**GOVT. COLLEGE WOMEN UNIVERSITY FAISALABAD**

**DEPARTMENT OF STATISTICS**

**COURSE CONTENTS**

**SEMESTER I**

**Course Title Introduction to Statistics**

**Course Code: STA-301**

**Credit Hours: 4(4-0)**

**Aims and objectives:**

To introduce the students about basic statistics and make them understand their role both in the society and to help the students to know about the various courses related with each other.

**THEORY:**

Meanings of Statistics. Main branches of Statistics. Types of variables. Measurements scales. Statistical data collection. Organizing of data. Classification of data. Graph and chars: Stem and Leaf diagram, Box and Whisker plots. Graph based on frequency distribution: Histogram, Frequency polygon, Ogive, Pie-chart.

Measure of Central Tendency: Arithmetic mean, Median, mode, Geometric mean, Harmonic mean, their properties, merits and demerits. Quantilies, Empirical relation between mean, median and mode.

Measure of Dispersion: Absolute and Relative measure of dispersion, their properties, merits and demerits. Standardized variables, moments, Sheppard’s correction, moments ratios, Kurtosis and Skewness.

**RECOMMENDED BOOKS:**

1. Chaudhary, SM and Kamal, S. (2009) “Introduction to Statistical Theory” Parts I & ii, 6th ed, Ilmi Kitab Khana, Lahore Pakistan.
2. Rauf, M (2001). Polymers Modern Statistics. Polymer Publication, Urdu Bazar, Lahore.
3. Spiegel, M.R. Schiller, J.L. and Sirinivasan, R.L. (2000) “Probability and Statistics”, 2nd ed. Schaums Outlines Series. McGraw Hill. NY.
4. Walpole, R.E (2001). Introduction to Statistics. Macmillan Publishing Company.

**SEMESTER II**

**Course Title Basic Probability & Random Variables**

**Course Code: STA-302**

**Credit Hours: 3(3-0)**

**Aims and objectives:**

To develop and understandings the basic concept and application of probability in statistics. To understand the idea of making probability distribution.

**THEORY:**

Probability concepts, Addition and Multiplication rules, Bivariate frequency tables, joint and marginal probabilities, conditional probability and independence, Bayers rule. Random variable. Discrete random variable, probability distribution of discrete random variable and its properties. Distribution function and its properties. Mean and variance of discrete random variable. Continuous random variable, probability density function with its properties.

**RECOMMENDED BOOKS:**

1. Chaudhary, SM and Kamal, S. (2009) “Introduction to Statistical Theory” Parts I & ii, 6th ed, Ilmi Kitab Khana, Lahore Pakistan.
2. Rauf, M (2001). Polymers Modern Statistics. Polymer Publication, Urdu Bazar, Lahore.
3. Spiegel, M.R. Schiller, J.L. and Sirinivasan, R.L. (2000) “Probability and Statistics”, 2nd ed. Schaums Outlines Series. McGraw Hill. NY.
4. Walpole, R.E (2001). Introduction to Statistics. Macmillan Publishing Company.

**SEMESTER III**

**Course Title Introduction to Probability Distributions**

**Course Code: STA-401**

**Credit Hours: 3(3-0)**

**Aims and objectives:**

To impart skilled knowledge about the properties and application of different discrete and continuous probability distributions.

**THEORY:**

Properties\* and application of following discrete probability distributions: Uniform Distribution, Bernoulli Distribution, Binomial Distribution, Poisson Distribution, Hyper-geometric Distribution, Geometric distribution, Negative Binomial distribution. Application and properties \* of following continuous distributions: Normal distribution, Exponential distribution, Gamma distribution, Beta distribution. Normal approximation to Binomial and Poisson distributions.

\*Properties include mean, variance, moments, moment generating function (if possible).

**RECOMMENDED BOOKS:**

1. Chaudhary, SM and Kamal, S. (2009) “Introduction to Statistical Theory” Parts I & ii, 6th ed, Ilmi Kitab Khana, Lahore Pakistan.
2. Rauf, M (2001). Polymers Modern Statistics. Polymer Publication, Urdu Bazar, Lahore.
3. Spiegel, M.R. Schiller, J.L. and Sirinivasan, R.L. (2000) “Probability and Statistics”, 2nd ed. Schaums Outlines Series. McGraw Hill. NY.
4. Walpole, R.E (2001). Introduction to Statistics. Macmillan Publishing Company.

**SEMESTER III**

**Course Title Introduction to Survey Sampling**

**Course Code: STA-403**

**Credit Hours: 3(3-0)**

**Aims and objectives:**

To develop skills to plan appropriate sampling using available resources. To create awareness about selection, care and use of different types of sampling in real life data.

**THEORY:**

Sampling: Basic definition, Objective, advantages and disadvantages of sampling, types of sampling (Concepts). Sampling distribution of mean, difference between two mean, variances, proportion, difference between two proportions. Central limit theorem.

**RECOMMENDED BOOKS:**

1. Chaudhary, SM and Kamal, S. (2009) “Introduction to Statistical Theory” Parts I & ii, 6th ed, Ilmi Kitab Khana, Lahore Pakistan.
2. Rauf, M (2001). Polymers Modern Statistics. Polymer Publication, Urdu Bazar, Lahore.
3. Spiegel, M.R. Schiller, J.L. and Sirinivasan, R.L. (2000) “Probability and Statistics”, 2nd ed. Schaums Outlines Series. McGraw Hill. NY.
4. Walpole, R.E (2001). Introduction to Statistics. Macmillan Publishing Company.

**SEMESTER III**

**Course Title Applied Statistics**

**Course Code: STA-406**

**Credit Hours: 4(4-0)**

**Aims and objectives:**

To provide knowledge of using statistical techniques in real life data.

**THEORY:**

Index Number: Construction and application of index number. Simple and composite Index number. Fixed based and chain base method. Unweighted and weighted index number. Theoretical tests for index number. (Time Reversal Tests, Factor Reversal Test, Circular Test). Consumer price index Number and Sensitive Price Index Number. Determination of Purchasing Power of Money, Real Wages, Inflation Rate on the basis of index number. Limitation of index number.

Time Series Analysis: Time Series Data, components of Time Series, Measurements of Systematic components of time series. (Measurement of Secular Trend, Seasonal Variation Cyclical Fluctuation). Detrending, Deseasonalization of data, Forecasting and Prediction.

Vital Statistics: Meaning of vital Statistics, registration of birth and death in Pakistan. Uses of Vital Statistics, short comings of vital statistics, rates and ratio (Sex Ratio, child ratio, birth and death ratio, population growth rate, classification of natal rates, death rates or mortality rates crude death rate, infant mortality rate, specific death 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.)

**RECOMMENDED BOOKS:**

1. Chaudhary, SM and Kamal, S. (2009) “Introduction to Statistical Theory” Parts I & ii, 6th ed, Ilmi Kitab Khana, Lahore Pakistan.
2. Rauf, M (2001). Polymers Modern Statistics. Polymer Publication, Urdu Bazar, Lahore.
3. Walpole, R.E (2001). Introduction to Statistics. Macmillan Publishing Company.

**SEMESTER IV**

**Course Title Introduction to Regression Analysis and ANOVA**

**Course Code: STA-402**

**Credit Hours: 4(4-0)**

**Aims and objectives:**

To introduce the students about the application of regression, correlation and ANOVA.

To gain the thorough understanding of regression and correlation with one and more than one independent variable.

