Year	Sem.	Course Code	Paper Title	Theory/Practical	Credits
I	I	B060101T	Descriptive Statistics (Univariate) and Theory of Probability	Theory	04
		B060102P	Descriptive Data Analysis Lab (Univariate)	Practical	02
	II	B060201T	Descriptive Statistics (Bivariate) and Probability Distributions	Theory	04
		B060202P	Descriptive Data Analysis Lab (Bivariate)	Practical	02
II	III	B060301T	Theory of Estimation and Sampling Survey	Theory	04
		B060302P	Sampling Survey Lab	Practical	02
	IV	B060401T	Testing of Hypothesis and Applied Statistics	Theory	04
		B060402P	Test of Significance and Applied Statistics Lab	Practical	02
III	V	B060501T	Multivariate Analysis and Non- parametric Methods	Theory	04
		B060502T	Analysis of Variance and Design of Experiment	Theory	04
		B060503P	Non-Parametric Methods and DOE Lab	Practical	02
	VI	B060601T	Statistical Computing and Introduction to Statistical Software	Theory	04
		B060602T	Operations Research	Theory	04
		B060603P	Operations Research and Statistical Computing Lab	Practical	02
IV	VII	B060701T	Stochastic Process	Theory	04
		B060702T	Linear Models and Design of experiments	Theory	04
		B060703T	Measure Theory	Theory	04
		B060704T	Sampling Theory	Theory	04
		B060705P	Lab based on theory papers 1,2,3,4	Practical	04
		B060706R	Research Project I	Project	04
	VIII	B060801T	Demography	Theory	04
		B060802T	Design and Analysis of experiments	Theory	04
		B060803T	Econometrics	Theory	04
		B060804T	Statistical Inference	Theory	04
		B060805P	Lab Based on theory papers 1,2,3,4	Practical	04
		B060806R	**Research Project II**	Project	04

Requirement: To study this subject a student must had the subject Mathematics in class 12th

Programme Outcomes (POs):

Students having Degree in B.Sc. (with Statistics) should have knowledge of different concepts and fundamentals of Statistics and ability to apply this knowledge in various fields of industry. They may pursue their future career in the field of Statistics and Research.

Programme Specific Outcomes (PSOs)

After completing B.Sc. (with Statistics) the student should have

- Knowledge of different concepts, principles, methodologies and tools (skills) of Statistics.
- Ability to collect, tabulate, represent graphically, analyze and interpret data/information by using appropriate statistical tools.
- Ability to identify and solve a wide range of problems in real life/industry related to Statistics.
- Familiarity with computational techniques and statistical software including programming language (e.g. R) for mathematical and statistical computation.
- Capability to use appropriate statistical skills in interdisciplinary areas such as finance, health, agriculture, government, business, industry, telecommunication and bio-statistics.
- Ability to compete with industrial/private sector demand in the field of data analysis, marketing, survey etc. In professional manner and pursue their future career in the field of Statistics.
- Ability to develop original thinking for formulating new problems and providing their solutions. As a result, they will be able to pursue higher studies or research in the field of Statistics.

Programme: B.Sc, Subject: Statistics

Semester	First	
Course Code	B060101T	
Course Title	Descriptive Statistics (Univariate) and Theory of Probability	
Credit	04	Maximum Marks : 25+50

Course Objective:
Students having Degree in B.Sc. (with Statistics) should have knowledge of different concepts and fundamentals of Statistics and ability to apply this knowledge in various fields of industry. They may pursue their future career in the field of Statistics and Research.

Course Outcomes: After successful completion of the syllabus, learners will be able to:

- ✓ . Knowledge of Statistics, its scope and importance in various fields.
- ✓ Ability to understand concepts of sample vs. population and difference between different types of data.
- ✓ Knowledge of methods for summarising data sets, including common graphical tools (such as box plots, histograms and stem plots). Interpret histograms and box plots.
- ✓ Ability to describe data with measures of central tendency and measures of dispersion.
- ✓ Ability to understand measures of skewness and kurtosis and their utility and significance.
- ✓ Ability to understand the concept of probability along with basic laws and axioms of probability.
- ✓ Ability to understand the terms mutually exclusive and independence and their relevance.
- ✓ Ability to identify the appropriate method (i.e. union, intersection, conditional, etc.) for solving a problem.
- ✓ Ability to apply basic probability principles to solve real life problems.
- ✓ Ability to understand the concept of random variable (discrete and continuous), concept of probability distribution.

Syllabus

Unit	Course Content
I	Introduction to Statistics, Meaning of Statistics, Importance of Statistics, Scope of Statistics in Industry, Introduction and contribution of Indian Scholars in Statistics. Concept of Statistical population, Attributes and Variables (Discrete and Continuous), Different types of scales – Nominal, Ordinal, Ratio and Interval, Primary data – designing a questionnaire and schedule, collection of primary data, checking their consistency, Secondary data. Presentation of data : Classification, Tabulation, Diagrammatic & Graphical Representation of Grouped data, Frequency distributions, Cumulative frequency distributions and their graphical representations, Histogram, Frequency polygon and Ogives. Stem and Leaf plot, Box Plot.
II	Measures of Central tendency and Dispersion and their properties, Merits and Demerits of these Measures. Moments and Factorial moments, Shephard's correction for moments, Measures of Skewness and Kurtosis and their significance, Measures based on quartiles.

III	Random experiment, Trial, Sample point and Sample space, Events, Operations of events, and Concept of equally likely, Mutually exclusive and Exhaustive events. Definition of Probability: Classical, Relative frequency and Axiomatic approaches. Discrete Probability Space, Properties of Probability under Set Theory Approach, Independence of Events, Conditional Probability, Total and Compound Probability theorems, Bayes theorem and its Applications.
IV	Random Variables – Discrete and Continuous, Probability Mass Function (pmf) and Probability density function (pdf), Cumulative distribution function (cdf). Joint distribution of two random variables, Marginal and Conditional distributions, Independence of random variables. Expectation of a random variable and its properties, Expectation of sum of random variables and product of independent random variables, Conditional expectation and related problems. Moments, Moment generating function (m.g.f.) & their properties, Continuity theorem for m.g.f. (without proof). Chebyshev's inequality, Weak law of large numbers for a sequence of independently and identically distributed random variables and their applications. (Statement Only)

References: Goon, A.M., Gupta, M.K. and Dasgupta, B. (2013). Fundamental of Statistics, Vol I, World Press, Kolkata.

Goon, A.M., Gupta, M.K. and Dasgupta, B. (2011). Fundamental of Statistics, Vol II, World Press, Kolkata.

Gupta, S.C. and Kapoor, V.K. (2000). Fundamentals of Mathematical Statistics (10th ed.), Sultan Chand and Sons.

Hanagal, D. D. (2009). Introduction to Applied Statistics: A Non-Calculus Based Approach. Narosa Publishing Comp. New Delhi.

