CURRICULUM

OF

STATISTICS
BS (4–YEAR)

2008

HIGHER EDUCATION COMMISSION
ISLAMABAD

CURRICULUM DIVISION, HEC

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PREFACE

Curriculum development is a highly organized and systematic process and involves a number of procedures. Many of these procedures include incorporating the results from international research studies and reforms made in other countries. These studies and reforms are then related to the particular subject and the position in Pakistan so that the proposed curriculum may have its roots in the socio-economics setup in which it is to be introduced. Hence, unlike a machine, it is not possible to accept any curriculum in its entirety. It has to be studied thoroughly and all aspects are to be critically examined before any component is recommended for adoption.

In exercise of the powers conferred by sub-section (1) of section 3 of the Federal Supervision of Curricula Textbooks and Maintenance of Standards of Education Act 1976, the Federal Government vide notification No. D773/76-JEA (cur.), dated December 4th 1976, appointed the University Grants Commission as the competent authority to look after the curriculum revision work beyond class XII at the bachelor level and onwards to all degrees, certificates and diplomas awarded by degree colleges, universities and other institutions of higher education.

In pursuance of the above decisions and directives, the Higher Education Commission (HEC) is continually performing curriculum revision in collaboration with universities. According to the decision of the special meeting of Vice-Chancellor's Committee, the curriculum of a subject must be reviewed after every 3 years.

A committee of experts comprising of conveners from the National Curriculum Revision of HEC in Basic, Applied Social Sciences and Engineering disciplines met in April 2007 and developed a unified template to standardize degree programs in the country to bring the national curriculum at par with international standards, and to fulfill the needs of the local industries. It also aimed to give a basic, broad based knowledge to the students to ensure the quality of education. The new BS degree shall be of 4 years duration, and will require the completion of 130-136 credit hours. For those social sciences and basic sciences degrees, 63.50% of the curriculum will consist of discipline specific courses, and 36.50% will consist of compulsory courses and general courses offered through other departments.

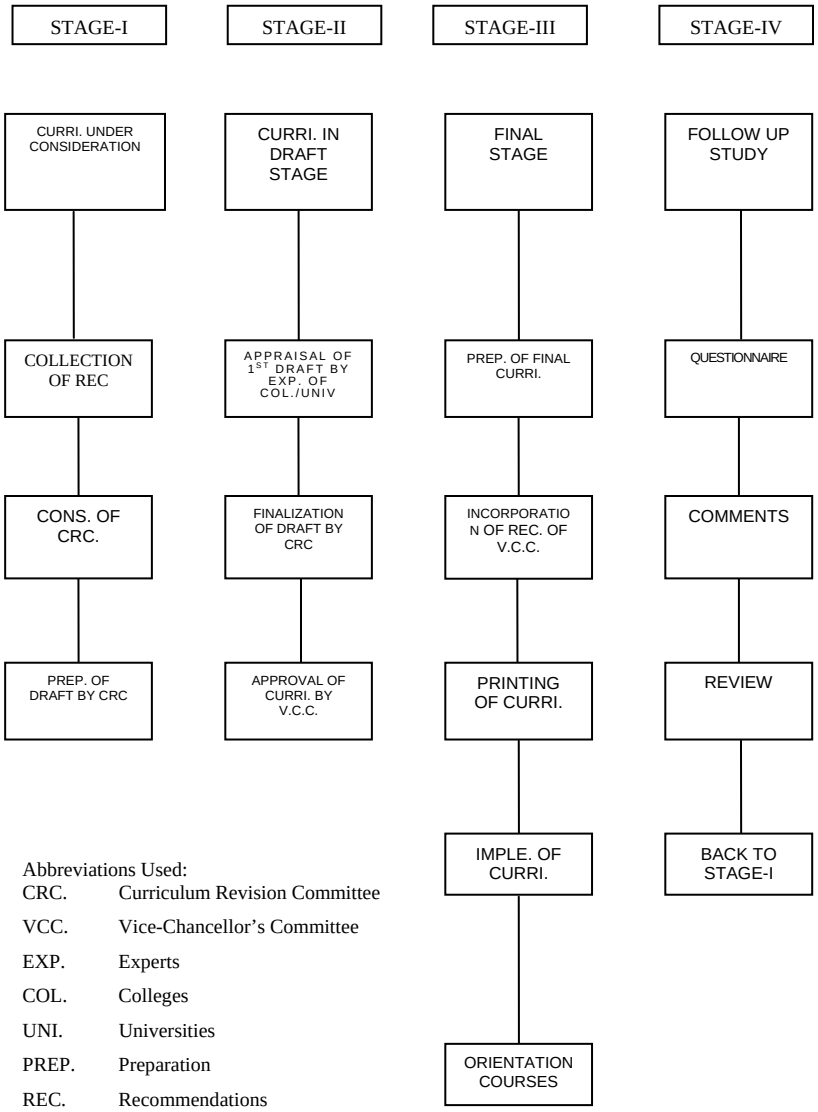
For the purpose of curriculum revision various committees are constituted at the national level, comprising of senior teachers nominated by universities, degree awarding institutions, R&D organizations and respective accreditation councils. The National Curriculum Revision Committee for Statistics in a meeting held on November 19 – 20, 2007 at

HEC Islamabad revised the curriculum in light of the unified template. The final draft prepared by the National Curriculum Revision Special Committee, duly approved by the competent authority, is being circulated for implementation in the concerned institutions.