**THEORY:**

Regression Analysis: Concept of regression analysis, scatter diagram, Simple linear regression, its model and assumptions. Inference regarding the parameters of simple linear regression. Multiple linear regression, inference regarding the parameter of multiple linear regression. Fitting of non-linear regression. Standard error of estimate. Coefficient of determination and its interpretation. Correlation and causation. Correlation coefficient, its properties and interpretation. Multiple and partial correlation coefficient and its interpretation, inference regarding the correlation coefficient, multiple correlation coefficeient and partial correlation coefficient.

Experimental Design: Analysis of variance, One way analysis of variance, two way analysis of variance, partitioning of total SS and degree of freedom in One way and two way analysis of variance. Multiple Comparisons tests. Analysis of Covariance.

**RECOMMENDED BOOKS:**

1. Chaudhary, SM and Kamal, S. (2009) “Introduction to Statistical Theory” Parts I & ii, 6th ed, Ilmi Kitab Khana, Lahore Pakistan.
2. Rauf, M (2001). Polymers Modern Statistics. Polymer Publication, Urdu Bazar, Lahore.
3. Walpole, R.E (2001). Introduction to Statistics. Macmillan Publishing Company.

**SEMESTER IV**

**Course Title Introduction to Estimation and Hypothesis Testing**

**Course Code: STA-404**

**Credit Hours: 4(4-0)**

**Aims and objectives:**

Imparting knowledge about the two major areas of statistical inference creating awareness about the role of estimation and hypothesis testing in social sciences.

**THEORY:**

Estimation: Point estimation and its properties. Point estimate for population mean difference between two population means, proportion and difference between tow population proportion, population variance. Interval estimation. Confidence interval and its interpretation. Confidence interval for population mean, difference between two population means, proportion and difference between two population proportions, population variance. One sided confidence interval. Determination of sample size for estimating population mean and proportion.

Hypothesis Testing: Basic definitions in hypothesis testing, types of error, power of test, construction and interpretation of OC curve. Hypothesis testing for single normal population mean, proportion and variance. Hypothesis testing for difference between two normal populations means, proportions and ratio of two populations variances.

Testing the hypothesis for quality of several normal population variances (test for homogeneity). Chi-Square independence test, Goodness of fit test.

**RECOMMENDED BOOKS:**

1. Chaudhary, SM and Kamal, S. (2009) “Introduction to Statistical Theory” Parts I & ii, 6th ed, Ilmi Kitab Khana, Lahore Pakistan.
2. Rauf, M (2001). Polymers Modern Statistics. Polymer Publication, Urdu Bazar, Lahore.
3. Spiegel, M.R. Schiller, J.L. and Sirinivasan, R.L. (2000) “Probability and Statistics”, 2nd ed. Schaums Outlines Series. McGraw Hill. NY.
4. Walpole, R.E (2001). Introduction to Statistics. Macmillan Publishing Company.

**SEMESTER V**

**Course Title Probability and probability Distributions-I**

**Course Code: STA-501**

**Credit Hours: 4(4-0)**

**Aims and objectives:**

To introduce the applications and properties of different probability distributions as well as to create a relationship among various distributions.

**THEORY:**

Probability set function. Kolomogrov’s axioms. Conditional probability. Total probability and Bayes theorem. Statistical independence. Random variable. Probability functions. Probability density function and distribution function. Mathematical expectations. Moment generation function, cumulant generating 0function and characteristics function. Factorial moment. Joint density function. Conditional and marginal function and expectation. Uniqueness theorem. Inversion theorem. Chebyshev’s inequality. Laws of large numbers. Central Limit Theorem. Discrete uniform, Bernoulli, hyper geometric, poison, negative Binomial, Multinomial. Distribution and their properties. Relationship among distributions. Continuous uniform, Normal, Negative exponential, gamma, beta, lognormal, weibull, Rayleigh, Pareto, double exponential and Cauchy Distribution. Applications of distributions and their properties. Relationship among distributions.

**RECOMMENDED BOOKS:**

1. Hogg, R.M. and Craig, A.T. (1995), Introduction to Mathematical Statistics. Prentice Hall, Engle wood Cliffs, New Jersey.
2. Mood, A.M. Graybill, F.A and Boss, D.C. (1997). Introduction to the theory of statistics MacGraw Hill, New York.

**SEMESTER V**

**Course Title Sampling Techniques-I**

**Course Code: STA-503**

**Credit Hours: 3(3-0)**

**Aims and objectives:**

To develop advanced understanding of the role of sampling. To study the steps and problems involved in planning and conduct of census and sample surveys.

**THEORY:**

Basic concepts, requirement of a good sample, sampling and Non-sampling errors, bias and its effects, steps and Problems involved in planning and conduct of census and sample surveys. Probability and Non-Probability sampling, probability sampling: simple random sampling, estimation of population mean, total, proportion, variance and standard error of estimates. Confidence limits. Sample size determination under different conditions. Supplementary information: stratification, construction of Strata, stratified random sampling. Different method of allocation of sample size. Sampling variance (of stratified mean and stratified proportion) under various allocation methods, gain in precession in stratified sampling as compare to simple random sampling. Applications of stratified sampling, stratified sampling for proportion/percentage, Non-Probability sampling techniques, quota sampling Judgment sampling, Snowball sampling etc. Applications and Limitations of Non-Probability sampling methods.

**RECOMMENDED BOOKS:**

1. Cochran, W.G. (1996). Sampling Techniques, John Wiley and Sons, New York.
2. Ferguson, T.S. (1996). A course in large sample theory, champan & Hall, London.
3. Kish, L. (1992). Survey sampling, John Wiley, New York.
4. Singh, R. and Singh N, (1996). Elements of Survey Sampling, Kulwar, Dodrecht.

**SEMESTER V**

**Course Title Statistical Methods**

**Course Code: STA-505**

**Credit Hours: 4(4-0)**

**Aims and objectives:**

To introduce the students with parametric and non-parametric methods. A brief study of different probability distributions, estimation and testing of hypothesis.

**THEORY:**

Applications of Binomial, negative Binomial, Geometric, Hyper geometric, Poisson. Normal, exponential, Chi-Square, t and F distributions. Statistical inference: Estimation of parameters and tests of Hypotheses, simple and composite Hypotheses. Type-I and Type-II Errors, Level of Significance and p-Values, Power of a test, Characteristic function and O.C. Curve. Inference about means, proportions, variances and associated power curves, determination of sample size. Testing homogeneity of variances, Bartlett test. Analysis of linear regression models, testing of Hypotheses about simple and Multiple Regression Coefficients, simple correlation, multiple and partial correlations up to three variables, concept of outliers, detection of outliers using different methods. Analysis of categorized data, coefficient of concordance partitioning of Chi-Square in a 2x2 table, fishers exact test, Log-Liner Models and their Applications. Introduction to vital statistics. Non-Parametric Methods: the sign test Wilcoxon signed rank test, Mann-Whitney U Test, Runs test, Tests of Goodness of Fit, Tests of Randommess, Kruskal-Wallis Test, Friedman Test.

**RECOMMENDED BOOKS:**

1. Dixon, W.J. and Massey, F.J. (1983). Introduction to Statistical Analysis McGraw Hill, New York
2. Montgomery Douglas, C. and Peck Elizabeth A (1992), Introduction to Linear Regression Analysis, John Wiley and Sons, Inc. New York.
3. Steel, R.G.D. Torrie, J.H. and Dickey, D.A. (1996), Principles and Procedures of Statistics, Latest Editions, McGraw Hill, New York.