Miller, I. and Miller, M. (2006). John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.

Mood, A.M. Graybill, F.A. and Boes, D.C. (2011). Introduction to the Theory of Statistics, 3rd Edn., Tata McGraw-Hill Pub. Co. Ltd. Weatherburn.

S.C. and Kapoor, V.K. (2000). Fundamentals of Mathematical Statistics (10th ed.), Sultan Chand and Sons.

Johnson, S. and Kotz, S. (1972). Distribution in Statistics Vol. I-II & III, Houghton and Mifflin.

Lipschutz, S., Lipson, M. L. and Jain, K. (2010). Schaum's Outline of Probability. 2nd Edition. McGraw Hill Education Pvt. Ltd, New Delhi.

Meyer, P. (2017). Introductory Probability and Statistical Applications (2nd ed.), New Delhi, Oxford & IBH Publishing Co. Pvt. Ltd.

Rohatgi, V.K. and Saleh, A.E. (2008). An introduction to Probability Theory and Mathematical Statistics, Wiley Eastern. **Suggested Online Links**/Readings:
http://heecontent.upsdc.gov.in/SearchContent.aspx,
https://swayam.gov.in/explorer?searchText=statistics, https://nptel.ac.in/course.html
https://www.edx.org/search?q=statistics, https://www.coursera.org/search?query=statistics&

Programme/Class: **Certificate**	Year: **First**	Semester: **First**
Subject: **STATISTICS**		
Course Code:-**B060102P**	Course Title: **Descriptive Data Analysis Lab (Univariate)**	

Course outcomes:

After completing this course a student will have:

- ✓ Ability to represent/summaries the data/information using appropriate Graphical methods including common graphical tools (such as boxplots, histograms and stemplots) and also to draw inferences from these graphs
- ✓ Acquire the knowledge to identify the situation to apply appropriate measure of central tendency as per the nature and need of the data and draw meaningful conclusions regarding behavior of the data.
- ✓ Acquire the knowledge to identify the situation to apply appropriate measure of dispersion as per the nature and need of the data and draw meaningful conclusions regarding heterogeneity of the data.
- ✓ Ability to measure skewness and kurtosis of data and define their significance.
- ✓ Acquire the knowledge to compute conditional probabilities based on Bayes Theorem.

Credits:**02**	Core: **Compulsory**
Max.Marks:**25**	Min. Passing Marks:.....

Total No. of Lectures-Tutorials-Practical (in hours per week):**0-0-4.**

	List of Practicals	No. of Lectures
	1. Problems based on graphical representation of data by Histogram, Frequency polygons, frequency curves and Ogives, Stem and Leaf Plot, Box Plot. 2. Problems based on calculation of Measures of Central Tendency. 3. Problems based on calculation of Measures of Dispersion. 4. Problems based on calculation of Moments, Measures of Skewness and Kurtosis. 5. Computation of conditional probabilities based on Bayes theorem	**60**

Semester	Second	
Course Code	B060201T	
Course Title	Descriptive Statistics (Bivariate) and Probabiity Distributions	
Credit	B060201T	Maximum Marks : 25+75

Course Objective:

Students having Degree in B.Sc. (with Statistics) should have knowledge of different concepts and fundamentals of Statistics and ability to apply this knowledge in various fields of industry. They may pursue their future career in the field of Statistics and Research.

Course Outcomes:

After completing this course a student will have:

- ✓ Knowledge of the method of least squares for curve fitting to theoretically describe experimental data with a function or equation and to find the parameters associated with the model.
- ✓ Knowledge of the concepts of correlation and simple linear regression and Perform correlation and regression analysis.
- ✓ Ability to interpret results from correlation and regression.
- ✓ Ability to compute and interpret rank correlation..
- ✓ Ability to understand concept of qualitative data and its analysis.
- ✓ Knowledge of discrete distributions. Discuss appropriate distribution negative binomial, Poisson, etc. with their properties and application of discrete distribution models to solve problems.
- ✓ Knowledge of continuous distributions. Discuss the appropriate distribution (i.e. uniform, exponential, normal, etc.) with their properties and application of continuous distribution models to solve problems.
- ✓ Knowledge of the formal definition of order statistics, derive the distribution function and probability density function of the r^{th} order statistic and joint distribution of $r^{th}$and s^{th}order statistics.

Ability to identify the application of theory of order statistics in real life problems.

Syllabus

Unit	Course Content
I	Bivariate data, Principles of least squares, Most plausible values, Meaning of curve fitting, Fitting of straight line, parabola, logarithmic, power curves and other simple forms by method of least squares. Bi-Variate frequency table, Correlation, Types of relationships, Scatter diagram, Karl-Pearson's Correlation Coefficient and its properties.
II	Rank correlation and its coefficient (Spearman and Kendall Measures) Regression analysis through both types of regression equations for X and Y variables. Attributes: Notion and Terminology, Contingency table, Class frequencies and Ultimate class frequencies, Consistency, Association of Attributes, Independence, Measures of association for 2X2 table, Chi-square, Karl Pearson's Coefficient of Association.

III	Discrete Probability Distributions: Binomial distribution, Poisson distribution (as limiting case of Binomial distribution), Hypergeometric, Geometric and Negative Binomial, Uniform and Multinomial distributions, fitting of Binomial, Poisson and Uniform distributions. Continuous Probability Distributions: Exponential, Gamma, Beta distributions (Introduction only without proof). Cauchy, Weibull, Log normal distributions (Introduction only without proof).
IV	Normal distribution and its properties, Standard Normal variate, Normal distribution as limiting case of Binomial distribution, fitting of Normal distribution. Order Statistics, Distributions of minimum, r^{th} and maximum order statistic, Joint distribution of r^{th} and s^{th} order statistics (in continuous case).

References: Goon, A.M., Gupta, M.K. and Dasgupta, B. (2013). Fundamental of Statistics, Vol I, World Press, Kolkata.

Goon, A.M., Gupta, M.K. and Dasgupta, B. (2011). Fundamental of Statistics, Vol II, World Press, Kolkata.

Gupta, S.C. and Kapoor, V.K. (2000). Fundamentals of Mathematical Statistics (10th ed.), Sultan Chand and Sons.

Hanagal, D. D. (2009). Introduction to Applied Statistics: A Non-Calculus Based Approach. Narosa Publishing Comp. New Delhi.

Miller, I. and Miller, M. (2006). John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.

Mood, A.M. Graybill, F.A. and Boes, D.C. (2011). Introduction to the Theory of Statistics, 3rd Edn., Tata McGraw-Hill Pub. Co. Ltd. Weatherburn.

Johnson, S. and Kotz, S. (1972). Distribution in Statistics Vol. I-II & III, Houghton and Mifflin.

Lipschutz, S., Lipson, M. L. and Jain, K. (2010). Schaum's Outline of Probability. 2nd Edition. McGraw Hill Education Pvt. Ltd, New Delhi.

