STATISTICS HONOURS SYLLABUS

Semester	Paper Code	Marks	Credits	Topic
1	ST31011T	100	5	Descriptive Statistics 1 & Probability Theory 1
	ST31022T	25	2	Real Analysis
	ST31022P	75	3	Practical- Using C Programming and Minitab Software
2	ST32031T	100	5	Descriptive Statistics 2 & Probability Theory 2
	ST32042T	25	2	Linear Algebra 1
	ST32042P	75	3	Practical- Using C Programming and Minitab Software
3	ST33051T	100	5	Descriptive Statistics 3 & Probability Theory 3
	ST33062T	25	2	Linear Algebra 2
	ST33062P	75	3	Practical- Using R and Minitab Software
4	ST34071T	100	5	Multivariate Analysis & Economic and Official Statistics
	ST34081T	100	5	Sampling distribution & Statistical Inference 1
	ST34091T	100	5	Statistical Quality Control & Population Statistics
	ST34511P	100	5	Practical-Using R and Minitab Software.
5	ST35101T	100	5	Linear Statistical Model & Time Series
	ST35111T	100	5	Statistical Inference 2 & Non Parametric Inference
	ST35121T	100	5	Statistical Inference 3 & Sample Survey 1
	ST35521P	100	5	Practical-Using R and Minitab Software.
6	ST36142T	60	4	Econometrics- Theory
	ST36142P	40	1	Econometrics- Practical
	ST36151T	100	5	Designs of Experiment & Sample Survey 2
	ST36531P	100	5	Practical- Using R and Minitab Software
	ST36543P	100	5	Dissertation

Semester: I
Paper Code: ST 31011T
Group: A
Topic: Descriptive Statistics – 1
Lecture hrs: 39 + 6 (tutorials) = 45

Introduction: Nature and scope of Statistics, Classification of data, Concept of population and sample, primary and secondary data, experimental design and survey data, observational studies, quantitative and qualitative data, discrete and continuous data, cross-sectional and time series data.   (8L)

Scales of measurement: Nominal, Ordinal, Ratio and Interval.   (2L)

Collection and scrutiny of data: Methods of collection of primary data, scrutiny of data for internal consistency and detection of errors in recording.   (4L)

Presentation of data: Textual and tabular presentation, stem and leaf display, diagrammatic presentation - Line diagrams, bar diagrams, pie diagram and sub-divided bar diagram. Frequency distribution of discrete and continuous variables. Column diagram, frequency polygon, histogram step diagram, ogive and frequency curves.   (8L)

Analysis of quantified data: Characteristics of Univariate frequency distribution – location, dispersion, skewness and kurtosis. Moment and quantile measures. Sheppard's correction (without derivation). Relative dispersion. Box-plot and detection of outliers. Trimmed mean and Winsorised mean.   (17L)

References:

1. Goon A.M, Gupta M.K. Dasgupta B. : Fundamentals of Statistics, Volume 1.
2. Yule G.U. and Kendall M.G. : An Introduction to the theory of Statistics..
3. Hogg and Tanis. : Probability and Statistical Inference.

Course Objective: This course introduces a student to different types of data and the art of data handling. Throughout the course the students will develop the techniques of summarization and identification of the salient features of the data through graphical displays and other descriptive measures. The emphasis will be on metric data corresponding to a single variable.

Paper Structure:

No. of ques to be set		No of ques to be answered		Marks	Marks	Total Marks
short	long	short	Long	(short ques)	(long ques)	
4	3	2	2	5x2=10	15x2=30	**40**

Semester: I
Paper Code: ST 31011T
Group: B
Topic: Probability Theory – 1

Lecture hrs: 39 + 6 (tutorials) = 45

Random Experiments: Trials, Sample points, Sample space, Events, Class of events.   (5L)

Definition of Probability: Classical definition, its application (using combinatorial analysis) and limitations, Stability of long-run relative frequency, Kolmogorov's Axiomatic definition. Probability of union and intersection of events. Probability of occurrence of exactly m & at least m events out of n events (proof for finite sample space only). Conditional probability & Independence of events. Bayes' theorem & its applications. Examples based on classical approach – illustrations using difference equation (of 1st order only). Repeated trials, product space and independent trials.   (34L)

References:
    1.   S.M. Ross : A First Course in Probability.
    2.   K.L. Chung : Elementary Probability Theory with Stochastic Process.
    3.   W. Feller : An Introduction to Probability Theory and its Application (Vol. 1).
    4.   A.M Gun, M.K. Gupta, B. Dasgupta : An Outline of Statistical Theory (Vol. 1).

Course Objective: At the end of the course a student should
- Understand different definitions and meaning of Probability.

- Know different laws of probability and the theorems connecting them.

- Be able to apply the laws of probability.