**SEMESTER V**

**Course Title Population Studies**

**Course Code: STA-509**

**Credit Hours: 3(3-0)**

**Aims and objectives:**

To understand, develop and apply the major concepts related to population census. Strengthen students’ knowledge, understanding and applications of demographic terms and techniques.

**THEORY:**

Sources of Demographic Data: the Population Census Registration of Vital Events. Housing & Demographic Surveys. Components of Population Growth, Composition of Population and Vital Events. Testing the Accuracy of Demographic Data. Types and Sources of Errors. Testing the Accuracy of Demographic Data. Types and Sources of Errors. General Testing Procedures. Testing the Accuracy of Age and Sex Data. Basic Demographic Measures: Fertility and Mortality Measures. Mortality Rates. Total and General Fertility Rates. Life Tables: construction of Complete and Abridged Life Tables. Different Types of Life Tables. Graphs of Lx, qx And dx. Description and Uses of Life Table Columns. Stationary Population Models. Population Estimates and Projections, Inter-Censal Estimates, Population Projections Through Various Methods. Population Models:. Population Estimates and Projections, Inter-Censal Estimates, Population Projections through Various Methods.

Population Models: Theory of Demographic Transition. 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.

**RECOMMENDED BOOKS:**

1. Hind, A., (1998). Demographic Method, Arriold.
2. Pollard, A.H., Yousaf, F & Pollard, G.M. (1982), Demographic Techniques, Pergamon Press, Sydney.

**SEMESTER V**

**Course Title Operations Research**

**Course Code: STA-507**

**Credit Hours: 3(3-0)**

**Aims and objectives:**

To introduce the students with phases, merits and demerits of OR study. To enable them for the development and solution of different models

**THEORY:**

Introduction to Operation Research. Classification of OR Models, Phases of OR study and Limitations of OR. Introduction to linear programming. Formulation of LP model. Matrix Form, Canonical Form, Standard For, Linear programming solutions with graphical method and simplex method. Duality and Sensitivity analysis. Solution of transportation and Assignment models. Network analysis, PERT and CPM networks. Queuing Models. Inventory control models.

**RECOMMENDED BOOKS:**

1. Deniss, B. (2001). Operations Research Calculations Handbook. Chapman & Hall, London.
2. Michael, W.C. and Camille, C.P. (2000). Operations Research: A Practical Introduction. Chapman & Hall, London.
3. Render, B. (2012) “Quantitative analysis for management” Prentice Hall.
4. Taha, H.A. (1999). Operations Research. MacMillan. London.

**SEMESTER VI**

**Course Title Probability and Probability Distribution-II**

**Course Code: STA-502**

**Credit Hours: 4(4-0)**

**Aims and objectives:**

To make students understand the transformation of variables for continuous and discrete distributions. To introduce the order statistics and different inequalities.

**THEORY:**

Transformation of variables for continuous and discrete distributions. Derivation of Chi-square, t and F distributions using moment generation function and transformation approach. Properties of Chi-Square, t and F distributions. Distributions of Sample mean and variance. Joint, Marginal and Conditional Distributions. Distributions of sample mean and variance. Joint, Marginal and Conditional Distributions. Covariance’s and correlation coefficients, Multinomial distribution, Bivariate and multivariate Normal distribution.

Convergence in probability, Convergence in distribution, Modes of convergence, Weak and Strong Laws of Large numbers. Limit Theorem, Markov’s, Chebyshev’s and Cuachy-Schewartz Inequalities. Introduction to order statistics. Distribution of the *r*th and *s*th order statistics, distribution of range and quantiles, Moments of these order statistics and their properties.

**RECOMMENDED BOOKS:**

1. Evans, M., Hastings, N. and Peacock, B. (2000). Statistical Distributions. Willey Interscience.
2. Hogg, R.M. and Craig, A.T. (1995), Introduction to Mathematical Statistics Prentice Hall, Engle wood Cliffs, New Jersey.
3. Hirai, A.S. (1998), A course in Mathematical Statistics, Ilmi Kutab Khana, Lahore.
4. Mood, A.M, Graybill, F.A and Boss, D.C. (1997). Introduction to the Theory of Statistics, MacGraw Hill, New York.
5. Nitis, M. (2000). Probability and Statistical inference. Marcel Dekker, USA.
6. Rohatgi, V.K. and Saleh, E. (2008). An introduction to Probability & Statistics John Willey & Sons (Asia) Pte. Ltd.
7. Ross, S.M. (2002). Introduction to probability Models, Academic Press.

**SEMESTER VI**

**Course Title Sampling Techniques-II**

**Course Code: STA-504**

**Credit Hours: 3(3-0)**

**Aims and objectives:**

To introduce the students about the ratio, product and regression estimators and their applications.

**THEORY:**

Cluster Sampling, Mean and variance of Cluster Sampling, Applications of Cluster Sampling, Ratio Estimator in Simple and Stratified Random Sampling. Combined and Separate Ratio Estimators, Product Estimator in Simple and Stratified Random Sampling. Combined and Separate Product Estimators, Regression Estimator in Simple and Stratified Random Sampling, combined and Separate Regression Estimators, Bias and MSE of Ratio, Product and Regression Estimators, Applications of Ratio, Product and Regression Estimators, Systematic Sampling, Types of Systematic Sampling, Linear and Circular Systematic Sampling, Applications of Systematic Sampling.

**RECOMMENDED BOOKS:**

1. Cochran, W.G. (1996). Sampling Techniques, John Wiley and Sons, New York.
2. Ferguson, T.S. (1996). A course in large sample theory, champan & Hall, London.
3. Kish, L. (1992). Survey sampling, John Wiley, New York.
4. Singh, R. and Singh N, (1996). Elements of Survey Sampling, Kulwar, Dodrecht.
5. Sukhatme, P.V, Sukhatme, B., Sukhatme, S., and Asok, A. (1985). Sampling Theory of Survey with Application. Lowa State University Press.

**SEMESTER VI**

**Course Title Design and Analysis of Experiments-I**

**Course Code: STA-506**

**Credit Hours: 4(4-0)**

**Aims and objectives:**

To introduce the students with principles, assumptions and application of design of experiments. To enable them to make estimation of missing values.

**THEORY:**

Principles of Design of Experiments. Analysis of Variance and its Assumptions, Models: Fixed, Random and Mixed Effects Models. Analysis of Fixed Effects Models, Decomposition of Total Sum of Squares, Expected Values of Mean Squares, Model Adequacy Checking. Violation of the Assumptions and Transformations, Statement of Cochran’s Theorem, Multiple Comparison Tests: Fisher’s LSD Test, Duncan’s Multiple Range Test (DMRT), Tuky’s W-Honestly Significant Difference (HSD) Test, Scheffe’s Test. Contrasts, Orthogonal Contrast, Testing of Hypotheses Involving Contrasts (Single Degree of Freedom Comparison), Scheffe’s Method for comparing all contrasts, Confidence Intervals. Basic Experimental Designs (Completely Randomized, Randomized Complete Block, Latin Square), Gracco-Latin Square. Cross-Over Designs. Layouts and Analysis. Missing Observations. Relative Efficiency of Designs. Analysis of Covariance with One Concomitant Variable ForCR, RCB And LS Designs, Estimation of Missing Values by Analysis of Covariance.