Meyer, P. (2017). Introductory Probability and Statistical Applications (2nd ed.), New Delhi, Oxford & IBH Publishing Co. Pvt. Ltd.

Rohatgi, V.K. and Saleh, A.E. (2008). An introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.

Programme/Class: **Certificate**	Year: **First**	Semester: **Second**
Subject: **STATISTICS**		
Course Code:-**B060202P**	Course Title: **Descriptive Data Analysis Lab (Bivariate)**	

Course Outcomes:

After completing this course a student will have:

- ✓ Ability to deal with the problems based on fitting of curves by Method of least squares e.g. fitting of straight line, second degree polynomial, power curve, exponential curve etc.
- ✓ Ability to deal with problems based on determination of Regression lines and calculation of Correlation coefficient – grouped and ungrouped data.
- ✓ Ability to deal with the problems based on determination of Rank correlation.
- ✓ Ability to fit binomial and poisson distribution for given data..

Credits:**02**	Core: **Compulsory**
Max.Marks:**25**	Min. Passing Marks:.....

Total No. of Lectures-Tutorials-Practical (in hours per week):**0-0-4.**

	Topic	No. of Lectures
	1. Problems based on fitting of curves by Method of least squares e.g. fitting of straight line, second degree polynomial, power curve, exponential curve etc. 2. Problems based on determination of Regression lines and calculation of Correlation coefficient – grouped and ungrouped data. 3. Problems based on determination of Rank correlation. 4. Fitting of binomial and poisson distribution.	**60**

Suggested Readings:

As suggested for paper code B060201T.

Semester	Third	
Course Code	B060301T	
Course Title	Theory of Estimation and Sampling Survey	
Credit	04	Maximum Marks : 25+50

Course Outcomes: After completing this course a student will have:

- ✓ Knowledge of the concept of Sampling distributions.
- ✓ Ability to understand the difference between parameter & statistic and standard error & standard deviation.
- ✓ Knowledge of the sampling distribution of the sum and mean.
- ✓ Ability to understand the t, f and chi-square distribution and to identify the main characteristics of these distributions.
- ✓ Knowledge of the concept of Point and Interval Estimation and discuss characteristics of a good estimator.
- ✓ Ability to understand and practice various methods of estimations of parameters.
- ✓ Ability to understand the concept of sampling and how it is different from complete enumeration.
- ✓ Knowledge of various probability and non-probability sampling methods along with estimates of population parameters
- ✓ Ability to identify the situations where the various sampling techniques shall be used.
- ✓ Knowledge of sampling and non-sampling errors.

Knowledge of regression and ratio methods of estimation in simple random sampling (SRS).

Syllabus

Unit	Course Content
I	Sampling Distributions: The concept of sampling distribution, Parameter, Statistic and Standard error. The sampling distribution for the sum of independent random variables of Binomial, Poisson and Normal distribution. Central limit theorem, sampling distribution of Z. Sampling distribution of t, f, and chi-square without derivations, Simple properties of these distributions and their interrelationship.
II	Point estimation: Characteristics of a good estimator: Unbiasedness, consistency, sufficiency and efficiency. Problems and examples, Interval estimation. Sampling distribution of t, f, and chi-square without derivations, Simple properties of these distributions and their inter relationship. Method of Maximum Likelihood and properties of maximum likelihood estimators (without proof), Method of minimum Chi-square. Method of least squares and methods of moments for estimation of parameters.
III	Sampling vs. Complete enumeration: Sampling units and Sampling frame, Precision and efficiency of estimators, Simple Random sampling with and without replacement, Use of random number tables in selection of simple random sample, Estimation of population mean and proportion, Derivation of expression for variance of these estimators, Estimation of variances, Sample size determination. Stratified random sampling, Problem of allocation, proportional allocation, optimum allocation. Derivation of the expressions for the standard error of the usual estimators when these allocations are used, Gain in precision due to Stratification, Role of sampling cost in the sample allocation, Minimization of variance for fixed cost

IV	Systematic Sampling: Estimation of Population mean and Population total, standard errors of these estimators, Regression and ratio methods of estimation in simple random sampling, Cluster sampling with equal clusters, Estimators of population mean and their mean square errors.

References:

Goon, A.M., Gupta, M.K. and Dasgupta, B. (2013). Fundamental of Statistics, Vol I, World Press, Kolkata.

Goon, A.M., Gupta, M.K. and Dasgupta, B. (2011). Fundamental of Statistics, Vol II, World Press, Kolkata.

Gupta, S.C. and Kapoor, V.K. (2000). Fundamentals of Mathematical Statistics (10th ed.), Sultan Chand and Sons.

Gupta, S.C. and Kapoor, V.K. (2000). Fundamentals of Applied Statistics (10th ed.), Sultan Chand and Sons.

Mukhopadyay,P.(2007).Survey Sampling. Narosa Publisher, NewDelhi.

Murthy, M. N. (1977). Sampling Theory and Statistical Methods. Statistical Pub. Society, Kolkata.

Singh, D. and Choudhary, F.S.(1977). Theory and Analysis of Sample Survey Designs. Wiley Eastern Ltd, New Delhi. (Reprint 1986)

Sukhatme, P.V. and Sukhatme, B.V. (1970). Sampling Theory Surveys with Applications (Second Edition). Iowa State University Press.

Sukhatme, P.V.,Sukhatme,B.V.,Sukhatme,S.&Asok,C.(1984):SamplingTheoriesof Survey with Applications, IOWA State University Press and ISAS.

Thompson, S.K.(2012). Sampling. John Wiley & Sons.

Programme/Class: **Diploma**	Year: **Second**	Semester: **Third**
Subject: **STATISTICS**		
Course Code:-**B060302P**	Course Title: **Sampling Techniques Lab**	

Course Outcomes:

After completing this course a student will have:

- ✓ Ability to draw a simple random sample with the help of table of random numbers.
- ✓ Ability to estimate population means and variance in simple random sampling.
- ✓ Ability to deal with problems based on Stratified random sampling for population means (proportional and optimum allocation).
- ✓ Ability to deal with problems based on Systematic random sampling
- ✓ Ability to deal with problems based on two stage sampling
- ✓ Ability to deal with problems based on Ratio and regression estimation of population mean and total.

Credits:**02**	Core: **Compulsory**
Max.Marks:**25**	Min. Passing Marks:.....
Total No. of Lectures-Tutorials-Practical(in hours per week):**0-0-4.**	

	Topic	No .of Lectures
	1. Problems based on drawing a simple random sample with the help of table of random numbers. 2. Problems based on estimation of population means and variance in simple random sampling. 3. Problems based on Stratified random sampling for population means (proportional and optimum allocation). 4. Problems based on Systematic random sampling 5. Problems based on two stage sampling 6. Problems based on Ratio and regression estimation of population mean.	**60**

Semester	Fourth	
Course Code	B060401T	
Course Title	Testing of Hypothesis and Applied Statistics	
Credit	04	Maximum Marks : 25+75

Course Objective:
Students having Degree in B.Sc. (with Statistics) should have knowledge of different concepts and fundamentals of Statistics and ability to apply this knowledge in various fields of industry. They may pursue their future career in the field of Statistics and Research.