Paper Structure:

No of Ques to be set		No of Ques to be answered		Marks	Marks	Total Marks
short	long	short	Long	(short ques)	(long ques)	
4	3	2	2	5x2=10	15x2=30	**40**

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Semester: I
Paper Code: ST 31022T
Group: A
Topic: Real Analysis
Lecture hrs: 26

{*concepts, statements (without proof) of major results and their applications*}
Sets and Functions. Sequence & Series of real numbers. Convergence, Limits, Absolute convergence. Concepts of o_n & O_n. Comparison, Ratio & Root tests.   (9L)
Continuity & Differentiability of real-valued functions. Riemann integration. Fundamental Theorem of integration. Differentiation under integration.   (6L)
Sequence & Series of functions. Pointwise & Uniform convergence. Simple tests, Power Series, Taylor's series expansion, Differentiation & Integration of series.   (6L)

Double integration. Evaluation of double integrals-repeated integrals & change of variables. (5L)

References:
1. Bertle, D. Sherbert : Introduction to Real Analysis
2. 2. R Goldberg : Methods of Real Analysis
3. K B Sinha, R L Karandikar et al. : Understanding Mathematics

Course Objective: At the end of the semester, a student should have learnt to define the important concepts of analysis of real numbers and real functions as a prerequisite for the development of further statistical studies.

Paper Structure:

No of Ques to be set		No of Ques to be answered		Marks	Marks	Total marks
short	long	Short	Long	(short ques)	(long ques)	
2	2	1	1	5x1=5	15x1=15	**20**

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Semester: I
Paper Code: ST 31022P
Group: B
Topic: C Programming & Data analysis using Minitab

Components of C: Introduction to C Program. Constants, Variables & Key Words. Loop Structures -*For* loop. Conditional Statements – *If, If-Else*. *Break, Exit* and *Continue* functions. Single Dimensional Array.

Paper Structure: All questions in this paper are compulsory.

Module	Topic	Marks
Module 1	C Programming :	15
	Data Analysis through MINITAB	35
Module 2	Viva-Voce	10
	Total	**60**

Semester: II

Paper Code: ST32031T

Group: A

Topic: Descriptive Statistics – 2
Lecture hrs: 39 + 6 (tutorials) = 45

Correlation & Regression Analysis: Bivariate data and scatter plot. Theory of Regression, least square method and related results. Coefficient of determination. Pearson's product moment correlation coefficient and its properties. (15L)

Non-linear regression: Fitting of polynomial and exponential curves. Correlation Index and Correlation Ratio. Transformations to linearity: log-linear and power transformations. (8L)

Regression diagnostics: Residual plots, outliers, leverage and influential data points, Cook's distance. (6L)

Some other types of correlation: Intra class correlation with equal and unequal class sizes, rank correlation – Spearman & Kendall (tied and untied cases), Grade correlation, Bi-Serial correlation. (10L)

References:

1. A.M. Gun, M.K.Gupta, B. Dasgupta : Fundamentals of Statistics, Volume 1.
2. G.U. Yule and M.G. Kendall: An Introduction to the theory of Statistics.
3. Hogg and Tanis. : Probability and Statistical Inference

Course Objective: This course is a continuation to the descriptive Statistics course in Semester I. Throughout this course student will handle bivariate data. The primary objective of this course would be to study the nature of association between two variables. The two problems in bivariate data analysis namely "Correlation and Regression" would be introduced. The focus will be primarily on metric data. Some special types of correlation measures would also be developed to handle clustered /array data, ordinal/nominal data. Regression diagnostics would be introduced to identify any unusual cases.

Paper Structure:

No of Ques to be set		No of Ques to be answered		Marks	Marks	Total Marks
short	long	Short	long	(short ques)	(long ques)	
4	3	2	2	5x2=10	15x2=30	**40**

Semester : **II**

Paper Code: **ST32031T**

Group: **B**

Topic: **Probability Theory - 2**
Lecture hrs: **39 + 6 (tutorials) = 45**

Random Variables (Univariate case): Definition of discrete & continuous random variables, Cumulative distribution function (cdf) & its properties (with proof), Probability mass function (pmf) & Probability density function (pdf), Expectation and Variance, Moments, Skewnss and Kurtosis. Quantiles of random variable. Probability generating function (pgf) & Moment generating function (mgf). (18L)

Probability Inequalities: Markoff's, Chebyshev's and Chernoff's inequalities. (5L)

Random Variables (Bivariate case): Cdf, pmf & pdf. Marginal & Conditional distributions, Independence. Bivariate moments, mgf and pgf Theorems on sum and product of two random variables, Theorems on Conditional Expectation & Variance, Correlation & Regression. (16L)

References:
1. S.M. Ross : A First Course in Probability.
2. K.L. Chung : Elementary Probability Theory with Stochastic Process.
3. V.K. Rohatgi : Introduction to Probability Theory and Mathematical Statistics.
4. A.M Goon, M.K. Gupta, B. Dasgupta : An Outline of Statistical Theory (Vol. 1).

Course Objective: At the end of the course a student should

1. Understand what is a random variable and its probability distribution.
2. Understand different aspects of Bivariate probability distribution.
3. Know different probability inequalities.