**RECOMMENDED BOOKS:**

1. Montgomery D.C. (2000). Design and Analysis of Experiments, John Wiley, New York.
2. Steel, Rebert, G.D., Torrie James H., and Dickey David A. (1997). Principles and Procedures of Statistics: A Biometrical Approach: Third Edition. McGraw Hill, New York.

**SEMESTER VI**

**Course Title Statistical Quality Control and Reliability**

**Course Code: STA-508**

**Credit Hours: 3(3-0)**

**Aims and objectives:**

This Course is designed for students to acquire knowledge about the concept of quality control as well as the methods in quality improvement.

**THEORY:**

Concept of quality control; total control; 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 chart: Average Run Length (ARL); Fast Initial Response (FIR). ARL and FIR for X, R and S-charts. Seven Quality Control Tools (Histogram, Pareto Chart, Cause and Effect Chart, Scatter Diagram, Run Chart, Flow Chart, Control Chart). Process capability analysis: Designed experiments. Process Improvements using design of experiments. Acceptance sampling for attributes and variables. Kind of Variations, Data Quality Indicators (Precsion, Bias, Sensibility etc). Acceptance sampling plans: Single, Double, and multiple sampling plans with their O.C curves, Military Standard 105 Sampling plans. Introduction to ISO-9000 and ISO-14000 Series.

**RECOMMENDED BOOKS:**

1. Miltag H.J. and Rinne H. (1993), Statistical Methods of Quality Assurance. Chapman & Hall, London
2. Montgomery, D.C. (1998); Introduction to Statistical Quality Control MacGraw Hill, New York
3. Nelson, W. (1990); Accelerated Testing John Wiley, New York.

**SEMESTER VI**

**Course Title Non-Parametric Methods**

**Course Code: STA-510**

**Credit Hours: 3(3-0)**

**Aims and objectives:**

To enhance the knowledge of students about the non-parametric methods and their application.

**THEORY:**

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 test and rank transformation. Kolmogrov’s test, Lilliefer’s test and Shapiro-Wilks test for normality, Tests and estimation for two independent samples; the median test, Wilcoxon Mann-Whitney test, the Siegal-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.

**RECOMMENDED BOOKS:**

1. Conover, W.J. (1999). Practical Nonparametric Statistics, 3rd Edition, John, Wiley and Sons, New York.
2. Gibbons, L.D. and Chakraborti, S. (1992), Nonparametric Statistical Inference, Marcel Decker, New York.
3. Martiz, J.S. (1995). Distribution-Free Statistical Methods. Chapman & Hall London.

**SEMESTER VII**

**Course Title Econometrics-I**

**Course Code: STA-601**

**Credit Hours: 3(3-0)**

**Aims and objectives:**

Imparting knowledge on econometrics, Basic concepts about modeling and econometrics data types. To introduce the students with dummy variables.

**THEORY:**

Introduction to Econometrics, Introduction and Basic Concepts about Econometric modeling, Econometrics data types. Classical Linear Regression, its assumptions and estimation via Least Square method, Properties of Least Square Estimators, Inference in the Linear Regression Model; significance Tests of egression Coefficients and intercepts of the Simple Linear Regression Mode, Prediction in Linear Regression Model. General Linear Model, Assumptions of the Linear Model, Ordinary least squares Estimators, Properties of Least Squares Estimators, Partition of the total Sum of Square & Degrees of Freedom, Properties of the Residual, Prediction in General Linear Regression Model, Significance Tests and Confidence Intervals, Tests of Single and Set of Regression Coefficients. Least Square Estimators for Partition Matrix, Use of Extraneous information in General Linear Regression Model, Tests of Significance of Subset of Coefficients, Exact Linear Restrictions, And Extraneous Unbiased Restricted Estimator for Partition Matrix. Introduction to piecewise linear Regression models.

Consequences and detection of outliers, leverage and influential points. Different criterion for Model selection; Adjusted AIC, BIC, Mallow’s Cp etc. Stepwise forward and backward Regression for variables selection. Orthogonal Polynomials.

Regression Models with Dummy Variables, interpretation of coefficient related to dummy variables.

**RECOMMENDED BOOKS:**

1. Gujrati. D. (1998). Econometrics, John Wiley, New York.
2. Johnston, J. and Di. Nardo, J., (1997). Econometric Method, Latest Edition, McGraw Hill, New York.

**SEMESTER VII**

**Course Title Design and Analysis of Experiments-II**

**Course Code: STA-603**

**Credit Hours: 4(4-0)**

**Aims and objectives:**

To increase understanding about the design and analysis of experiments using factorial experiments. To introduce the students wit response surface methodology.

**THEORY:**

Factorial experiments:, Series and Mixed Level Factorial Experiments and Their Analysis. Advantages and Disadvantages of Factorial Experiments P x Q Factorial in Randomized Complete Design. Confounding in Factorial Experiments: Complete and Partial Confounding. Confounding in Factional Replications, Split-Plot, Split Block and Nasted Design. Missing Observations in Split-Plot Design. Incomplete Block Design: Balance Incomplete Block Design BIBD-Lattice Designs, Lattice Square and Youden Squares. Partially Balance Incomplete Block Design PBIBD with Recovery of Block information. Generalized Lattices, Introduction of Response Surface Methodology: First and 2nd Order Designs, Central Composite Designs, Fitting of Response Surface Models and Estimation of Optimum/Maximum Response.

**RECOMMENDED BOOKS:**

1. Montgomery D.C. (2000). Design and Analysis of Experiments, John Wiley, New York.
2. Steel, Rebert, G.D., Torrie James H., and Dickey David A. (1997). Principles and Procedures of Statistics: A Biometrical Approach: Third Edition. McGraw Hill, New York.

**SEMESTER VII**

**Course Title Multivariate Analysis-I**

**Course Code: STA-605**

**Credit Hours: 3(3-0)**

**Aims and objectives:**

This course aims to introduce the students about multivariate data and its analysis. It prepares students to develop transformations to make non-normal data to normal.

**THEORY:**

Introduction to Multivariate data and analysis, Basics of matrix and vector algebra, Geometry of vectors and sample, expectation of sample mean, covariance matrix linear combination of variables, generalized variance, Multivariate Normal Distributions: Multivariate Normal density and its properties, Maximum Likelihood Estimation, Sampling distribution of sample mean vector and covariance matrix including their large sample behavior. Assessing normality, transformation to make non-normal data to normal, outliers, Hotelling’s and likelihood ratio tests, inferences about mean vector(s), Confidence regions and simultaneous comparisons of component means, Multivariate Linear Regression.

**RECOMMENDED BOOKS:**

1. Anderson, T.W. (2003). An introduction to Multivariate Statistical Analysis, John Wiley, New York.
2. Flurry B. (1997) A First Course in Multivariate Statistics, Springer Valerg, New York.
3. Hair, J.F., Anderson R.E., Jatham, R.L. and Black W.C., (1998). Multivariate Data Analysis, 5th ed. Person Education, Re print 2005, Asia edition.
4. Johnson, R.A. and Wincher, D.W. (2004). Applied Multivariate Statistical Analysis. Prentice Hall. London
5. Manly, B.F.J. (1994). Multivariate Statistical Methods. A Printer 2nd Edition, Chapman and Hall, London.
6. Morrison. F. (1990). Multivariate Statistical Methods, McGraw Hill, New York.
7. Sharma, S. (1996), Applied Multivariate Techniques, John Wiley and Sons, New York.