Syllabus

Unit	Course Content
I	Statistical Hypothesis (Simple and Composite), Testing of hypothesis. Type –I and Type – II errors, Significance level, p-values Power of a test, Definitions of Most Powerful (MP), Uniformly Most Powerful (UMP) and Uniformly Most Powerful Unbiased (UMPU) tests.
II	Test of significance: Large sample tests for (Attributes and Variables) proportions and means (i) for one sample (ii) for two samples. Correlation coefficient in case of $\rho=\rho_0$. Small sample test based on t, f and chi-square.
III	Introduction & Definition of Time Series, its different components, illustrations, additive and multiplicative models. Determination of trend by free hand curve, semi average method, moving average method, method of least squares, Analysis of Seasonal Component by Simple average method, Ratio to moving Average Ratio to Trend, Link relative method. Index number – its definition, application of index number, price relative and quantity or volume relatives, link and chain relative, problem involved in computation of index number, use of averages, simple aggregative and weighted average method. Laspeyre's, Paasche's and Fisher's index number, time and factor reversal tests of index numbers, consumer price index.
IV	Measurement of Fertility– Crude birth rate, general fertility rate, age-specific birth rate, total fertility rate, gross reproduction rate, net reproduction rate, standardized death rates Complete life table, its main features and construction. Introduction to Statistical Quality Control, Process control, tools of statistical quality control, 3 sigma control limits, Principle underlying the construction of control charts. Control charts for variables, 'X' and 'R' charts, construction and interpretation, Control charts for attributes 'p' and 'c' charts, construction and interpretation

References:

Ferund J.E (2001): Mathematical Statistics, Prentice Hall of India.

Goon, A.M.,Gupta,M.K.&Dasgupta,B.(2002).Fundamentals of Statistics,Vol.I., Kolkata, The World Press.

Hogg, R.V., McKean, J. W .& Craig, A.T.(2009).Introduction to Mathematical Statistics (6^{th} ed.), Pearson.

Gupta, S.C. and Kapoor, V.K. (2008). Fundamentals of Applied Statistics (4^{th}ed.), Sultan Chand and Sons.

Montgomery D.C.(2009):Introduction to Statistical Quality Control (6^{th}ed.), Wiley India Pvt. Ltd.

Mukhopadhyay, P(2011):AppliedStatistics,2ndeditionrevisedreprint,Booksand Allied (P) Ltd.

Programme/Class: **Diploma**	Year: **Second**	Semester: **Fourth**
Subject: **STATISTICS**		
Course Code:-**B060402P**	Course Title: **Tests of Significance and Applied Statistics Lab**	

Course Outcomes:

After completing this course a student will have:

- ✓ Ability to conduct test of significance based on t–test and Chi-square test.
- ✓ Knowledge about Fisher's Z-transformation and its use in testing
- ✓ Ability to deal with problems based on large sample tests.
- ✓ Ability to deal with problems based on time series and calculation of its different components for forecasting.
- ✓ Ability to deal with problems based on Index number.
- ✓ Acquire knowledge about measurement of mortality and fertility.
- ✓ Ability to deal with problems based on life table.
- ✓ Ability to work with control charts for variables and attributes and draw inferences.

Credits:**02**	Core: **Compulsory**
Max.Marks:**25**	Min. Passing Marks:.....

Total No. of Lectures-Tutorials-Practical(in hours per week):**0-0-4.**

	Topic	No. of Lectures
	1. Problems based on t –test. 2. Problems based on F-test. 3. Problems based on Chi-square test. 4. Problems based on Fisher's Z-transformation and its use in testing 5. Problems based on calculation of power curve. 6. Problems based on large sample tests. 7. Problems based on time series and its different components 8. Problems based on Index number. 9. Problems based on measurement of mortality and fertility. 10. Problems based on logistic curve fitting. 11. Problems based on life table. 12. Problems based on control charts for variables and attributes.	**60**

Programme/Class: **B.Sc.**	Year: **Third**	Semester: **Fifth**
Subject: **STATISTICS**		
Course Code:-**B060501T**	Course Title: **Multivariate Analysis and Non-parametric Methods**	

Course Outcomes:

After completing this course a student will have:

- ✓ Ability to understand the basic concepts of vector space and matrices in order to study multivariate distribution.
- ✓ Knowledge of the applications of multivariate normal distribution and Maximum Likelihood estimates of mean vector and dispersion matrix.
- ✓ Knowledge of Principal Component Analysis and Factor Analysis.
- ✓ Ability to apply distribution free tests (Non-parametric methods) for one and two sample cases.

Credits:**04**	Core: **Compulsory**
Max.Marks:**25+50**	Min. Passing Marks:.....

Total No. of Lectures-Tutorials-Practical(in hours per week):**4-0-0.**

Unit	Topic
I	Introduction to Vector Space, Subspace, Linear Combination, Linear Independence, Inner Product, Row and Column Rank, Rank of Matrix, Elementary operations on Matrices, Inverse of a matrix.
II	Multivariate Normal Distribution, Marginal and Conditional Distributions, Moment Generating and Characteristics functions, Maximum Likelihood Estimation of Mean vector and Dispersion matrix, Independence and point sufficiency of these estimates.
III	Applications of Multivariate Analysis: Principal Components Analysis and Factor Analysis (Application Oriented discussion, derivations not required), Multiple and Partial correlations and Multiple Regressions.
IV	Non-parametric tests, Tests for randomness and test for goodness of fit. One sample tests: Sign test, Wilcoxon Signed rank tests. Two sample tests: Run test, Median test and Mann-Whitney U test.

References: Anderson, T.W. (2003): An Introduction to Multivariate Statistical Analysis, 3rd Edn., John Wiley

Muirhead, R. J.(1982): Aspects of Multivariate Statistical Theory, John Wiley.

A.M. (1972): Multivariate Analysis, 1st Edn. Marcel Dekker.

Johnson, R.A. And Wichern, D.W. (2007): Applied Multivariate Analysis, 6th Edn., Pearson & Prentice Hall

Goon, A.M., Gupta, M.K. and Dasgupta, B. (2002): Fundamentals of Statistics, Vol. I, 8th Edn. The World Press, Kolkata.

Gibbons, J. D. and Chakraborty, S (2003): Nonparametric Statistical Inference. 4th Edition. Marcel Dekker, CRC.

Rohatgi,V.K. and Saleh, A.K. Md. E.(2009):An Introduction to Probability and Statistics. 2nd Edn. (Reprint) John Wiley and Sons.