Paper Structure:

No of Ques to be set		No of Ques to be answered		Marks	Marks	Total Marks
short	long	Short	long	(short ques)	(long ques)	
4	3	2	2	5x2=10	15x2=30	**40**

Semester: **II**
Paper Code: **ST32042T**
Group: **A**
Topic: **Linear Algebra – 1**

Lecture hrs: 26

Vector Algebra: Vector spaces defined on field of real numbers. Euclidean space and subspaces. Linear independence of vectors. Concepts of Spanning Set, Basis & Dimension of a vector space. Orthogonal vectors, Gram-Schmidt orthogonalization, ortho-complement space.   (16)

*Matrix Algebra***:** Matrices (definition and types). Matrix inverse. Inverse and determinant of Partitioned matrices. Orthogonal matrix. Row space & column space of a matrix, Null space and nullity.   (10)

References:
1. Linear Algebra, G. Hadley
2. An Introduction to Vectors and Matrices, A.M. Gun
3. A text book of Matrices, Shanti Narayan
4. Linear Algebra, Searle.

Course Objective: After completion of the course a student is expected to have (i)through idea of vector spaces, subspaces, their dimensions and basis (ii) matrix algebra, determinants & the subspaces associated with a matrix. This course is expected to lay the foundations to learn the courses like Multivariate Analysis and ANOVA.

Paper Structure:

No of Ques to be set		No of Ques to be answered		Marks	Marks	Total marks
short	long	Short	long	(short ques)	(long ques)	
2	2	1	1	5x1=5	15x1=15	**20**

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Semester: II
Paper Code: ST32042P
Group: B
Topic: C Programming & Data Analysis using Minitab

Components of C: Loop Structures – *While, Do-While*. Two Dimensional Arrays, *Functions* (passing values only).

Paper Structure: All questions in this paper are compulsory

Module	Topic	Marks
Module 1	C Programming :	15
Module 2	Data Analysis through MINITAB	35
	Viva-Voce	10
	Total	**60**

Semester: III
Paper Code: ST33051T
Group: A
Topic: Descriptive Statistics – 3

Lecture hrs: 26 +4 (tutorials) = 30

Introduction to Categorical Data: 2 X 2 contingency table, notion of independence & association, ideas of complete and absolute association.   (6L)

Measures of association (nominal data): Odds ratio, log-odds ratio, relative risk, coefficient of association due to Yule and Cramer, Pearson's chi-square, log-linear model for 2 X 2 tables, generalization to k X l contingency table. Matched pair data.   (14L)

Measures of association (ordinal data): Kendall's τ & τ_b, Goodman-Kruscal's γ, linear-bilinear association.   (6L)

References:

1. A.M. Gun, M.K.Gupta, B. Dasgupta : Fundamentals of Statistics, Volume 1.
2. G.U. Yule and M.G. Kendall: An Introduction to the theory of Statistics.
3. J.F. Simonoff: Analyzing Categorical Data.
4. S.E. Fienberg: The Analysis of Cross Classified data.
5. Michael S. Lewis Beck. : Basic Statistics.

Course Objective: This course introduces a student to categorical data. Throughout the course the students will study many real life application areas for instance applications in biomedical, behavioural or social sciences where data in fact is categorical in nature. Exposition to both nominal and ordinal data would be given. The focus will be on studying the association between two attributes and to develop various descriptive measures for contingency tables. A part of the course would be devoted to modelling of categorical responses.

Paper Structure:

No of Ques to be set		No of Ques to be answered		Marks	Marks	Total marks
short	long	Short	long	(short ques)	(long ques)	
4	2	2	1	5x1=5	15x1=15	**25**

Semester: III
Paper Code: ST33051T
Group: B
Topic: Probability Theory – 3

Lecture hrs: 52+8 (tutorials) = 60

Univariate Discrete Distributions: Uniform, Binomial, Hypergeometric, Poisson, Geometric, Negative Binomial distributions & their properties & applications.   (18L)

Univariate Continuous Distributions: Rectangular, Normal, Cauchy, Gamma, Exponential, Beta, Log-normal, Pareto, Logistic distributions & their properties & applications.

(16L)

Truncated Univariate Distributions: Binomial, Poisson & Normal.   (6L)

Bivariate Discrete Distribution: Trinomial distribution - its properties & applications.   (2L)

Bivariate Continuous Distribution: Bivariate Normal distribution - its properties & applications.
(5L)

Scaling of data: Z scores and Equivalent scores (use of normal distribution).   (5L)

References:
    1.   S.M. Ross : Introduction to Probability Models.
    2.   V.K. Rohatgi : Introduction to Probability Theory and Mathematical Statistics.
    3.   A.M Goon, M.K.Gupta, B. Dasgupta : An Outline of Statistical Theory (Vol. 1).
    4.   N.L. Johnson & S.M. Kotz : Discrete Distributions.
    5.   N.L. Johnson & S.M. Kotz : Continuous Distributions.

Course Objective: At the end of the course a student should
    1. Know the genesis of different discrete and continuous distributions.
    2. Know the characteristics of different discrete and continuous distributions.
    3. Be able to apply these distributions appropriately.