**SEMESTER VII**

**Course Title Statistical Inference-I**

**Course Code: STA-607**

**Credit Hours: 3(3-0)**

**Aims and objectives:**

To increase understanding about properties of estimators, different methods of estimation and to introduce Bayesian estimation method.

**THEORY:**

Estimation of Parameters: Estimation, Parameters, Properties of Estimators, un-biasedness, consistency, sufficiency, efficiency, completeness. Cramer-Rao inequality, Methods of Estimation: Method of Moments, Method of Maximum Likelihood, Method of least-squares, minimum Chi-square estimation; Bayesian Estimation method.

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

**RECOMMENDED BOOKS:**

1. Hogg. R.V. and Craig, AT (1996). Introduction to Mathematical Statistics. Prentice Hall, New Jersey.
2. Mood, A.M. Graybill, F.A. and Boss D.C. (1997). Introduction to the Theory of Statistics. McGraw Hill, New York.

**SEMESTER VII**

**Course Title Statistical Software-I**

**Course Code: STA-609**

**Credit Hours: 3(0-3)**

**Aims and objectives:**

This course is designed to enable the students to handle and analysis the statistical data using different software. This course helps them most in their research work.

**THEORY:**

Statistical Data analysis using MS Excel: introduction to Excel software. Mathematical function in Excel and its applications. Matrixes algebra in Excel. Statistical functions in Excel and its applications. Introduction to data analysis and solver-in option. Monte-Carlo simulations. Graphical representation of data.

Statistical Data analysis using Minitab: creating, saving and opening a worksheet. Data coding and manipulation, Row and column statistics, Standardizing variables in a variety of ways, extracting date/time to numeric/text, Making patterned data and indication variable, Generating random numbers from different probability distributions, calculating probability density, cumulative probability and inverse cumulative probability of discrete and continuous distributions, Matrix Handling, arithmetic and other operations, to solve the practical problems in regression, multiple regression, correlation and partial correlation, Scatter plots and matrix plot in regression and multiple regression, residuals analysis. Analysis of variance. Design of experiments. Attribute and variable control charts. Tabulation & Chi-square test. Graphs and charts. Non-parametric test. Normality tests both graphically and statistically for unvariate and multivariate data sets.

Statistical Data Analysis using SPSS: Orientation of SPSS for social sciences. Data handling and manipulation in SPSS. Basic statistical data analysis using frequency distributions. Cross-tabulation. A questionnaire and what to do with it: types of data and relevant analysis, what types of analyses, what type of analyses can we perform on this questionnaire? Descriptive statistics. Graphical representation. Testing of Hypothesis in SPSS Software. Data reduction: Factor Analysis, Scree plot.

**RECOMMENDED BOOKS:**

1. Griffith, A. (2007). SPSS for dummies. Wiley publishing, Inc.
2. Leech, N. L., Barret, K.C. and Morgan, G.A. (2005). SPSS for intermediate statistics use and interpretation.
3. Meyer, R. and Krueger, D. (2001) A Minitab guide to Statistics, 2nd Edition Prentice Hall.
4. Stephen, L. (2007). Excel 2007 data analysis for dummies. Wiley publishing, Inc.

**SEMESTER VIII**

**Course Title Biostatistics**

**Course Code: STA-618**

**Credit Hours: 3(3-0)**

**Aims and objectives:**

To understand the importance of biostatistics in the field of health and medical sciences.

To give the awareness of variables and observations in biological research.

**THEORY:**

Definition of biostatistics, viz-a-viz the type of variables and observations in biological. Health and medical sciences, uniqueness in terms of behavior 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 odds. Distributional behavior of biological variables (Binomial, Poisson and Normal), Role of transformation for analysis of biological variables. Probit and Logit transformation and their analysis, p-Values, its importance and role. Confidence interval in simple and composite hypothesis testing.

**RECOMMENDED BOOKS:**

1. Daniel, W.W. (1996). “Biostatistics: A Foundation for the Health Sciences”. 6th Edition, John Willey New York.
2. Diggle, J.P. Liang, Kung-Yee and Zegar, S.L (1996). “Analysis of Longitudinal Data”, Clarendon Press, Oxford
3. Shoukri, M.M & Pause, C.A (1998). “Statistical Methods for Health Sciences”. F2nd Edition, CRC Press, Florida.
4. Zar, J. (2000). “Bio Statistical Analysis” 5th Edition John Willey & Sons.

**SEMESTER VIII**

**Course Title Econometrics-II**

**Course Code: STA-602**

**Credit Hours: 4(4-0)**

**Aims and objectives:**

To develop understanding about structure, causes, consequences and tests for detection of violation assumptions in regression study.

**THEORY:**

Assumptions of the Linear Regression Model, Violation of Assumption of Linear Regression model; Structure, Causes, Consequences and tests for detection of violation assumptions like Heteroscedasticity, Multicollinearity, Autocorrelation and Remedial Measures. Errors in Variables, Model specification diagnostic testing, specification tests. Measurement Error. Models with Binary Response Variables; Logit, Probit and other log Linear models. Ridge Regression. Lagged Variables and Distributed Lagged models.

Simultaneous Equation Models; nature and examples of simultaneous equation bias. Concept of endogenous and exogenous variables. Identification problem; under identification, over identification and exact identification, order and rank conditions for identification. Estimation Methods in exact or over identified equations: indirect least squares, instrumental variables two stage least squares. Concept of three stages least squares and restricted least squares.

**RECOMMENDED BOOKS:**

1. Gujrati. D. Latest Edition. Econometrics, John Wiley, New York.
2. Johnston, J. and Di. Nardo, J., Latest Edition. Econometric Method, Latest Edition, McGraw Hill, New York.

**SEMESTER VIII**

**Course Title Statistical Inference-II**

**Course Code: STA-604**

**Credit Hours: 4(4-0)**

**Aims and objectives:**

To introduce the students with sequential tests, non-central distributions and also their applications. To enable students to deriving tests of hypothesis concerning parameters in different distribution.

**THEORY:**

Tests of Hypothesis: Simple and composite hypotheses, critical regions, Type-I and Type-II errors, Power of a test, best Critical Regions, Neyman-Pearson Lemma, power functions, uniformly most powerful tests. Deriving tests of Hypotheses concerning parameters in normal, exponential, gamma and uniform distributions. Randomized Tests. Unbiased tests, Likelihood ratio tests and their asymptotic properties. Generalized likelihood-ratio tests. Sequential Analysis: Introduction to sequential tests, Average sample number and Operating characteristic functions. Non-central Distributions: The derivation of Chi-Square, t and F. Non-central distributions and their applications.

**RECOMMENDED BOOKS:**

1. Hogg. R.V. and Craig, AT (1996). Introduction to Mathematical Statistics. Prentice Hall, New Jersey.
2. Mood, A.M. Graybill, F.A. and Boss D.D. (1997). Introduction to the theory of Statistics. McGraw Hill, New York.

**SEMESTER VIII**

**Course Title Multivariate Analysis-II**

**Course Code: STA-606**

**Credit Hours: 3(3-0)**

**Aims and objectives:**

To understand, develop and application of the different techniques related to multivariate data.

