQC). Shewhart control charts: philosophy, construction, advantages. CUSUM and moving average control charts: Average Run Length (ARL); Fast Initial Response (FIR). ARL and FIR for X, R and S-charts.

Process capability analysis: Designed experiments. Process improvements using design of experiments. Taguchy Method. Orthogonal fractional factorial designs.

Acceptance sampling for attributes and variables.

Acceptance sampling plans: Single, double, and multiple sampling plans with their O.C. curves, Military Standard 501 Sampling Plans. Introduction to ISO- 9000 and ISO-14000 series.

Pre-Requisite: STAT-301

Books Recommended

1. ***** Montgomery, D.C. (2004). "*Introduction to Statistical Quality Control*". McGraw Hill, New York.
2. Miltag H. J. and Rinne H. (1993). "*Statistical Methods of Quality Assurance*", Chapman & Hall, London.
3. Nelson, W. (1990). "*Accelerated Testing*". John Wiley, New York.
4. Banks, J. (1989). "*Principles of Quality Control*". John Wiley, New York.
5. Ryan, T.P. (1989). "*Statistical Methods for Quality Improvement*". John Wiley, New York.
6. Juran, J.M. and Guyana, F.K. (1988). "*Juan's Quality Control Handbook*". McGraw Hill New York.
7. Feigenbaum, A.V. (1986). "*Total Quality Control*". McGraw Hill, New York.

Recommendations

The following recommendations were made by the committee to enhance the teaching and application of Statistics:

1. Departments of Statistics in the universities should make efforts to interact with the statistical organizations, industry and other users of statistics in the public and private sector.

2. Internship should be funded by the HEC and offered to students in the 7th semester in B.S programme.

3. Most of the courses must involve problem solving using computers.

4. Highly qualified statisticians are in short supply in Pakistan. There is a need of giving extra quota for statistics students for higher education in foreign countries leading to Ph.D. degree. HEC is therefore, impressed upon to give extra scholarships to statistics graduates.

5. The committee strongly recommends the creation of "Department of Biostatistics" for teaching and research guidance at all medical colleges/universities and the post of biostatistician in all hospitals.

6. Practicals conducted during the first 2 years for BS programme should be in the form of case studies. Secondary data published by different organizations may be used in such case studies.

7. Statistics at the intermediate (F.A./F.Sc.) level should also be taught in all the colleges of all the provinces.

8. Each university should create a Centre of Excellence so that a student who wishes to specialize in a specific field should know the best possible university to join.

9. Refresher courses at post-graduate level should be regularly arranged by the HEC.

10. HEC may support universities for the development of computer labs, departmental libraries, students and staff participation in seminars.

Annexure "A"
COMPULSORY COURSES IN ENGLISH FOR BS
(4 YEAR) IN BASIC & SOCIAL SCIENCES
English I (Functional English)
Objectives: Enhance language skills and develop critical thinking.
Course Contents
    Basics of Grammar
    Parts of speech and use of articles
    Sentence structure, active and passive voice
    Practice in unified sentence
    Analysis of phrase, clause and sentence structure
    Transitive and intransitive verbs
    Punctuation and spelling
    Comprehension
    Answers to questions on a given text
    Discussion
    General topics and every-day conversation (topics for discussion to be at the discretion of
    the teacher keeping in view the level of students)
    Listening
    To be improved by showing documentaries/films carefully selected by subject teachers

    Translation skills

    Urdu to English
    Paragraph writing
    Topics to be chosen at the discretion of the teacher
    Presentation skills
    Introduction
Note: Extensive reading is required for vocabulary building
Recommended books:
1. **Functional English**
a) Grammar

1. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 1. Third edition. Oxford University Press. 1997. ISBN 0194313492
2. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. Third edition. Oxford University Press. 1997. ISBN 0194313506
   b) Writing
1. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 0 19 435405 7 Pages 20-27 and 35-41.
   c) Reading/Comprehension
1. Reading. Upper Intermediate. Brain Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 453402 2.
   d) Speaking

English II (Communication Skills)

Objectives: Enable the students to meet their real life communication needs.