Paper Structure:

No of Ques to be set		No of Ques to be answered		Marks	Marks	Total marks
short	long	Short	long	(short ques)	(long ques)	
4	5	2	3	5x2=10	15x3=45	**55**

Semester: III
Paper Code: ST33062T
Group: A

Topic: **Linear Algebra – 2**
Lecture hrs: **26**

Matrix Algebra: Elementary matrices & their uses. Echelon Matrix. Rank of a matrix. Method of finding Rank by Sweep-out method. (10)

*Linear Equations***:** Systems of Linear Equations and their consistency (using rank criterion). Gaussian method of successive elimination. Ideas of Linear transformation. (7)

Characteristic Roots and vectors of a matrix: Definition and Properties of characteristic roots and vectors of symmetric matrices only. (5)

*Quadratic Forms***:** Classification & statement of important results. Diagonalization of a single positive definite matrix using characteristic root and characteristic vector. (4)

References:
1. Linear Algebra, G. Hadley.
2. An Introduction to Vectors and Matrices, A.M. Gun.
3. A text book of Matrices, Shanti Narayan.
4. Linear Algebra, Searle.

Course Objective: This course is in continuation to the Linear Algebra I course of semester II. After completion of this course a student is expected to understand the concepts of rank of a matrix and Systems of linear equations. Thorough idea of characteristic roots and vectors of symmetric matrices only is to be developed along with the understanding of classification of quadratic forms and diagonalization of a single positive definite matrix using characteristic root and characteristic vector. This course also introduces a student to the Ideas of Linear transformation in connection to matrices.

Paper Structure:

No of Ques to be set		No of Ques to be answered		Marks	Marks	Total marks
short	long	Short	long	(short ques)	(long ques)	
2	2	1	1	5x1=5	15x1=15	**20**

Semester: **III**
Paper Code: **ST33062P**
Group: **B**
Topic: **R and Data Analysis using Minitab**

Paper Structure: All questions in this paper are compulsory

Module	Topic	Marks
Module 1	R	15
Module 2	Data Analysis through MINITAB	35
	Viva-Voce	10
	Total	**60**

Semester: **IV**
Paper Code: ST34071T
Group: **A**
Topic: **Multivariate Analysis**
Lecture hrs: 52 +8 (tutorials) =60

Multivariate Data: Muliple correlation, partial correlation and their properties. Multiple
regression and related results.   (18L)
Random Vector: Probability mass & density functions, Distribution function, Mean vector &
Dispersion matrix, Marginal & Conditional distributions, Ellipsoid of Concentration, Multiple
Regression and correlation, Partial correlation.   (16L)
Multivariate Distributions: Multinomial & Multivariate Normal distributions and their
properties.   (10L)
Binary response, logit model, multiple logistic regression.   (8L)

References:

1.   T.W. Anderson : Multivariate Analysis.
2.   A.M.Gun, M.K. Gupta & B. Dasgupta: An Outline of Statistical Theory (Vol. 1).
3.   A.M.Gun, M.K. Gupta & B. Dasgupta: Fundamentals of Statistics (Vol. 1).
4.   P. Mukhopadhyay: Mathematical Statistics.

Course Objective: At the end of the course a student should
1.   Understand what are multivariate data and different types of analyses concerning a multivariate data set.
2.   Know Multivariate Probability Distribution.
3.   Know Multinomial and Multivariate Normal distributions along with their properties.
4.   Know Multiple Logistic Regression.

Paper Structure:

No of Ques to be set		No of Ques to be answered		Marks	Marks	Total marks
short	long	Short	long	(short ques)	(long ques)	
4	5	2	3	5x2=10	15x3=45	**55**

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Semester: **IV**
Paper Code: ST34071T

Group: B
Topic: **Economic and Official Statistics**
Lecture hrs: **26 + 4 (tutorials) = 30 hrs**

Economic Statistics:
Index Numbers: Price, Quantity & Value indices.   (2L)

Price Index Numbers: Construction, Uses, Limitations, Tests for index numbers, Various formulae & their comparisons, Chain Index Number.   (6L)

Some Important Indices: Consumer Price Index, Wholesale Price Index & Index of Industrial Production – methods of construction & uses.   (4L)
National Accounts: Definition of national income. A brief account of product, expenditure and income approaches.   (4L)
Measures of inequality: Gini's coefficient, Lorenz curve, Use of Pareto and Log-Normal Distributions.   (5L)

Official Statistics
The Statistical System in India: Central & State Government organizations. Central Statistical Office (CSO) & National Sample Survey Office (NSSO). Sources of Official Statistics in India relating to population, agriculture, industry, trade, price, finance & employment.   (3L)

Comparative Social Statistics: Indices related to human development and gender dispariy.
                                        (2L)
References:

1.   A.L. Nagar and R.K. Das : Basic Statistics.
2.   A.M.Gun, M.K. Gupta & B. Dasgupta: Fundamentals of Statistics (Vol. 2).
3.   F.E. Croxton and D.J. Cowden : Applied General Statistics.