**THEORY:**

Principal components analysis, Factor Analysis, Path Analysis, Structured Equation Modeling (SEM), Canonical Correlation analysis, Discrimination and Classification, Cluster Analysis. Pre-Requisite: Multivariate Analysis-I

**RECOMMENDED BOOKS:**

1. Anderson, T.W. (2003). An introduction to Multivariate Statistical Analysis, John Wiley, New York.
2. Flurry B. (1997) A First Course in Multivariate Statistics, Springer Valerg, New York.
3. Hair, J.F., Anderson R.E., Jatham, R.L.and Black W.C., (1998). Multivariate Data Analysis, 5th ed. Pearson Education, Re print 2005, Asia Edition.
4. Johnson, R.A. and Wincher, D.W. (2004). Applied Multivariate Statistical Analysis. Prentice Hall. London.
5. Manly, B.F.J. (1994). Multivariate Statistical Methods, A Primer 2nd Edition, Chapman and Hall, London.
6. Morrison. F. (1990). Multivariate Statistical Methods, McGraw Hill, New York.
7. Sharma, S. (1996), Applied Multivariate Techniques, John Wiley and Sons, New York.
8. Tabachnick, B.G and Fidell, L.S. (1996), Using Multivariate Statistics, 3rd ed. Harper Collins College, Publishers.

**SEMESTER VIII**

**Course Title Statistical Software-II**

**Course Code: STA-608**

**Credit Hours: 3(0-3)**

**Aims and objectives:**

To introduce the students with the advanced statistical software, which helps them in their research work.

**THEORY:**

Introduction to R as a language and environment for statistical computing and graphics. Manipulations of numbers, vectors and matrices. Methods of data input; importing data from different other statistical software’s Descriptive statistics using R. Regression Analysis using Matrix approach and using built-in R function, Statistical inference. Handling Regression OUTPUT in R. Logistic Regression. Two Stage Least Squares. Getting a Random Sample from Given data. Obtaining repeated samples. Finding P-values and tabulated values for different probability distributions. Random number generation for different probability distributions. Demonstration of Multivariate analysis using R with examples. Introduction to Programming in R and hands-on experimentation demonstrating the covered techniques and some other basic statistical that has been taught in other course like Econometrics, Statistics Inference and Quality Control. Introduction to SAS or MATHEMATICA. Data importation, graphing, and basic analysis.

(Making student just familiar with SAS or MATHEMATICA)

**RECOMMENDED BOOKS:**

1. Grawley, M.J. (2012). The R Book. 2nd Ed. Publisher: Wiley.
2. Cohen, Y. Cohen, J. Y. (2008). Statistics and Data with R: An Applied Approach through Examples. Publisher: Wiley.
3. Dalgaard, P. (2004). Introductory Statistics with R. Springer Series in Statistics and Computing
4. Maindonald, J., Braun, W.J. (2006). Data Analysis and Graphics Using R: an Example-Based Approach. 2nd Ed. Cambridge Series in Statistical and Probabilistic Mathematics.
5. Purohit, S. G., Gore, S. D. and Deshmukh, S.R. (2008). Statistics Using R. Narosa Publishing House, New Delhi, India.
6. The Official Manuals for R, SAS and Mathematica.

**SEMESTER VII**

**Course Title Seminar**

**Course Code: STA-629**

**Credit Hours: 1(0-1)**

**SEMESTER VIII**

**Course Title Analysis of Time Series and Forecasting**

**Course Code: STA-614**

**Credit Hours: 3(3-0)**

**Aims and objectives:**

To enable the students to understand the fitting rules of models, Principles and their effects related to time series data.

**THEORY:**

Introduction to time series analysis. Basics of stationary and non-stationary time series. Test for unit root problem and stationary. Stochastic Process, Auto-Correlation and auto-covariance, estimates functions and standard error of the auto-correlation functions and PACF, Period gram, Correlogram, spectral density functions, comparison with ACF, Linear stationary models, autoregressive, moving average and mixed models, Non-stationary models, Time series model building with Box-Jenkins methodology, estimation, and forecasting. Measures of forecasting, ARIMA Seasonal Models. Exponential Smoothing Techniques.

**RECOMMENDED BOOKS:**

1. Box, G.E.P. and Jenkins, G.M (1999). “Time Series Analysis: Forecasting and Control”, San Francisco.
2. Chatfield, C. (1996). “The Analysis of Time Series: An Introduction”, Chapman and Hall, London.

**SEMESTER VIII**

**Course Title Categorical Data Analysis**

**Course Code: STA-616**

**Credit Hours: 3(0-3)**

**Aims and objectives:**

This course is designed to provide a broad overview of the categorical data and its analysis by using different techniques.

**THEORY:**

A brief history of categorical data analysis, Principles of likelihood-based inference, Sampling distributions for contingency tables, Measures of association for 2x2 tables, Testing independence in contingency tables, Exact inference for two-way tables, inferences for three-way tables. Introduction to generalized linear models, Logistic regression, Model building, Alternative link functions for binary outcome, Diagnostics, Exact methods and conditional logistic regression, Methods for analyzing matched case-control Data, Multinomial response models for nominal data, Multinomial response models for ordinal data. Poisson regression model, Poisson regression for rates, Loglinear models for contingency tables, Negative binomial models, Quasi-Likelihood and Generalized Estimating Equations, Generalized Linear mixed models.

**RECOMMENDED BOOKS:**

1. Alan Agresti (2013) Categorical Data Analysis (2nd edition). John Wiley & Sons.
2. Alan Agresti (2007) An Introduction to Categorical Data Analysis (2nd Edition). John Wiley & Sons.
3. Alan Agresti (2010) Analysis of ordinal categorical data (2nd edition). John Wiley & Sons.
4. Bishop Y. M., Fienberg S.E., Holland P. W. (2007) Discrete Multivariate Analysis. Springer.
5. Collett D. (2003) Modeling Binary Data. Champman and Hall/CRC.
6. Fienberg S.E. (2007) The Analysis of Cross-Classified Categorical Data Springer.
7. Fleiss J.L., Levin, B., Paik M. C., (2004) Statistical Methods for Rates and Proportions. Wiley.
8. Powers D.A., and Yu Xie (2008) Statistical Methods for Categorical data Analysis (2nd Edition). Emerald Group Publishing.
9. Simonoff J.S. (2003) Analyzing Categorical Data. Springer.

**SEMESTER VIII**

**Course Title Bayesian Statistics**

**Course Code: STA-620**

**Credit Hours: 3(0-3)**

**Aims and objectives:**

To introduce the students with Bayesian statistics, different prior and posterior distributions as well as different loss functions.

**THEORY:**

What is Bayesian, Prior information, Prior distributions, Posterior distribution, and Different Loss functions: squared error loss function, absolute loss function, etc. Different prior distributions: informative prior, non-informative prior, Bayes estimators under loss functions, mean and variances of uni-variate and bivariate posterior distributions, predictive prior and posterior distribution, Bayesian hypothesis testing: Bayes factor, the highest density region; posterior probability of the hypothesis.

**RECOMMENDED BOOKS:**

1. Bernardo, J. M & Smith, A.F.M, Bayesian Theory, John Wiley, New York. (1994).
2. Lee, P. M. Bayesian Statistics, An Introduction, Oxford University Press New York (1991).
3. O. Hagan A. Kendall’s Advanced Theory of Statistics (Vol 2B), Bayesian Inference, Cambridge, The University Press (1994).

The Courses include minor for all disciplines at graduate level for BS (Hons) degree offered by the department of Statistics.

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| **Course No** | **Credit Hours** | **Title** |
| STA-320 | 3(3-0) | Introduction to Statistical Theory |
| STA-321 | 3(3-0) | Statistics-I |
| STA-322 | 3(3-0) | Statistics-II |
| STA-323 | 3(2-1) | Applied Statistical Theory |

The courses include minor for all disciplines at post graduate levels for M.Sc and M.Phil degrees offered by the department of Statistics.