Course Contents

Paragraph writing
Practice in writing a good, unified and coherent paragraph

Essay writing
Introduction

CV and job application
Translation skills
Urdu to English

Study skills
Skimming and scanning, intensive and extensive, and speed reading, summary and précis writing and comprehension

Academic skills
Letter/memo writing, minutes of meetings, use of library and internet

Presentation skills
Personality development (emphasis on content, style and pronunciation)

Note: documentaries to be shown for discussion and review

Recommended books:
   Communication Skills
a) Grammar
1. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. Third edition. Oxford University Press 1986. ISBN 0 19 431350 6.
   b) Writing
      1. Writing. Intermediate by Marie-Chrisitine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 019 435405 7 Pages 45-53 (note taking).
      2. Writing. Upper-Intermediate by Rob Nolasco. Oxford Supplementary Skills. Fourth Impression 1992. ISBN 0 19 435406 5 (particularly good for writing memos, introduction to presentations, descriptive and argumentative writing).

   c) Reading
1. Reading. Advanced. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1991. ISBN 0 19 453403 0.
      2. Reading and Study Skills by John Langan
      3. Study Skills by Riachard Yorky.

English III (Technical Writing and
Presentation Skills)
Objectives: Enhance language skills and develop critical thinking
Course Contents
   Presentation skills
   Essay writing
   Descriptive, narrative, discursive, argumentative
   Academic writing
   How to write a proposal for research paper/term paper
   How to write a research paper/term paper (emphasis on style, content, language, form, clarity, consistency)
   Technical Report writing
   Progress report writing
Note: Extensive reading is required for vocabulary building

Recommended books:
Technical Writing and Presentation Skills
a) Essay Writing and Academic Writing
1. Writing. Advanced by Ron White. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 435407 3 (particularly suitable for discursive, descriptive, argumentative and report writing).

2. College Writing Skills by John Langan. Mc=Graw-Hill Higher Education. 2004.

3. Patterns of College Writing (4th edition) by Laurie G. Kirszner and Stephen R. Mandell. St. Martin's Press.

b) Presentation Skills
c) Reading

The Mercury Reader. A Custom Publication. Compiled by norther Illinois University. General Editiors: Janice Neulib; Kathleen Shine Cain; Stephen Ruffus and Maurice Scharton. (A reader which will give students exposure to the best of twentieth century literature, without taxing the taste of engineering students).

Annexure "B"

Pakistan Studies (Compulsory)

Introduction/Objectives
- Develop vision of historical perspective, government, politics, contemporary Pakistan, ideological background of Pakistan.
- Study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.

Course Outline

1. **Historical Perspective**

   a. Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-i-Azam Muhammad Ali Jinnah.

   b. Factors leading to Muslim separatism

   c. People and Land

      i. Indus Civilization

      ii. Muslim advent

      iii. Location and geo-physical features.

2. **Government and Politics in Pakistan**

   Political and constitutional phases:

   a. 1947-58

   b. 1958-71

   c. 1971-77

   d. 1977-88

   e. 1988-99

   f. 1999 onward

3. **Contemporary Pakistan**

   a. Economic institutions and issues

   b. Society and social structure

   c. Ethnicity

   d. Foreign policy of Pakistan and challenges

e. Futuristic outlook of Pakistan

Books Recommended

1. Burki, Shahid Javed. *State & Society in Pakistan,* The Macmillan Press Ltd 1980.
2. Akbar, S. Zaidi. *Issue in Pakistan's Economy.* Karachi: Oxford University Press, 2000.
3. S.M. Burke and Lawrence Ziring. Pakistan's Foreign policy: An Historical analysis. Karachi: Oxford University Press, 1993.
4. Mehmood, Safdar. *Pakistan Political Roots & Development.* Lahore, 1994.
5. Wilcox, Wayne.*The Emergence of Banglades.,* Washington: American Enterprise, Institute of Public Policy Research, 1972.
6. Mehmood, Safdar. *Pakistan Kayyun Toota,* Lahore: Idara-e-Saqafat-e-Islamia, Club Road, nd.
7. Amin, Tahir. *Ethno - National Movement in Pakistan,* Islamabad: Institute of Policy Studies, Islamabad.
8. Ziring, Lawrence. *Enigma of Political Development.* Kent England: WmDawson & sons Ltd, 1980.
9. Zahid, Ansar. *History & Culture of Sindh.* Karachi: Royal Book Company, 1980.
10. Afzal, M. Rafique. *Political Parties in Pakistan,* Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research, 1998.
11. Sayeed, Khalid Bin. *The Political System of Pakistan.* Boston: Houghton Mifflin, 1967.
12. Aziz, K.K. *Party, Politics in Pakistan,* Islamabad: National Commission on Historical and Cultural Research, 1976.
13. Muhammad Waseem, Pakistan Under Martial Law, Lahore: Vanguard, 1987.
14. Haq, Noor ul. *Making of Pakistan: The Military Perspective.* Islamabad: National Commission on Historical and Cultural Research, 1993.