DR.RIAZ-UL-HAQ TARIQ
Member Academics

June 2008

CURRICULUM DEVELOPMENT



Abbreviations Used:

CRC.	Curriculum Revision Committee
VCC.	Vice-Chancellor's Committee
EXP.	Experts
COL.	Colleges
UNI.	Universities
PREP.	Preparation
REC.	Recommendations

INTRODUCTION

A meeting of National Curriculum Revision Committee in Statistics was held on November 19-20, 2007 at HEC, Islamabad. The following attended the meeting:-

1.	Prof. Dr. Munir Akhtar, Chairman, Department of Statistics, Islamia University, Bahawalpur	Convener
2.	Prof. Asim Jamal Siddiqui, Chairman, Department of Statistics, University of Karachi, Karachi	Member
3.	Prof.Dr.Muhammad Aslam Chairman, Department of Statistics, Quaid-e-Azam University, Islamabad.	Member
4.	Prof. Dr.Faqir Muhammad Chairman, Department of Statistics & Mathematics Allama Iqbal Open University, Islamabad.	Member
5.	Prof.Dr.M.Khalid Pervaiz Dean, Faculty of Arts & Social Sciences, Government College University, Lahore.	Member
6.	Mr. S. Sajjad Hussain Bokhari, Chairman, Department of Statistics, Gomal University, D.I.Khan	Member
7.	Prof.Raja Muhammad Ilyas Rajput Chairman, Department of Statistics, University of Sindh, Jamshoro	Member
8.	Prof.Dr.Arif Zaman Department of Computer Science Lahore University of Management Science, Opposite Sector U, Defense House uthority, Lahore	Member
9.	Dr. Ayesha Roohi, Associate Professor, Lahore College for Women University, Jail Road, Lahore.	Member
10.	Prof.Muhammad Iqbal Kasi Chairman, Department of Statistics, University of Balochistan, Quetta	Member
11.	Prof. Dr. Salahuddin, Department of Statistics, University of Peshawar, Peshawar.	Member/Secretary

The meeting started with the recitation of Holy Quran by Mr. Shafiullah Khan, Assistant Director (Curriculum) HEC. Prof. Dr. Riaz-ul-Haq Tariq, Member (Academics) briefed the participants about the overall structure of approved unified template/scheme of studies for BS 4-YEAR programme and asked them to adjust the revised Curriculum in Statistics (2006) with that template. He also asked the participants to incorporate latest books in various courses which are easily available in the market and also identify Text Books in each course. After this Mr. Shafiullah Khan requested the participants to select Convener and Secretary of the meeting. The forum unanimously selected Prof. Dr. Munir Akhtar as Convener and Prof. Dr. Salahuddin as Secretary.

The agenda item was discussed. After a thorough discussion the following scheme of studies for BS (4-YEAR) programme was approved.

FRAME WORK FOR BS (4-YEAR) IN STATISTICS

LAYOUT

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** **3**	6. Sociology 7. Business Administration (Entrepreneurship)	**3** **3**	5. Introduction to Regression Analysis & Experimental Design	**3**
7. CALCULUS-I	**3**			6. Applied Statistics	**3**
8. CALCULUS-II	**3**	OR		7. Probability & Probability Distribution-1	**3**
9. INTRODUCTION TO COMPUTER		* 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 4. Time Series and Forecasting	**3** **3**
4. Sampling Techniques-II	**4**		
5. Econometrics	**4**	OR	
6. Design & Analysis of Experiment-II	**4**	** from the list of elective courses.	
7. Non Parametric Methods	**3**		
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, Conditional 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 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-102 Introduction to Probability Distributions

Discrete Random Variables, Probability Distribution, Mean and Variance of a discrete random variable. Bernoulli trials. Proerties, applications and f itting of Binomial, Poisson, Hypergeometric, 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 Binomial 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 and Experimental 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, Ilmi 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",* McGraw 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-Requisite: 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, confidence interval based on these tests. Runs test for randomness.

Distribution tests and rank transformation. 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: 2^k, 3^k 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 lx, 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 demographic 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, Discriminate 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 Processes",* Chapman and Hall, London.

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 7^{th} 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 Methods and Data Analysis", Kitab Markaz, Bhawana Bazar Faisalabad.