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| **Course No** | **Credit Hours** | **Title** |
| STA-700 | 3(3-0) | Elements of Statistics and Biometry |
| STA-701 | 3(3-0) | Experimental Statistics |
| STA-702 | 3(3-0) | Statistical Methods for Business Management |
| STA-703 | 3(3-0) | Design and Analysis of Experiments for Research |
| STA-704 | 3(3-0) | Statistical Methods for Social Sciences |
| STA-705 | 3(3-0) | Statistical Methods |

**Annexure**

**(A)**

**Minor Course Outline for all BS (H) Programs**

**Course Title: Introduction to Statistical Theory**

**Credit Hours 3(3-0)**

**Course Code: STA-320**

Introduction and scope of statistics, Basic concepts of statistics, Different types of variables, types of data and methods of data collection, Scales of measurement, Data arrangement and presentation, formation of tables and charts, Measures of central tendency: mean, median and mode and quantiles from grouped and ungrouped data. Measures of dispersion: compilation of range, variance, standard deviation, and coefficients of variation, Skewness and Kurtosis, Definition of probability, Different terminology used in probability, Different laws of probability, Discrete distribution (Binomial distribution, passion distribution, Negative Binomial distribution, geometric distribution, hyper geometric distribution with their properties application), Correlation and Regression, Survey sampling, Types of Sampling (probability and non-probability sampling), Sampling Distribution of mean, Hypothesis testing: Z-test for single and difference between mean, student’s ‘t’ test for single and difference between mean. Chi-square test of independence and goodness of fit, Analysis of variance and LSD.

**Recommended Books**

1. Ronald Walpole, Myers, Myers, Ye, “Probability & Statistics for Engineers & Scientists”, 8th edition, 2008, Prentice Hall Publisher.
2. Sher M. Chaudhary, Shahid Kamal, “Introduction to Statistical Theory I and II”
3. Steel, R.G.D. and Torrie, J. H., 1980. Principals and procedures of statistics McGraw Hill International Editions.
4. Zar, 1998. Biostatistics Analysis

**Course Title: Introduction to Statistical Theory-I**

**Credit Hours: 3(3-0)**

**Course Code: STA-321**

Introduction and scope of statistics, Basic concepts of statistics, Different types of variables, types of data and methods of data collection, Scales of measurement, Data arrangement and presentation, formation of tables and charts, Measures of central tendency: mean, median and mode and quantiles from grouped and ungrouped data. Measures of dispersion: competition of range, variance, standard deviation, and coefficients of variation, Skewness and Kurtosis, Definition of probability, Different terminology used in probability, Different laws of probability, Discrete distribution (Binomial distribution, Poisson distribution, Negative Binomial distribution, geometric distribution, hyper geometric distribution with their properties and application), Continuous distribution (Normal distribution with their properties and application), Correlation and Regression.

**Recommended Books**

1. Ronald Walpole, Myers, Myers, Ye, “Probability & Statistics for Engineers & Scientists”, 8th edition, 2008, Prentice Hall Publisher.
2. Sher M. Chaudhary, Shahid Kamal, “Introduction to Statistical Theory I and II”
3. Steel, R.G.D. and Torrie, J. H., 1980. Principals and procedures of statistics McGraw Hill International Editions.
4. Zar, 1998. Biostatistics Analysis

**Course Title: Introduction to statistical Theory-II**

**Credit Hours: 3(3-0)**

**Course Code: STA-322**

Survey sampling, Types of sampling (probability and non-probability sampling), Sampling Distribution of mean, Hypothesis testing, Z-test for single and difference between mean, student’s ‘t’ test for single and difference between mean. Chi-square test of Independence and goodness of fit, Analysis of variance and LSD, Concept of experimental design, Basic principles of experimental designs, CRD, RCBD.

**Recommended Books**

1. Ronald Walpol, Myers, Myers, Ye, “Probability & Statistics for Engineers & Scientists”, 8th edition, 2008, Prentice Hall Publisher.
2. Sher M. Chaudhary, Shahid Kamal, “Introduction to Statistical Theory I and II”
3. Steel, R.G.D. and Torrie, J. H., 1980. Principals and procedures of statistics McGraw Hill International Editions.
4. Zar, 1998. Biostatistics Analysis

**Course Title: Applied Statistical Theory**

**Credit Hours: 3(2-1)**

**Course Code: STA-323**

Introduction and scope of statistics, Basic concepts of statistics, Different types of variables, types of data and methods of data collection, Scales of measurement, Data arrangement and presentation, formation of tables and charts, Measures of central tendency: mean, median and mode and quantiles from grouped and ungrouped data. Measures of dispersion: competition of range, variance, standard deviation, and coefficients of variation, Skewness and Kurtosis, Definition of probability, Different terminology used in probability, Different laws of probability, Discrete distribution (Binomial distribution, Poisson distribution, Negative Binomial distribution, geometric distribution, hyper geometric distribution with their properties and application), Continuous distribution (Normal distribution with their properties and application), Correlation and Regression, Survey sampling, Types of Sampling (probability and non-probability sampling), Sampling Distribution of mean, Hypothesis testing: Z-test for single and difference between mean, student’s ‘t’ test for single and difference between mean. Chi-Square test of independence and goodness of fit, Analysis of variance and LSD.

**Practical:**

1. Introduction of SPSS, How to enter the data in SPSS.
2. How to find the Histogram, Bar Char, Pie Diagram in SPSS.
3. How to find the Measures of Central Tendency in SPSS.
4. How to find the Measures of Dispersion in SPSS.
5. How to find the Correlation, Multiple Correlation and Regression Models in SPSS.

**Recommended Books**

1. Ronald Walpole, Myers, Myers, Ye, “Probability & Statistics for Engineers & Scientists”, 8th edition, 2008, Prentice Hall Publisher.
2. Sher M. Chaudhary, Shahid Kamal, “Introduction to Statistical Theory I and II”
3. Steel, R.G.D. and Torrie, J. H., 1980. Principals and procedures of statistics McGraw Hill International Editions.
4. Zar, 1998. Biostatistics Analysis

**Course Title Elements of Statistics and Biometry**

**Course Code: STA-700**

**Credit Hours: 3(3-0)**

Definition and scope of statistics in research, Measurement scales, Type of variables, continuous and discrete data. Grouping of data. Presentation of data, one dimensional diagrams and graphic presentation of frequency distribution, stem-leaf and box plots.Measures of central tendency and their graphic location. Measures of dispersion, Tchebychev law, sampling and sampling distribution of single population mean. Tests of significance for single population mean and proportion, difference between means and proportions and their confidence intervals. One and two way analysis of variance calculations only.

**RECOMMENDED BOOKS:**

1. Choudhary, M. 2000. Introduction to Statistical theory. Ilmi Kitab Khana Urdu Bazar, Lahore
2. Muhammad F. 2000. Statistical Methods and data analysis. Kitab Markaz, Bahwana Bazar, Faisalabad
3. Zar J. H. 2009. Biostatistical Analysis Prentice Hall 5th Edition Prentice Hall.

**Course Title Experimental Statistical**

**Course Code: STA-701**

**Credit Hours: 3(3-0)**

Functional relation among variables, regression analysis, simple and multiple linear regression analysis, curve fitting, correlation analysis; simple partial and multiple correlation, estimation & testing of hypotheses, test of independence and goodness of fit, analysis of variance, basic design, basic principles of experiment design, post hoc tests. Some designs of experiment with illustrations of problems from various agricultural disciplines, factorial, split plot, split block experiments, Hierarchical analysis with 2 & 3 factors.