Annexure "C"

ISLAMIC STUDIES
(Compulsory)
Objectives:
This course is aimed at:
1 To provide Basic information about Islamic Studies
2 To enhance understanding of the students regarding Islamic Civilization
3 To improve Students skill to perform prayers and other worships
    4 To enhance the skill of the students for understanding of issues related to faith and religious life.
Detail of Courses

Introduction to Quranic Studies

    1) Basic Concepts of Quran
    2) History of Quran
    3) Uloom-ul -Quran

Study of Selected Text of Holly Quran
    1) Verses of Surah Al-Baqra Related to Faith(Verse No-284-286)
    2) Verses of Surah Al-Hujrat Related to Adab Al-Nabi
      (Verse No-1-18)
    3) Verses of Surah Al-Mumanoon Related to Characteristics of faithful (Verse No-1-11)
    4) Verses of Surah al-Furqan Related to Social Ethics (Verse No.63-77)
    5) Verses of Surah Al-Inam Related to Ihkam(Verse No-152-154)

Study of Sellected Text of Holly Quran
    1) Verses of Surah Al-Ihzab Related to Adab al-Nabi (Verse No.6,21,40,56,57,58.)
    2) Verses of Surah Al-Hashar (18,19,20) Related to thinking, Day of Judgment
    3) Verses of Surah Al-Saf Related to Tafakar,Tadabar (Verse No-1,14)

Seerat of Holy Prophet (S.A.W) I
    1) Life of Muhammad Bin Abdullah (Before Prophet Hood)
    2) Life of Holy Prophet (S.A.W) in Makkah

3) Important Lessons Derived from the life of Holy Prophet in Makkah

Seerat of Holy Prophet (S.A.W) II
   1) Life of Holy Prophet (S.A.W) in Madina
   2) Important Events of Life Holy Prophet in Madina
   3) Important Lessons Derived from the life of Holy Prophet in Madina

Introduction To Sunnah
   1) Basic Concepts of Hadith
   2) History of Hadith
   3) Kinds of Hadith
   4) Uloom –ul-Hadith
   5) Sunnah & Hadith
   6) Legal Position of Sunnah

Selected Study from Text of Hadith
Introduction To Islamic Law & Jurisprudence
   1) Basic Concepts of Islamic Law & Jurisprudence
   2) History & Importance of Islamic Law & Jurisprudence
   3) Sources of Islamic Law & Jurisprudence
   4) Nature of Differences in Islamic Law
   5) Islam and Sectarianism

Islamic Culture & Civilization
   1) Basic Concepts of Islamic Culture & Civilization
   2) Historical Development of Islamic Culture & Civilization
   3) Characteristics of Islamic Culture & Civilization
   4) Islamic Culture & Civilization and Contemporary Issues

Islam & Science
   1) Basic Concepts of Islam & Science
   2) Contributions of Muslims in the Development of Science
   3) Quranic & Science

Islamic Economic System
   1) Basic Concepts of Islamic Economic System
   2) Means of Distribution of wealth in Islamic Economics
   3) Islamic Concept of Riba
   4) Islamic Ways of Trade & Commerce

Political System of Islam
   1) Basic Concepts of Islamic Political System
   2) Islamic Concept of Sovereignty

3) Basic Institutions of Govt. in Islam

Islamic History
   1) Period of Khlaft-E-Rashida
   2) Period of Ummayyads
   3) Period of Abbasids

Social System of Islam
   1) Basic Concepts Of Social System Of Islam
   2) Elements Of Family
   3) Ethical Values Of Islam

Reference Books:

1) Hameed ullah Muhammad, "Emergence of Islam" , IRI, Islamabad

2) Hameed ullah Muhammad, "Muslim Conduct of State"
3) Hameed ullah Muhammad, 'Introduction to Islam
4) Mulana Muhammad Yousaf Islahi,"

5) Hussain Hamid Hassan, "An Introduction to the Study of Islamic Law" leaf Publication Islamabad, Pakistan.
6) Ahmad Hasan, "Principles of Islamic Jurisprudence" Islamic Research
Institute, International Islamic University, Islamabad (1993)
7) Mir Waliullah, "Muslim Jrisprudence and the Quranic Law of Crimes" Islamic Book Service (1982)
8) H.S. Bhatia, "Studies in Islamic Law, Religion and Society" Deep & Deep Publications New Delhi (1989)
9) Dr. Muhammad Zia-ul-Haq, "Introduction to Al Sharia Al Islamia" Allama Iqbal Open University, Islamabad (2001)

Annexure "D"

Note: One course will be selected from the following six courses of Mathematics.

COMPULSORY MATHEMATICS
COURSES FOR BS (4 YEAR)
(FOR STUDENTS NOT MAJORING IN
MATHEMATICS)

1. MATHEMATICS I (ALGEBRA)

Prerequisite(s): Mathematics at secondary level

Credit Hours: 3 + 0

Specific Objectives of the Course: To prepare the students, not majoring in mathematics, with the essential tools of algebra to apply the concepts and the techniques in their respective disciplines.

Course Outline:

Preliminaries: Real-number system, complex numbers, introduction to sets, set operations, functions, types of functions. *Matrices:* Introduction to matrices, types, matrix inverse, determinants, system of linear equations, Cramer's rule.

Quadratic Equations: Solution of quadratic equations, qualitative analysis of roots of a quadratic equations, equations reducible to quadratic equations, cube roots of unity, relation between roots and coefficients of quadratic equations.

Sequences and Series: Arithmetic progression, geometric progression, harmonic progression. *Binomial Theorem:* Introduction to mathematical induction, binomial theorem with rational and irrational indices. *Trigonometry:* Fundamentals of trigonometry, trigonometric identities.

Recommended Books:

Dolciani MP, Wooton W, Beckenback EF, Sharron S, *Algebra 2 and Trigonometry*, 1978, Houghton & Mifflin,

Boston (suggested text)

Kaufmann JE, College *Algebra and Trigonometry*, 1987, PWS-Kent Company, Boston

Swokowski EW, *Fundamentals of Algebra and Trigonometry* (6th edition), 1986, PWS-Kent Company, Boston

2. MATHEMATICS II (CALCULUS)

Prerequisite(s): Mathematics I (Algebra)

Credit Hours: 3 + 0

Specific Objectives of the Course: To prepare the students, not majoring in mathematics, with the essential tools of calculus to apply the concepts and the techniques in their respective disciplines.

Course Outline:

Preliminaries: Real-number line, functions and their graphs, solution of equations involving absolute values, inequalities. *Limits and Continuity:* Limit of a function, left-hand and right-hand limits, continuity, continuous functions.

Derivatives and their Applications: Differentiable functions, differentiation of polynomial, rational and transcendental functions, derivatives.

Integration and Definite Integrals: Techniques of evaluating indefinite integrals, integration by substitution, integration by parts, change of variables in indefinite integrals.

Recommended Books:

Anton H, Bevens I, Davis S, *Calculus: A New Horizon* (8th edition), 2005, John Wiley, New York

Stewart J, *Calculus* (3rd edition), 1995, Brooks/Cole (suggested text)

Swokowski EW, *Calculus and Analytic Geometry*, 1983, PWS-Kent Company, Boston

Thomas GB, Finney AR, *Calculus* (11th edition), 2005, Addison-Wesley, Reading, Ma, USA

3. MATHEMATICS III (GEOMETRY)

Prerequisite(s): Mathematics II (Calculus)

Credit Hours: 3 + 0

Specific Objectives of the Course: To prepare the students, not majoring in mathematics, with the essential tools of geometry to apply the concepts and the techniques in their respective disciplines.