Course Objective: After completion of the course a student is expected to have preliminary ideas of formulating statistical measures to account for inflation/deflation and economic growth of a country and also mechanisms of collecting and sources of official statistics in India. This course also introduces a student to comparative social statistics.

Paper Structure:

No of Ques to be set		No of Ques to be answered		Marks	Marks	Total marks
Short	long	Short	Long	(short ques)	(long ques)	
4	2	2	1	5x1=5	15x1=15	**25**

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Semester: **IV**
Paper Code: ST34081T
Group: **A**
Topic: **Sampling Distributions**
Lecture hrs: 39+ 6 (tutorials) = 45

Introduction: Multiple Integration, Orthogonal & Polar Transformations.
Random Sampling from a theoretical distribution, Statistics and Sampling Distributions of Statistics. Derivation of sampling distribution using Distribution Function, Moment Generating function & Transformation of Variables. (12L)

Some Standard Sampling Distributions: χ^2 distribution. Distributions of Mean and Variance of a random sample from a Normal population, t & F distributions. Distributions of means, variances & correlation coefficient (null case) of a random sample from a Bivariate Normal population. Distribution of regression coefficient and linear predictor (for non-stochastic independent variable). (15L)

Distribution of Order Statistics and sample range. (5L)

Concepts of generation of random samples from Binomial, Poisson, Exponential, Normal, Chi-Square, t and F distributions. (7L)

References:
1. R.V. Hogg & A.T. Craig : Introduction to Mathematical Statistics.
2. V.K Rohatgi.: Introduction to Probability and MathematicalStatistics.
3. A.M. Gun, M.K. Gupta & B. Dasgupta : An Outline of Statistical Theory (Vol. 1).

Course Objective: This course introduces you to the concept of sampling distribution. But the main aim is to make the students look at this course as distribution of function of random variables (both discrete and continuous):i.e to find the distribution of g(x) when the distribution of X is known where g(x) is any function of x. We will extend this idea for bivariate case as well as for *n* random variables. We will learn different techniques and transformations which will help us in finding these distributions easily. We will also learn the distributions of some specific statistics like order statistics, regression coefficient, correlation coefficient etc.

Paper Structure:

No of Ques to be set		No of Ques to be answered		Marks	Marks	Total Marks
short	long	Short	long	(short ques)	(long ques)	
4	3	2	2	5x2=10	15x2=30	**40**

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Semester: IV
Paper Code: ST34081T
Group: B
Topic: Statistical Inference 1
Lecture hrs: 39+ 6 (tutorials) = 45

Introduction: Parametric inference. Point and interval estimation, testing of hypothesis. (5L)

Elements of Point Estimation: Notion of Mean Square Error and Bias. Unbiased and Minimum Variance Unbiased Estimators (MVUE). Properties of MVUE. (10L)

Elements of Hypothesis Testing: Null & Alternative hypotheses, Simple & Composite hypotheses, Definition of a Statistical test, Critical Region, Type I & Type II Errors, Level of Significance & p-value for symmetric null distribution, Power. (5L)

Exact tests of Significance related to: single Binomial proportion & Poisson parameter, Two Binomial proportions & Poisson parameters. The mean & variance of a univariate Normal distribution, The difference of means & ratio of variances of two independent Normal distributions. Difference of means, Ratio of variances & correlation coefficients of a Bivariate Normal distribution. Test for regression parameters (case of non-stochastic independent variable only). (12L)

Interval Estimation: Pivotal method of obtaining confidence limits. Applications to the mean & variance of a univariate Normal distribution, the difference of means & ratio of variances of two independent Normal distributions. (7L)

References:
1.   R.V. Hogg & A.T. Craig : Introduction to Mathematical Statistics.
2.   G. Casella & R.L. Berger : Statistical Inference.
3.   P.J. Bickel & K.A. Doksum : Mathematical Statistics.

Course Objective: This course will equip you to take wise decisions in the face of uncertainty on the basis of the data at hand. The two basic problems of Statistical inference namely Estimation and Testing of hypothesis would be introduced. Throughout the course we will develop different optimal estimators. Tests related to the parameters arising in the normal, binomial and Poisson populations would be discussed.