Programme/Class: **B.Sc.**	Year: **Third**	Semester: **Fifth**
Subject: **STATISTICS**		
Course Code:-**B060502T**	Course Title: **Analysis of Variance and Design of Experiment**	

Course outcomes:

After completing this course a student will have:

- ✓ Knowledge of the concept of Analysis of Variance (ANOVA).
- ✓ Ability to carry out the ANOVA for One way and Two-way Classification.
- ✓ Ability to carryout the post-hoc analysis.
- ✓ Knowledge of the concept of Design of experiment and its basic principles.
- ✓ Ability to perform the basic symmetric designs CRD, RBD and LSD with and without missing observations.
- ✓ Knowledgeoftheconceptoffactorialexperimentsandtheirpracticalapplications.

Credits:**04**	Core: **Compulsory**
Max.Marks:**25+50**	Min. Passing Marks:.....

Total No. of Lectures-Tutorials-Practical (in hours per week):**4-0-0.**

Unit	Topic
I	Definition of Analysis of Variance, Assumptions and Limitations of ANOVA, One way classification. Two way classification with equal number of observations per cell.
II	Principles of Design of Experiment: Randomization, Replication and Local Control, Choice of size and type of a plot using uniformity trials. Completely Randomised Design (CRD), Randomized Block Design (RBD), Concept and definition of efficiency of design, Comparison of efficiency between CRD and RBD.
III	Latin Square Design (LSD), Lay-out, ANOVA table, Missing plot technique: Estimation of missing plots by minimizing error sum of squares in RBD and LSD with one missing observations.
IV	Factorial Experiments: General description of factorial experiments, 2^2, 2^3 and 2^n factorial experiments arranged in RBD and LSD, Definition of Main effects and Interactions in 2^2 and 2^3 factorial experiments, Preparation of ANOVA by Yates procedure, Estimates and tests for main and interaction effects (Analysis without confounding).

References:

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

Das, M.N. and Giri, N.S. (1986).Design and Analysis of Experiments (2^{nd}Edition).Wiley.

Dean, A. and Voss, D. (1999). Design and Analysis of Experiments. Springer-Verlag, New York.

Montgomery, D.C. (2017). Design and analysis of Experiments, 9^{Th}Edition. John Wiley &Sons.

Programme/Class: **B.Sc.**	Year: **Third**	Semester: **Fifth**
Subject: **STATISTICS**		
Course Code:-**B060503P**	Course Title: **Non-parametric Methods and DOE Lab**	

Course outcomes:

After completing this course a student will have:

1. Ability to conduct test of significance based non-parametric tests.
2. Ability to deal with multivariate data.
3. Knowledge of Principal Component Analysis and Factor Analysis. Ability to perform ANOVA for one way and two classification.
4. Ability to conduct analysis of CRD, RBD and LSD with and without missing observations.
5. Ability to conduct analysis for Factorial experiments (without confounding).

Credits:**02**	Core: **Compulsory**
Max.Marks:**50**	Min. Passing Marks:.....

Total No. of Lectures-Tutorials-Practical(in hours per week):**0-0-4**.

	Topic	No. of Lectures
	1. Problems based on Non-parametric tests for one sample. 2. Problems based on Non-parametric tests for two samples. 3. Problems based on Rank and Inverse of a matrix. 4. Problems based on Mean vector and Dispersion matrix of a multivariate normal distribution. 5. Problems based on Principal Component Analysis 6. Problems based on Factor Analysis. 7. Problems based on Analysis of variance in one-way and two-way classification (with and without interaction terms). 8. Problems based on Analysis of a Latin square design. 9. Problems based on Analysis of variance in RBD and LSD with one or two missing observations. 10. Problems based on Factorial Experiment Practical.	**60**

Programme/Class: **B.Sc.**	Year: **Third**	Semester: **Sixth**
Subject: **STATISTICS**		
Course Code:-**B060601T**	Course Title: **Statistical Computing and Introduction to Statistical Software**	

Course Outcomes:

After completing this course a student will have:

- ✓ Basic Knowledge of SPSS and R programming with some basic notations for developing their own simple programs and visualizing graphics in R.
- ✓ Ability to perform data analysis for both univariate and multivariate data sets using R as well as SPSS

Credits:**04**	Core: **Compulsory**
Max.Marks:**25+50**	Min. Passing Marks:.....

Total No. of Lectures-Tutorials-Practical (in hours per week):**4-0-0.**

Unit	Topic
I	Introduction to Computer: Generation of Computer, Basic Structure of Computer, Digital computer and its peripherals, number systems (Binary, Octal, Hexadecimal Systems). Flow chart for simple statistical problems. Introduction to R Programming and R Studio, Installing R, R as a calculator. Creating a data set, Understanding a data set, Data structure: Vectors, Matrices, Arrays, Data Frames, Factors and Lists
II	Data inputs: Entering data from the keyboard, Importing Data from Excel, SPSS. SAS, STATA, creating new variables, recoding variable, renaming variables, Graphs using R, Inferential Statistics- Parametric test: Test for Normality, t-test for single mean, t-test for difference between means, paired t-test.
III	Analysis of Variance (One- way & Two way Anova), Karl Pearson correlation coefficient, Linear Regression : Simple and Multiple regression SPSS Environment, entering data, Importing and Exporting data, Data Preparation, Data Transformation. Descriptive Statistics, Explore, Graphs using SPSS
IV	Graphs using SPSS, Inferential Statistics- Parametric test: Test for Normality, t-test for single mean, t-test for difference between means, paired t-test. Using SPSS: Non-parametric tests, Analysis of Variance (One-way & Two way Anova), Karl Pearson correlation coefficient, Linear Regression : Simple and Multiple regression

Reference: Chambers, J. (2008).Software for Data Analysis: Programming with R, Springer

Crawley, M.J. (2017). The R Book, John Wiley & Sons.

Eckhouse, R. H. and Morris, L .R.(1975). Minicomputer Systems Organization, Programming and Applications, Prentice-Hall.

Matloff, N. (2011). The Art of R Programming, No Starch Press, Inc.

Programme/Class: **B.Sc.**	Year: **Third**	Semester: **Sixth**
Subject: **STATISTICS**		
Course Code:-**B060602T**	Course Title: **Operations Research**	

Course Outcomes:

After completing this course a student will have:

- ✓ An idea about the historical background and need of Operations research.
- ✓ Abilitytoidentifyanddevelopoperationalresearchmodelsfromtheverbal description of the real life problems.
- ✓ Knowledgeofthemathematicaltoolsthatareneededtosolveoptimizationproblems.
- ✓ Ability of solving Linear programming problem, Transportation and Assignment problems, Replacement problems, Job sequencing, etc.
- ✓ Ability to solve the problems based on Game Theory.

Credits:**04**	Core: **Compulsory**
Max.Marks:**25+50**	Min. Passing Marks:.....