**RECOMMENDED BOOKS:**

1. Mead R., R. N. Curnowa. M., Hasted and R.M Curnow, 2002. Statistical Methods in Agriculture and Experimental Biology, 3rd Edition. Chapman & Hall.
2. Muhammad F. 2000. Statistical Methods and data analysis. Kitab Markaz, Bahwana Bazar, Faisalabad
3. Snedecor G.W. and W.G Cochran, 1989 Statistical Methods, lowa State University Press Ames Lowa USA.
4. Steel R.G.D., J.H. Torrieand D.A Dickey. 1997. Principles and procedure of statistics: A Biometrical Approach. McGraw Hill. N.Y.

**Course Title Statistical Methods for Business Management**

**Course Code: STA-702**

**Credit Hours: 3(2-1)**

Introduction to business research, business research process, Errors in business research. Types of research and research Designs. Type of Variables and measurement scales, Measurement scale of attitude, Data collection instruments, Questionnaire designs. Concepts of validity and reliability. Concept of sampling and sampling designs, Estimation of mean, variance and proportion under different probability sampling designs. Estimation of mean, variance and proportion under different probability sampling designs estimation and interpretation of simple linear Regression inference in sample linear Regression Estimation and interpretation of Multiple linear Regression Standardized regression Coefficients, inference in Multiple Linear Regression, Chi-square test of independence, measures of associations, Linear Correlation, Inference in Simple Linear Correlation, Principal component analysis, Cluster Analysis.

Practical:

Introduction to Minitab, data manipulation in Minitab, Programming in Minitab, Construction in Minitab, Programming in Minitab, Construction of Macroes in Minitab. Introduction to SPSS, data manipulation in SPSS.

**RECOMMENDED BOOKS:**

1. Anderson, D.R. Sweeney. 2008. Statistics for Business and Economics. Cengage Learning.
2. Huizingh, E. 2007. Applied Statistics with SPSS Sage Publications LTD.
3. Nebebe, F,M. and L. Memeault, 1990. Statistics with Minitab. Pearson Custom Publishing, N.Y.

**Course Title Design and Analysis of Experiments for Researchers**

**Course Code: STA-703**

**Credit Hours: 3(3-0)**

Factorial experiments, main effects and interactions analysis of variance model, fixed, random and mixed models, treatment structure, contrasts, orthogonal contrasts and polynomials for quantitative treatment factors, single replicated trials, split plot design and its variants, hierarchical classification, combining experiments over locations, seasons and years, confounding in 2nd and 3rd factorial experiments and their analysis. Fractional factorials, cross over designs, response surface designs for optimal response.

**RECOMMENDED BOOKS:**

1. Gomez K.A. and Gomez A. A. 1984. Statistical Procedures for Agricultural research. Wiley Interscience Publications.
2. Kehul, R.O. 2000. Design of Experiments: Statistical principles of research design and analysis. Duxbury/ Thomson Learning.
3. Montgomery D.C. 2005. Design and analysis of experiments. John Wiley & Sons, N. York.
4. Richard, A.D. and W.H. Harvey. 1987. Experimental design, ANOVA and Regression. Harper and Row N.Y.

**Course Title Statistical Methods for Social Sciences**

**Course Code: STA-704**

**Credit Hours: 3(3-0)**

Sampling and sampling designs, selection of best sample design, procedure for planning and conduct of census and surveys, determination of sample size under diggerent conditions, Test of significance for population proportion, multifactor analysis of variance, multiple comparisons, non-parametric methods Sign test, Signed ran test, Mann-Whitney U test, Kruskal-Wallis test, Friendman test, Spearman’s and Kendall’s rank Correlation:, Non-Parametric multiple comparisons, Multi-way contingency tables, log linear models logistic Regression.

**RECOMMENDED BOOKS:**

1. Agresti, A. 2010. Analysis of Ordinal Categorical Data. John Wiley & Sons.
2. Agresti A. and B. Finlay. 2009. Statistical Methods for social sciences. Prentice Hall.

**Course Title Statistical Methods**

**Course Code: STA-705**

**Credit Hours: 3(3-0)**

Statistics and Scientific methods inference about the parameters of Binomial, Poisson and Normal distributions, Estimation of sample size, chi-Square procedure, chi-Square Goodness-of-fit test, non-parametric and distribution analysis, Test of significance of simple, multiple and partial correlation coefficients, inference regarding regression parameters, relative importance of regression, linear and non-linear regression prediction, adequacy of regression models.

**RECOMMENDED BOOKS:**

1. Draper, N. and H. Smith. 1981. Applied Regression Analysis John Wiley and Sons, Inc, N.Y.
2. Ott, R.L,. and L. Michael, 2008. An Introduction to Statistical Methods and Data Analysis. Duxlary Press Canada.
3. Sendecor, G, W. and W.G. Cochran, 1989. Blackwell.
4. Wiesberg, S.2005. Applied Linear Regression Wiley Series in Probability & Statistics.
5. Zar, J.H. 2009. Biostatistical Analysis 5th Edition. Prentice Hall.

**Course Title Mathematics-I**

**Course Code: MTH-321**

**Credit Hours: 3(0-3)**

**Aims and objectives:**

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.

**THEORY:**

Preliminarics: Real-number system, complex numbers. Introduction to sets. Set operations, functions, types of functions.

Matrices: Introduction to matrices, types, matrix inverse, determinates 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 Theorern: Introduction to mathematical induction binomal theorem with rational and irrational indices.

Trigonometry: Fundamentals of trigonometry, trigonometric identities.

**RECOMMENDED BOOKS:**

1. J. E. Kaufmann, College Algebra and Trigonometry, PWS-Kent Company. Boston.
2. M.P. Dolciani, W. Wooton, E. F. Beckenback, S. Sharron, Algebra 2 and Trigonometry, Houghton & Mifflin, Latest Edition.
3. W. E. Swokowski, Fundamentals of Algebra and Trigonometry PWS-Kent Company, Boston.

**Course Title Mathematics-II**

**Course Code: MTH-322**

**Credit Hours: 3(3-0)**

**Aims and objectives:**

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.

**THEORY:**

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 function, derivatives.

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

**RECOMMENDED BOOKS:**

1. B.G. Thomas. A.R. Finney. Calculus. Addison-Wesley, Reading, Ma, USA. Latest Edition.
2. H. B. Anton, I. Davis. Calculus: A New Horizon. John Wiley. Latest Edition.
3. J. Stewart, Calculus. Brooks/Cole. Latest Edition
4. W. Swokowski. Calculus and Analysis Geometry. PWS-Kent Company. Boston Latest Edition.

**Course Title Mathematics-III**

**Course Code: MTH-324**

**Credit Hours: 3(3-0)**

**Aims and objectives:**

To Prepare the students, not majority in mathematics, with the essential tools of geometry to apply the concepts and the techniques in their respective disciplines.

**THEORY:**

Geometry in Two Dimensions: Cartesian-coordinate 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:**

1. J. E. Kaufmann, College Algebra and Trigonometry, PWS-Kent Company. Boston Latest Edition.
2. S. Abraham, Analytic Geometry, Scott, Freshman and Company, Latest Edition
3. W. E. Swokowski, Fundamentals of Algebra and Trigonometry PWS-Kent Company, Boston. Latest Edition.