Course Outline:

Geometry in Two Dimensions: Cartesian-coördinate mesh, slope of a line, equation of a line, parallel and perpendicular lines, various forms of equation of a line, intersection of two lines, angle between two lines, distance between two points, distance between a point and a line.
Circle: Equation of a circle, circles determined by various conditions, intersection of lines and circles, locus of a point in various conditions.
Conic Sections: Parabola, ellipse, hyperbola, the general-second-degree equation

Recommended Books:

Abraham S, Analytic Geometry, Scott, Freshman and Company, 1969
Kaufmann JE, College *Algebra and Trigonometry*, 1987, PWS-Kent Company, Boston
Swokowski EW, *Fundamentals of Algebra and Trigonometry* (6th edition), 1986, PWS-Kent Company, Boston

4. COURSE FOR NON-MATHEMATICS MAJORS IN SOCIAL SCIENCES

Title of subject: MATHEMATICS
Discipline : BS (Social Sciences).

Pre-requisites : SSC (Metric) level Mathematics
Credit Hours : 03 + 00
Minimum Contact Hours: 40
Assessment : written examination;
Effective : 2008 and onward
Aims : To give the basic knowledge of Mathematics and prepare the students not majoring in mathematics.
Objectives : After completion of this course the student should be able to:

- Understand the use of the essential tools of basic mathematics;
- Apply the concepts and the techniques in their respective disciplines;
- Model the effects non-isothermal problems through different domains;

Contents :
1. *Algebra* : *Preliminaries:* Real and complex numbers, Introduction to sets, set operations, functions, types of functions. *Matrices:* Introduction to matrices, types of matrices, inverse of matrices, determinants, system of linear equations, Cramer's rule. *Quadratic equations:* Solution of quadratic equations, nature of roots of quadratic equations, equations reducible to quadratic equations. *Sequence and Series:* Arithmetic, geometric and harmonic progressions. *Permutation and combinations*: Introduction to permutation and combinations, *Binomial Theorem:* Introduction to binomial theorem. *Trigonometry:* Fundamentals of trigonometry, trigonometric identities. *Graphs:* Graph of straight line, circle and trigonometric functions.

2. *Statistics* : *Introduction*: Meaning and definition of statistics, relationship of statistics with social science, characteristics of statistics, limitations of statistics and main division of statistics. *Frequency distribution*: Organisation of data, array, ungrouped and grouped data, types of frequency series, individual, discrete and continuous series, tally sheet method, graphic presentation of the frequency distribution, bar frequency diagram histogram, frequency polygon, cumulative frequency curve. *Measures of central tendency*: Mean medium and modes, quartiles, deciles and percentiles. *Measures of dispersion*: Range, inter quartile deviation mean deviation, standard deviation, variance, moments, skewness and kurtosis.

Books Recommended:

1. Swokowski. E. W., '*Fundamentals of Algebra and Trigonometry*', Latest Edition.
2. Kaufmann. J. E., '*College Algebra and Trigonometry*', PWS-Kent Company, Boston, Latest Edition.
3. Walpole, R. E., '*Introduction of Statistics*', Prentice Hall, Latest Edition.

4. Wilcox, R. R., '*Statistics for The Social Sciences*',

5. MATHEMATICS FOR CHEMISTRY
Credit Hours: 3
Prerequisites: Mathematics at Secondary level
Specific Objectives of Course: To prepare the students not majoring in mathematics with the essential tools of Calculus to apply the concepts and the techniques in their respective disciplines.
Course Outline:
Preliminaries: Real Numbers and the Real Line, *Functions and their graphs*: Polynomial Functions, Rational Functions, Trigonometric Functions, and Transcendental Functions. Slope of a Line, Equation of a Line, Solution of equations involving absolute values, Inequalities. *Limits and Continuity:* Limit of a Function, Left Hand and Right Hand Limits, Continuity, Continuous Functions. *Derivatives and its Applications:* Differentiation of Polynomial, Rational and Transcendental Functions, Extreme Values of Functions. *Integration and Indefinite Integrals:* Integration by Substitution, Integration by Parts, Change of Variables in Indefinite Integrals. Least-Squares Line.
Recommended Books:

1. Thomas, Calculus, 11th Edition. Addison Wesley publishing company, 2005.
2. H. Anton, I. Bevens, S. Davis, Calculus, 8th edition, Jhon Willey & Sons, Inc. 2005.
3. Hughes-Hallett, Gleason, McCallum, et al, Calculus Single and Multivariable, 3rd Edition. John Wiley & Sons, Inc. 2002.
4. Frank A.Jr, Elliott Mendelson, Calculus, Schaum's Outline Series, 4th edition, 1999.
5. E. W. Swokowski, Calculus and Analytic Geometry PWS Publishers, Boston, 1983.
6. John H. Mathews, Numerical Methods for Mathematics Science and Engineering, Prentice-Hall, Second Edition 1992.

6. MATHEMATICS FOR PHYSICS
Contents
1. Preliminary calculus.
   • Differentiation

   Differentiation from first principles; products; the chain rule; quotients; implicit differentiation; logarithmic differentiation;

Leibnitz' theorem; special points of a function; theorems of differentiation.

• Integration

Integration from first principles; the inverse of differentiation; integration by inspection; sinusoidal function; logarithmic integration; integration using partial fractions; substitution method; integration by parts; reduction formulae; infinite and improper integrals; plane polar coordinates; integral inequalities; applications of integration.

2. Complex numbers and hyperbolic functions
   • The need for complex numbers
   • Manipulation of complex numbers
Additions and subtraction; modulus and argument; multiplication; complex conjugate; division
   • Polar representation of complex numbers
       Multiplication and division in polar form
   • de Moivre's theorem
       Trigonometrical identities; finding the nth roots of unity; solving polynomial equations
   • Complex logarithms and complex powers
   • Applications to differentiation and integration
   • Hyperbolic functions

Definitions; hyperbolic-trigonometric analogies; identities of hyperbolic functions; solving hyperbolic equations; inverses of hyperbolic functions; calculus of hyperbolic functions

3. Series and limits
   • Series
   • Summation of series

Arithmetic series; geometric series; arithmetico-geometric series; the difference method; series involving natural numbers; transformation of series

   • Convergence of infinite series
       Absolute and conditional convergence; convergence of a series containing only real positive terms; alternating series test
   • Operations with series
   • Power series
Convergence of power series; operations with power series

- Taylor series

  Taylor's theorem; approximation errors in Taylor series; standard Maclaurin series
- Evaluation of limits

4. Partial differentiation
- Definition of the partial derivative
- The total differential and total derivative
- Exact and inexact differentials
- Useful theorems of partial differentiation
- The chain rule
- Change of variables
- Taylor's theorem for many-variable functions
- Stationary values of many-variable functions
- Stationary values under constraints

5. Multiple integrals
- Double integrals
- Triple integrals
- Applications of multiple integrals

  Areas and volumes; masses, centers of mass and centroids; Pappus' theorems; moments of inertia; mean values of functions
- Change of variables in multiple integrals

  Change of variables in double integrals;

6. Vector algebra
- Scalars and vectors
- Addition and subtraction of vectors
- Multiplication by a scalar
- Basis vectors and components
- Magnitude of a vectors
- Multiplication of vectors

  Scalar product; vector product; scalar triple product; vector triple product
- Equations of lines and planes

  Equation of a line; equation of a plane
- Using vectors to find distances

  Point to line; point to plane; line to line; line to plane
- Reciprocal vectors

7. Matrices and vector spaces
- Vectors spaces

Basic vectors; the inner product; some useful inequalities
- Matrices
- The complex and Hermitian conjugates of a matrix
- The determinant of a matrix
  Properties of determinants
- The inverse of a matrix
- The rank of a matrix
- Simultaneous linear equations
  N simultaneous linear equations in N unknowns
- Special square matrices
Diagonal; symmetric and antisymmetric; orthogonal; Hermitian; unitary normal
- Eigen vectors and eigen values
  Of a normal matrix; of Hermitian and anti-Hermitian matrices; of a unitary matrix; of a general square matrix
- Determination of eigen values and eigen vectors
  Degenerate eigen values

8. Vector calculus

- Differentiation of vectors
Composite vector expressions; differential of a vector
- Integration of vectors
- Space curves
- Vector functions of several arguments
- Surfaces
- Scalar and vector fields
- Vector operators
  Gradient of a scalar field; divergence of a vector field; curl of a vector field
- Vector operator formulae
  Vector operators acting on sums and products; combinations of grad, div and curl

- Cylindrical and spherical polar coordinates
Cylindrical polar coordinates; spherical polar coordinates

Annexure "E"
INTRODUCTION TO STATISTICS
Credit hrs: 3(3-0)
Unit 1. What is Statistics?