Total No. of Lectures-Tutorials-Practical (in hours per week):**4-0-0.**

Unit	**Topic**
I	History & background of OR, General linear programming problems and their formulations. Solving LPP by Graphical Method. Solving LPP by, Simplex method, Big–M method, Two Phase Method, Degeneracy and Duality in LPP.
II	Transportation problem: North-west corner rule, Least cost method, Vogel's approximation method. Assignment Problem: Hungarian Method, Travelling Salesman Problem.
III	Replacement problem: Individual and Group replacement. Job sequencing: n jobs–2 machines, n jobs–k machines, 2 jobs – n machines.
IV	Game theory: Introduction, Competitive Situations, Characteristics of Competitive Games. Rectangular game, Two-Person Zero-Sum game, minimax-maximin principle, Solution to rectangular game using graphical method Dominance and modified dominance property to reduce the game matrix and solution to rectangular game with mixed strategy, LPP method.

Suggested Readings:

Swarup, K., Gupta P.K. and ManMohan(2007). *Operations Research*(13thed.),Sultan Chand & Sons.

Taha,H.A.(2007).*Operations Research*: *An Introduction(8thed.)*,Prentice Hall of India. Hadley, G: (2002) : Linear Programming, Narosa Publications

Hillier, F. A and Lieberman ,G.J. (2010): Introduction to Operations Research-Concepts and cases, 9th Edition, Tata McGraw Hill.

Programme/Class: **B.Sc.**	Year: **Third**	Semester: **Sixth**
Subject: **STATISTICS**		
Course Code:-**B060603P**	Course Title: **Operations Research and Statistical Computing Lab**	

Course outcomes:

After completing this course a student will have:

1. Knowledge of mathematical formulation of L.P.P
2. Ability of solving LPP using different methods.
3. Ability to solve Allocation Problem based on Transportation and. Assignment model.
4. Ability to solve problems based on Game Theory.
5. Ability to use programming language R as Calculator.
6. Knowledge of using R in simple data analysis.
7. Able to perform statistical analysis by using SPSS.

Credits:**02**	Core: **Compulsory**
Max.Marks:**50**	Min. Passing Marks:.....

Total No. of Lectures-Tutorials-Practical (in hours per week):**0-0-4.**

	Topic	No. of Lectures
	1. Problem based on Mathematical formulation of L.P.P 2. Problem based on solving LPP using Graphical Method 3. Problem based on solving LPP using Simplex Method 4. Problem based on solving LPP using Charne's Big M method involving artificial variables. 5. Allocation Problem based on Transportation model. 6. Allocation Problem based on Assignment model. 7. Problems based on Game pay off matrix. 8. Problem based on solving Graphical solution to mx2/ 2xn rectangular game. 9. Problem based on solving Mixed strategy game. 10. Problem based on solving game using LPP method. 11. Problem based on application of R as Calculator. 12. Problem based on application of R in simple data analysis 13. Problem based on application of SPSS in data analysis	**60**

Programme/Class: **B.Sc.**	Year: **IV**	Semester: **VII**
Subject: **STATISTICS**		
Course Code: **B060701T**	Course Title: **STOCHASTIC PROCESS**	
Course outcomes: ➢ This paper provides knowledge about the stochastic process related definitions and its uses in various fields.		
Credits:04	Core Compulsory	
Max.Marks:25+50		
Total No. of Lectures-Tutorials-Practical(in hours per week):L-T-P: 4-0-0		

Unit	**Topics**
I	Stochastic process, introduction, classification, examples. Markov Chain, definition, transition probability matrix, distribution of the Chain, transition graph. Higher transition probabilities, Chapman - Kolmogorov equation, evaluation of nth order transition probabilities, multiplication of Matrices, generating function and limiting behavior.
II	Classification of states and chains: accessible, communicable states, closed sets, irreducible chain, first return and first passage probabilities, recurrence and transience, periodicity, mean of first passage time and recurrence time, ergodic chain. Stationary distribution, balancing equation, examples.
III	Simple random walk, unrestricted, reflecting, absorbing and elastic barriers, examples, distribution and generating function of unrestricted random walk. Gambler's ruin problem, distribution, expected duration of the game. Markov process with discrete state Space. Poisson Process, distribution, additive property, interval between two successive occurrences, Birth and Death process, Generating function, pure birth process and pure death process.
IV	Markov process with continuous state Space. Limiting distribution of random walk, differential equation, distribution of first passage time. Renewal process in discrete time, relation between F(s)and P(s), renewal interval,

References:

1. Stochastic Models: Analysis and Applications---B. R. Bhat, New Age
2. Stochastic processes---S. K. Srinivasan, K. M. Mehata, T.M.H
3. Stochastic Processes---J. Medhi, New Age International
4. Markov Chains-With Stationary Transition Probabilities---Kai Lai Chung, Springer

Programme/Class: **B.Sc.**	Year: **IV**	Semester: **VII**
Subject: **STATISTICS**		
Course Code: **B60702T**	Course Title: **LINEAR ESTIMATION AND DESIGN OF EXPERIMENTS**	
Course outcomes: ➢ This paper provides knowledge about the regression analysis and associated models and related properties.		
Credits:**04**	Core Compulsory/Elective: **COMPULSORY**	
Max.Marks:25+50		
Total No. of Lectures-Tutorials-Practical(in hours per week):L-T-P:4-0-0		

Unit	**Topics**
I	Block design (designing of an experiment, treatments, blocks, yields, experimental error) Generalized inverse of a matrix, Idempotent matrix, Random vector and dispersion matrix, Linear Model, Estimable parametric function and condition of estimability, Estimation space, Error space and error function, best linear unbiased estimate (BLUE), Gauss – Markoff's linear model, Normal equation, Residual vector, Theory of linear estimation.
II	Regression analysis, Stochastic and non-stochastic relation, random disturbance, Simple and multiple linear regression model, Test of linear hypothesis regarding the parameter for two variable linear model as well as multiple linear regression model.
III	Gauss Markoff's Theorem, Estimate of variance, Variance and covariance of estimated parameters. Nested or hierarchical classification, Analysis of nested Balanced design, Two–way elimination of heterogeneity.
IV	General theory of intra – block analysis of block design, contrast and elementary treatment contrast, connected and orthogonal block design, Balanced and resolvable block design, Estimation of a missing plot in RBD and LSD, Efficiency of R.B.D. with one missing value over no missing value.