Paper Structure:

No of Ques to be set		No of Ques to be answered		Marks	Marks	Total Marks
short	long	Short	long	(short ques)	(long ques)	
4	3	2	2	5x2=10	15x2=30	**40**

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Semester: **IV**
Paper Code: ST34091T
Group: **A**
Topic: **Statistical Quality Control**
Lecture hrs: 39+ 6 (tutorials) = 45

Introduction: Concepts of Quality & Quality Control, Process Control & Product Control.
(5L)

Process Control: Rational Subgroups, 3-sigma limits & Probability limits. Control charts & their uses. Choice of Subgroup sizes. Construction of $\overline{X}$, R, SD, np, p & c charts (fixed & variable sample sizes). Interpretation of non-random patterns of points. Modified control charts. (15L)

Product Control: Description of Rectifying Sampling Inspection Plans. Producer's Risk, Consumer's Risk, Single sampling plan by attributes, OC, ASN (ATI), AQL, LTPD & AOQL. Selection of plans using IS2500 plans. (13L)

Reliability: Concepts, Hazard function and related estimation problems using Exponential and Weibull distributions. (6L)

References:
1. A.M. Gun, M.K. Gupta & B. Dasgupta :: Fundamentals of Statistics (Vol. 2).
2. P. Mukhopadhyay : Applied Statistics
3. Montgomery : Introduction to Statistical Quality Control

Course Objective: At the end of the semester, a student is expected to :
1. Have an exposure to the application of statistical theory in the industry.
2. Distinguish the various phases of SQC and capturing the variation in quality of the manufactured items.
3. Statistical Techniques used in various phases, namely Control Charts in Process Control and Sampling Inspection Techniques in Product Control.
4. Identifying Reliability as an important dimension in studying quality of products. Modelling reliability using suitable probability distributions and estimating the parameters involved.

Paper Structure:

No of Ques to be set		No of Ques to be answered		Marks	Marks	Total Marks
short	long	Short	long	(short ques)	(long ques)	
4	3	2	2	5x2=10	15x2=30	**40**

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Semester: IV
Paper Code: ST34091T
Group: B
Topic: Population Statistics
Lecture hrs: 39+ 6 (tutorials) = 45

Introduction: Sources of population data – Census and Registration data. Demographic events and processes. Rates & Ratios of Vital events. (3L)
Age-Sex Composition: Sex-Ratio, sex-ratio at birth, dependency ratio,aging of a population (mean and median age) and age pyramid. (2L)

Measurements of Mortality: Crude Death Rate, Specific Death Rate, Standardized Death Rate, Comparative Mortality Index, Cause of death rate, Infant Mortality Rate, Neonatal and Perinatal Mortality Rates. (10L)

Measurements of Morbidity: Morbidity Incidence & Morbidity Prevalence Rates. (2L)

Life Tables: Description of a complete life tables – functions and relations, force of mortality, average age at death, life table death rate, cohort vs current life tables, Stable population & Stationary population, average length of a generation, construction of complete life table from census & registration data. Description of abridged life table. Uses of life tables. (7L)

Measurements of Fertility: Crude Birth Rate, General Fertility Rate, Age Specific Fertility Rate, Total Fertility Rate. (6L)

Measurement of Population Growth: Crude Rate of Natural Increase & Vital Index, Gross & Net Reproduction Rates. (5L)

Population Estimation & Forecasting: Use of A.P. and G.P. methods of population estimates, Logistic curve for population forecasting & fitting by Rhode's method. (4L)

References:
1. A.M. Gun, M.K. Gupta & B. Dasgupta :: Fundamentals of Statistics (Vol.2)
2. R. Ramakumar : Technical demography.

Course Objective: At the end of the course a student should
1. Have an idea about a population and population study.
2. Know some of the basic as well as derived measures for the study of human population,
3. Understand the concept of a life table and its significance in real life.
4. Be familiar with the notion of growth of a population along with methods of estimating and forecasting the same.

Paper Structure:

No of Ques to be set		No of Ques to be answered		Marks	Marks	Total Marks
short	long	Short	long	(short ques)	(long ques)	
4	3	2	2	5x2=10	15x2=30	**40**

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Semester: IV
Paper Code: ST34511P
Topic: R and Data Analysis using Minitab

Paper Structure: All questions in this paper are compulsory

R: sampling distribution and Statistical Inference 1
Minitab: Multivariate, Economic & Official Statistics, SQC, Population Statistics

Module	Topic	Marks
1	R	20

2	Data Analysis through MINITAB	50
	Viva-Voce	10
	Total	**80**

Semester: V
Paper Code: ST35101T
Group: A
Topic: **Linear Statistical Model**
Lecture hrs: 39+6 (tutorials) = 45

Linear Statistical Models

Introduction: Gauss Markov Linear Model, Linear parametric functions, Estimability, Estimation space, Error Space and BLUE (concepts and statements only). Gauss-Markov theorem. Test of General Linear Hypotheses and the fundamental theorem of least squares. Classificaton – ANOVA, regression, ANCOVA.   (7L)

ANOVA: One-way classified data, Two-way classified data with equal number of observations per cell for fixed & random effects model only.   (18L)

Application of ANOVA to Regression Problems: Test for existence of regression, linear and quadratic regression, parallelism and identity of a set of regression lines, Multiple correlation & Partial correlation coefficients and related problems.   (14L)

References:
   1.   A.M. Gun, M.K. Gupta & B. Dasgupta : Fundamentals of Statistics (Vol. 2).
   2.   A.M. Gun, M.K. Gupta & B. Dasgupta : An Outline of Statistical Theory (Vol.   1).
   3.   C.R. Rao : Linear Statistical Inference.