Definition of Statistics, Population, sample Descriptive and inferential Statistics, Observations, Data, Discrete and continuous variables, Errors of measurement, Significant digits, Rounding of a Number, Collection of primary and secondary data, Sources, Editing of Data. Exercises.

Unit 2. Presentation of Data

Introduction, basic principles of classification and Tabulation, Constructing of a frequency distribution, Relative and Cumulative frequency distribution, Diagrams, Graphs and their Construction, Bar charts, Pie chart, Histogram, Frequency polygon and Frequency curve, Cumulative Frequency Polygon or Ogive, Historigram, Ogive for Discrete Variable. Types of frequency curves. Exercises.

Unit 3. Measures of Central Tendency

Introduction, Different types of Averages, Quantiles, The Mode, Empirical Relation between Mean, Median and mode, Relative Merits and Demerits of various Averages. properties of Good Average, Box and Whisker Plot, Stem and Leaf Display, definition of outliers and their detection. Exercises.

Unit 4. Measures of Dispersion

Introduction, Absolute and relative measures, Range, The semi-Inter-quartile Range, The Mean Deviation, The Variance and standard deviation, Change of origin and scale, Interpretation of the standard Deviation, Coefficient of variation, Properties of variance and standard Deviation, Standardized variables, Moments and Moments ratios. Exercises.

Unit 5. Probability and Probability Distributions.

Discrete and continuous distributions: Binomial, Poisson and Normal Distribution. Exercises

Unit 6. Sampling and Sampling Distributions

Introduction, sample design and sampling frame, bias, sampling and non sampling errors, sampling with and without replacement, probability and non-probability sampling, Sampling distributions for single mean and proportion, Difference of means and proportions. Exercises.

Unit 7. Hypothesis Testing
Introduction, Statistical problem, null and alternative hypothesis, Type-I and Type-II errors, level of significance, Test statistics, acceptance and rejection regions, general procedure for testing of hypothesis. Exercises.

Unit 8. Testing of Hypothesis- Single Population
Introduction, Testing of hypothesis and confidence interval about the population mean and proportion for small and large samples, Exercises

Unit 9. Testing of Hypotheses-Two or more Populations
Introduction, Testing of hypothesis and confidence intervals about the difference of population means and proportions for small and large samples, Analysis of Variance and ANOVA Table. Exercises

Unit 10. Testing of Hypothesis-Independece of Attributes
Introduction, Contingency Tables, Testing of hypothesis about the Independence of attributes. Exercises.

Unit 11. Regression and Correlation
Introduction, cause and effect relationships, examples, simple linear regression, estimation of parameters and their interpretation. r and R^2. Correlation. Coefficient of linear correlation, its estimation and interpretation. Multiple regression and interpretation of its parameters. Examples

Recommended Books

1 Walpole, R. E. 1982. "Introduction to Statistics", 3rd Ed., Macmillan Publishing Co., Inc. New York.
   2 Muhammad, F. 2005. "Statistical Me

A meeting of first meeting of the board of studies of statistics was held on March 27th, 2013,the following attended the meeting:-

Name and address	Status	Signature
1. Asst. Prof. Dr. Sohail Akhtar In Charge Department of Statistics University of Malakand	Chairman/ Convener	
2. Prof. Dr. Salahudin Professor Department of Statistics University of Peshawar	Member	
3. Dr. Qamruz Zaman Associate Professor Department of Statistics University of Peshawar	Member	
4. Mr. Zahid Khan Lecturer , Department of Statistics University of Malakand.	Member	
5. Mr. Rihayash Shah Assistant Professor Govt. Degree College Gulabad	Member	
6. Mr. Gohar Ali Lecturer GDC Samar Bagh, Dir Lower	Member	
7. Mr. Safdar Sahib, Govt Degree College Thana GGDC Thana, Malakand Agency	Member	