References:

1. Chakrabarti M. C. - Mathematic of design and analysis of Experiments
2. Aloke Dey - Theory of Block Designs
3. M. N. Das and N. C. Giri - Design and analysis of experiments
4. D. D. Joshi - Linear estimation and design of experiments
5. C. R. Rao - Linear statistical inference and its application
6. Goon, Gupta, Das Gupta - An outline of Statistical theory,(Vol.2)
7. Goon, Gupta, Das Gupta - Fundamentals of Statistics(Vol.2)
8. Gupta,S.C. and Kapoor,V.K.- Fundamentals of Applied Statistics

Programme/Class: B.Sc.	Year: IV	Semester: VII
Subject: **STATISTICS**		
CourseCode:**B060703T**	Course Title: **INTRODUCTION TO MEASURE THEORY**	
Course outcomes: ➢ This paper provides very potent and efficient knowledge about the probabilistic nature of Statistics in mathematical sense.		
Credits:**04**	Core Compulsory/Elective: **COMPULSORY**	
Max.Marks:25+50		
Total No. of Lectures-Tutorials-Practical(in hours per week):L-T-P:**0-0-4**		

Unit	Topics
I	Algebra of sets, Limit of a sequence of a set, Field of sets, Monotone Classes, Sigma field, Boral Field, Set function, Additive set function, Continuity of set function.
II	Measure and its properties, Lebesgue and Lebesgue–stiltjes measure, probability Measure sequence theorem.
III	Measurable Space, Measurable sets, Simple Function, Elementary Function, Measurable Function, Measurability theorem, Convergence in measure, Convergence Almost everywhere.
IV	Integration of measurable function with respect to a measure, Helly – Bray lemma & Helly – Bray theorem, Dominated Convergence theorem, Monotone Convergence theorem, Fatou lemma.

References :

1. PaulR.Halmos - MeasureTheory
2. P.K.Jain&V.P.Gupta - LebesguemeasureandIntegration
3. B.R.Bhatt - ModernProbabilityTheory
4. SingmanS.J.andTaylorJFC - IntroductiontoMeasureandProbability

Programme/Class: **B.Sc.**	Year: **IV**	Semester: **VII**
Subject: **STATISTICS**		
Course Code: **B060704T**	Course Title: **SAMPLING THEORY**	
Course outcomes: This paper provides knowledge about the sampling and its uses in various fields.		
Credits:**04**	Core Compulsory/Elective: **COMPULSORY**	
Max.Marks:25+50		
Total No. of Lectures-Tutorials-Practical(in hours per week):L-T-P:0-0-4		

Unit	**Topics**
I	Review of some important results in SRSWOR and SRSWR, estimator of population mean/total and its variance for stratified population, Estimation of gain in precision due to stratification, Post stratification, estimation of population mean and its variance under post-stratification, inaccuracy in strata sizes and their effect, comparison with estimator under SRSWOR.
II	Ratio method of estimation, second approximation to the expectation and variance of ratio estimator, An optimum property of ratio estimator, ratio estimator for stratified population, separate and combined ratio estimators and their variances, estimate of variances , ratio type and unbiased ratio type estimators and their variances, product estimator, comparison with estimator under SRSWOR, ratio cum product Estimator and their MSE.
III	Regression method of estimation, Difference estimator, regression estimator of population mean/total, its bias and MSE, conditions under which regression estimator is optimum, weighted regression estimator and its variance, regression estimation for stratified population, separate and combined regression estimator And their MSE.
IV	Systematic sampling, comparison of systematic with SRSWOR and stratified sampling for auto-correlated population and population with linear trend, balanced systematic sampling. Interpenetrating subsamples and its Application in stratified sampling.

References

1. Sukhatme, P.V., Sukhatme, B.V., - Sampling Theory of Surveys with Applications
2. Cochran, W.G. - Sampling Techniques
3. Murthy, M.N. - Sampling Theory and Methods
4. Des Raj - Sampling Theory
5. Singh, D. and Chaudhary, F.S. - Theory and Analysis of Sample Survey Designs

Programme/Class: **B.Sc.**	Year: **IV**	Semester: VII
Subject: **STATISTICS**		
Course Code: **B060705P**	Course Title :**Practical Lab**	
Course outcomes: ➢ This paper provides practical knowledge on the basis of Paper I, II, III & IV.		
Credits:**04**	Core Compulsory/Elective: **COMPULSORY**	
Max.Marks:100		

RESEARCH PROJECT WORK–I

Course Code- B060706R **Credits:04**

Concept and definitions, variables and hypotheses, theory and facts, formulation of research problems, development of research methodology and research methods-collection of data, statistical techniques used, evaluation and accuracy of results, developments of knowledge-approaches, rationalistic mode, scientific mode. Identification of problem, formulation of hypotheses, imagination in the formulation of scientific law, recognition of a problem area and identifying the relative questions.

References:

1. Kothari, C.R.(1985): Research Methodology: Methods and Techniques, Wiley Eastern.
2. Dominowski, R.L.(1980): Research Methods, Prentice Hall Inc., New Jersey.
3. Mishra, R.P.(1980):Research Methodology, Handbook Concept Publishing Company, New Delhi.
4. Majhi, P. R., Khatua, P.K.(2016): Research Methodology, Himalaya Publishing House

Programme/Class: B.Sc.	Year: IV	Semester: VIII
Subject: STATISTICS		
Course Code: B060801T	Course Title: DEMOGRAPHY	

Course outcomes:

- This paper provides knowledge about the fertility, mortality, life-table, population projection and their uses in various fields.

Credits:04	Core Compulsory/Elective: COMPULSORY
Max. Marks: 25+50	

Total No. of Lectures-Tutorials-Practical(in hours per week):L-T-P:4-0-0

Unit	Topics
I	Sources of Demographic Data, Census, Registration, Ad-hoc surveys and Hospital records, Coverage and Content errors in Demographic Data, Chandrasekharan – Deming Formula to check completeness of registration data, Adjustment of age-data–Use of Whipple, Myer and UN Indices, Population Transition Theory.
II	Measures of fertility-Crude Birth Rate, General Fertility Rate, Age-Specific Fertility Rate, Total Fertility Rate, Order and Parity Specific Fertility Rate, Parity Progression Ratio, Measures of Reproduction- Gross Reproduction Rate and Net Reproduction Rate, Fecundability and its estimation based on proportion of women conceiving first time in a particular month after marriage, Birth Intervals and Stochastic Models for Reproduction,Distributionoftimeofbirthand Inter–liveBirthIntervals,Estimation of parameters.
III	Measures of Mortality- Crude Death Rate, Standardized Death Rate, Age-Specific Death Rate, Maternal Mortality Rate, Neonatal and Post-Neonatal Mortality Rates, Infant Mortality Rate and its adjustments, Complete Life Table, Construction of Abridged Life Tables, Stable and Stationary Population, Models of population growth and their fitting to population growth.
IV	Migration, Internal migration and its measurements, Migration Models, Concept of International Migration, Methods of Population Projection including Logistic Curve Fitting, Intercensal and Post – censal Estimates.

References:

1. Kumar, R.(1986): Technical Demography, Wiley Eastern Ltd.
2. Benjamin, B.(1969): Demographic Analysis, George, Allen and Unwin.
3. Chiang, C. L.(1968): Introduction to Stochastic Progression.
4. Cox, P .R.(1970): Demography, Cambridge University Press.
5. Keyfitz, N.(1977): Introduction to the Mathematics of Population-with Revisions, Addison-Wesley, London.
6. Spiegelman, M. (1969): Introduction to Demographic Analysis, Harvard University Press.
7. Wolfenden, H. H.(1954): Population Statistics and Their Compilation, Am Actuarial Society.