Course Objective: Linear algebra is a prerequisite of this course. This course introduces a student to gauss Markov linear model and estimation of the parameters arising in such a model. Real life problems where the response is continuous and the explanatory variable is (i) intrinsically qualitative and (ii) intrinsically quantitative will be studied. This will open up two branches of study namely Analysis of Variance and Regression respectively.

Paper Structure:

No of Ques to be set		No of Ques to be answered		Marks	Marks	Total Marks
short	long	Short	long	(short ques)	(long ques)	
4	3	2	2	5x2=10	15x2=30	**40**

Semester: V

Paper Code: ST35101T
Group: B
Topic: Time Series
Lecture hrs: 39+6 (tutorials) = 45

Introduction: Examples of time series (discrete and continuous), time series as a sequence of random variables, objectives of time series analysis, some simple time series models: zero mean models (iid noise and random walk), models with trend and seasonality and stationary models (mean, variance, auto-covariance functions and weak stationarity), a general approach to time series modeling, measures of goodness of fit of time series models.   (8L)

Analysis of trend and seasonal components: Classical decomposition models, estimation and elimination of trend in absence of seasonality (simple and weighted moving averages and polynomial fitting), elimination of trend by differencing, use of inverted delta and B operators, estimation and elimination of both trend and seasonality (method of averages).   (12L)

Analysis of residuals: Difference sign and Run test.   (2L)

Probability models for stationary time series: Moving Average (MA) Auto-regressive (AR) models, correlogram analysis, fitting of MA(1) , AR(1) and AR(2) models using Yule- Walker equations.   (13L)

Forecasting:
Extrapolation of trend curves, fitting of asymptotic growth curves and simple exponential smoothing.   (4L)

References:
1. Brockwell & Davis : Introduction to Time Series & Forecasting.
2. Cooray : Applied Time Series.
3. Chatfield : Analysis of Time Series.

Course Objective: At the end of the course on Time Series Analysis a student should be able to:
1. Identify a time series and time series data and understand its basic difference from other types of data.
2. Remove the major components viz trend, seasonal and cyclical from the data using appropriate models.
3. Study the behavior of the residual series.
4. Apply an analysis for stationarity of the residual series if possible.
5. Predict future observations of the series.

Paper Structure:

No of Ques to be set	No of Ques to be	Marks	Marks	Total

		answered				Marks
short	long	Short	long	(short ques)	(long ques)	
4	3	2	2	5x2=10	15x2=30	**40**

Semester: V
Paper Code: ST35111T
Group: A
Topic: Statistical Inference 2
Lecture hrs: 52+8 (tutorials) = 60

Data Reduction: Partition of a sample space by a statistic, Principle of Sufficiency, Sufficient Statistic, Factorization theorem (proof for discrete cases only), Minimal Sufficiency (concept only), Completeness and Exponential family of distributions. (10L)

Techniques for obtaining UMVUE: Cramer-Rao lower bound (derivation for continuous cases only), Rao-Blackwell and Lehmann-Scheffe theorem. (6L)

Methods of Estimation: Method of Moments, Likelihood principle, Maximum Likelihood estimators & their accuracy, invariance and sufficiency. Use of score function. (8L)

Neyman-Pearson Theory: Size and Power function, Critical function of a test. Randomized test. Most Powerful (MP), Uniformly Most Powerful (UMP) tests. Fundamental Neyman-Pearson Lemma (proof for the sufficiency part only) & its use in the construction of MP & UMP tests (single parameter with range independent of the parameter). Concept of a unbiased test and Uniformly Most Powerful Unbiased (UMPU) test. (11L)

Interval Estimation: Applications to Difference of means, Ratio of variances & the regression & correlation coefficients of a Bivariate Normal distribution. Confidence belt, Shortest confidence interval. Relationship of confidence interval with testing of hypothesis. (9L)

Likelihood-based Test: Likelihood Ratio test and its application. (6L)

Multiple Comparisons: Combination of Probabilities, Bonferroni procedure. (2L)

References:
1. A.M. Gun, M.K. Gupta & B. Dasgupta : Fundamentals of Statistics (Vol. 2).
2. Kale : A first course in Parametric Inference
3. Casella & Berger : Statistical Inference
4. Hogg & Craig : Mathematical Statistics.

Course Objective: This course is a continuation to Statistical Inference 1. Two branches of Statistical Inference namely Estimation (both point and interval) and testing of hypothesis would be studied under a parametric set up. In estimation theory one would learn the different criteria for good estimators and techniques to develop optimal estimators. Similarly in testing of hypothesis one would learn the different optimal tests and methods to develop such optimal tests.