Programme/ Class: B.Sc.	Year IV	Semester: VIII
Subject: **STATISTICS**		
Course Code: **B060802T**	Course Title: **DESIGN AND ANALYSIS OF EXPERIMENT**	

Course outcomes:

- This paper provides knowledge about the design of experiments with various designs and Related problems.

Credits:**04**	Core Compulsory/Elective: **COMPULSORY**
Max.Marks:25+50	

Total No. of Lectures-Tutorials-Practical(in hours per week):L-T-P:4-0-0

Unit	Topics
I	Complete block design, Incomplete block design, Balanced incomplete block design (BIBD) and its properties (with proof), Analysis of BIBD(Intra-block),Efficiency of BIBD over R.B.D., Symmetric BIBD, Resolvable BIBD, Partially BIBD.
II	General description of factorial experiment and standard order of treatment combination of 3^n factorial experiment, linear and quadratic component, extension of Yate's method for computing sum of squares of main and interaction effects, Analysis of 3^nfactorial experiment in RBD, Advantages and disadvantages of factorial experiment, split plot experiment and its advantages and disadvantages.
III	Confounding in factorial experiment, confounding arrangement, defining contrasts, confounding in 2^nfactorial experiments and its analysis, Generalized interactions, General rule in confounding, Principal (Key) block, Complete and partial confounding, analysis of complete and partially confounded 2^n experiment, advantage and disadvantage of confounding.
IV	Analysis of covariance (ANOCOVA), ANOCOVA for one way classification (C.R.D.) with one concomitant variable, ANOCOVA for two-way classification (R.B.D.) with one concomitant variable.

References:

1. Chakrabarti M. C. - Mathematic of design and analysis of Experiments
2. Aloke Dey - Theory of Block Designs
3. M. N. Das and N. C. Giri - Design and analysis of experiments
4. D. D. Joshi - Linear estimation and design of experiments
5. C. R. Rao - Linear statistical inference and its application
6. Goon, Gupta, Das Gupta - An outline of Statistical theory,(Vol.2)
7. Goon, Gupta, Das Gupta - Fundamentals of Statistics(Vol.2)
8. Gupta,S.C. and Kapoor, V.K.- Fundamentals of Applied Statistics

Programme/Class: B.Sc.	Year: IV	Semester: VIII
Subject: **STATISTICS**		
Course Code: **B060803T**	Course Title: **ECONOMETRICS**	

Course outcomes:

- This paper provides knowledge about the econometrics with related problems and its uses in Economics and various fields.

Credits:**04**	Core Compulsory/Elective: **COMPULSORY**
Max.Marks: 25+50	

Total No of Lectures- Tutorials-Practical (in hours per week):L-T-P:4-0-0

Unit	Topics
I	Econometrics (definition and objective) and model, Simple, Multiple and general linear regression model, Estimation of regression parameter of simple, multiple and general linear regression model, properties of estimator, correlation matrix, Prediction in general linear model, Restricted estimator and its properties, Multicollinearity and its consequences, Tests for detecting multicollinearity, Methods for removing multicollinearity.
II	Generalized least square estimators and its properties, Heteroscedasticity and its consequences, Tests for Heteroscedasticity, Different heteroscedastic structure, Autocorrelation, Coefficient of autocorrelation, mean, variance and covariance of disturbance term in autocorrelated model, effect of Autocorrelation on OLS estimators, Test for autocorrelation.
III	Simultaneous equation model (SEM), Complete SEM, Endogenous and exogenous (Predetermined) variable, Types of models in simultaneous equation, methods for estimation of parameters in SEM: Indirect Least Square(ILS),Two stage least square(2SLS).
IV	Structural and Reduced form equation /Parameters, Identification problem, classifying structural equation, identification status of an equation, rank and order condition of identification.

References:

1. G. M. K. Madnani- Introduction to Econometrics, Oxford & IBH Publishing Co.
2. Apte P.G.(1990)- Text book of Econometrics Tata–McGraw–Hill Publishing Co. Ltd.
3. Gujarathi, D. -Basic Econometrics, McGraw–Hill
4. Kotsoyiannis, A.- Theory of Econometrics, Macmillan Press
5. J. Johnston -EconometricsMethods,3rd EditionMacgraw–Hill

Programme/Class: B.Sc.	Year: IV	Semester: VIII
Subject: STATISTICS		
Course Code: B060804T	Course Title: STATISTICAL INFERENCE	

Course outcomes:

- This paper provides knowledge about the sampling and its uses in various fields.

Credits:04	Core Compulsory/Elective: COMPULSORY
Max. Marks: 25+50	

Total No. of Lectures-Tutorials-Practical(in hours per week):L-T-P:4-0-0

Unit	Topics
I	Generalization of N.P. Lemma, Likelihood ratio and its properties, Monotone likelihood ratio families, U.M.P. tests for one-and two- Sided hypothesis for one parameter exponential family
II	Unbiased test and locally unbiased most powerful tests, construction of M.P. and U.M.P., critical regions sampling from normal population, Test having Neyman Structure, Invariant tests, Admissibility.
III	Properties of exponential distribution, Estimation of mean life with complete and censored samples in exponential model, Estimation of parameter in Weibull distribution, Reliability estimation.
IV	Mixture of exponentials and Weibull distribution, Maximum likelihood estimators of parameters, Tests of hypothesis and confidence Intervals for exponential and normal distribution.

References:

1. Lehmann - Testing of Statistical Hypothesis
2. Goon, Gupta, Das Gupta - An outline of Statistical Theory(Vol.II)
3. Sinha S.K. - Reliability and Life Testing
4. Hogg and Crag - Probability and Statistical Inference

Programme/Class: B.Sc.	Year: IV	Semester: VIII
Subject: STATISTICS		
Course Code: B060805P	Course Title :Practical Lab	

Course outcomes:

- This paper provides practical knowledge on the basis of Paper I, II, III & IV.

Credits:04	Core Compulsory/Elective: COMPULSORY
Max.Marks:100	

Research Project Work–I(b)

Course Code: B060806R Credits: 04, Max. Marks: 100

After the wide discussion of various points in Project work-I, the remaining steps are as follows-

Steps in research process-

a) Conceptual phase- formulation of the research problem, literature review, developing the hypothesis.
b) Empirical phase- preparing the research design, determination of sample size, collection of data.
c) Analytical phase- analysis of data, hypothesis testing, generalization and interpretations, writing up, conclusions.

Types of variables-independent, dependent and control variables. Measurements - concept and level of measurement, scaling technique, validity and reliability of a measurement.

Types of data and methods of collection of data, pre-testing, pilot survey, longitudinal survey, prospective and retrospective surveys, sampling and non-sampling errors, sampling unit and sampling frame, population and sample, scrutinizing of data, estimation of coverage and errors in data collection, revisits.