Paper Structure:

No of Ques to be set		No of Ques to be answered		Marks	Marks	Total marks
short	long	short	long	(short ques)	(long ques)	
4	5	2	3	5x2=10	15x3=45	**55**

Semester: V
Paper Code: ST35111T
Group: B
Topic: Non Parametric Inference
Lecture hrs: 26+ 4(tutorial) =30

Introduction: Distribution free approach vs. non-parametric approach. Empirical distribution functions.   (2L)

Test for location: One sample problems - Sign test and Wilcoxon signed rank test (including bivariate case), median test. Two sample problem – Wilcoxon rank sum test, Mann-Whitney U test, Mood's median test.   (10L)

Test for identity of two populations: Kolmogorov-Smirnov test, Wald-Wolfowitz run test.   (4L)

Test for randomness: Run test.   (2L)

Interval Estimation: Distribution free confidence limits and tolerance limits. Confidence limits for distribution function and population quantiles, tolerance limits for a continuous distribution.
                                                                                       (8L)

References:

1. Goon, Gupta & Dasgupta : An Outline of Statistical Theory (Vol 2).
2. Hogg & Craig : Mathematical Statistics.

Course Objective: This course mainly deals with testing of hypothesis problems where no or minimal assumptions are made on the distribution of the parent population from where the random sample is drawn.
Paper Structure:

No of Ques to be set		No of Ques to be answered		Marks	Marks	Total marks
Short	long	short	Long	(short ques)	(long ques)	
4	2	2	1	5x1=5	15x1=15	**25**

Semester: V
Paper Code: ST35121T
Group: A
Topic: **Statistical Inference 3**
Lecture hrs: 52 + 8 (tutorials) =60

Limit Theorems: Convergence in Probability, Weak Laws of Large Numbers and their applications, Convergence in Distribution, relation between two kind of convergence, Slutsky's Theorem, De-Moivre-Laplace Limit Theorem. Normal approximation to Poisson distribution, Statement of Central Limit Theorem (iid case) and its use in test and confidence interval for binomial proportions and Poisson means (10L)

Standard Errors of Statistics: Derivation and uses of large sample standard error of sample moments, Standard deviation, Coefficient of Variation, b_1 & b_2 measures, Correlation coefficient. Asymptotic distribution of sample quantiles. (14L)

Variance Stabilization: Transformation of Statistics, Derivation and use of $\sin^{-1}$, square root, logarithmic & Fisher's Z- transformations. (10L)

Asymptotic Property of Estimators: Consistency Asymptotic efficiency, ARE, CAN and BAN estimators. Properties of MLE (statement only) and their uses in testing and confidence interval. (8L)

Pearsonian χ^2: Large Sample distribution of Pearsonian χ^2 statistic & its uses (goodness of fit, independence, homogeneity). Yates' correction in a 2x2 contingency table. (10L)

References:
1. A.M.Gun, M.K. Gupta & B.Dasgupta:An Outline of Statistical Theory (Vol.1&2)
2. P. Mukhopadhyay : Mathematical Statistics.
3. V.K. Rohatgi & A.K.M.E. Saleh: An Introduction to Probability and Statistics.
4. C.R. Rao: Linear Statistical Inference and its Application.
5. R.V. Hogg and A.T. Craig: Introduction to Mathematical statistics.

Course Objective: At the end of the course students should
1. Understand different modes of convergence of statistics and inter-relationship among them.

2. Come to know about Central Limit Theorem and its applications.
3. Understand the large sample behaviour of different statistics (based on both moments and quantiles) relating to estimation and tests of hypothesis.
4. Come to know about various transformations on statistics and their use in inferential problems.
5. Come to know about Pearsonian Chi-Square statistic and its uses.

Paper Structure:

No of Ques to be set		No of Ques to be answered		Marks	Marks	Total marks
short	long	short	long	(short ques)	(long ques)	
4	5	2	3	5x2=10	15x3=45	**55**

Semester: V
Paper Code: ST35121T
Group: B
Topic: Sample Survey 1
Lecture hrs: 26+ 4(tutorials)=30

Sample Survey 1:

Introduction: Concepts of finite population & sample, Need for sampling, Complete enumeration & sample surveys, Judgment & Probability sampling. (6L)

Sampling & Estimation Procedures: Simple Random Sampling with & without replacement. Random Number Tables & their uses. Stratified Random Sampling. Cluster Sampling, Two-Stage (with equal sized first stage units) Sampling with equal selection probabilities at each stage; Associated unbiased estimators of population total, mean & proportion, Associated variances & unbiased variance estimators. Determination of sample size in simple random sampling. Allocation problem in stratified random sampling, optimum choice of sampling & sub-sampling fractions in two-stage sampling. (20L)

References:
1. A.M. Gun, M.K. Gupta & B. Dasgupta : Fundamentals of Statistics (Vol. 2).
2. W.G. Cochran: Sampling Techniques.
3. M.N. Murthy: Sampling Theory and Methods.
4. Des Raj & P. Chandhok : Sample Survey Theory.
5. P. Mukhopadhyay : Theory and Methods of Survey Sampling.
6. S. Sampath : Sampling Theory and Methods.

Course Objective: This course introduces a student to the need for probability sampling when we cannot assume any population distribution. A student is expected to get oriented with

different sampling schemes like simple random sampling, Stratified Random Sampling, cluster and two-stage sampling with the situations where the respective schemes are applicable. Under each sampling scheme need for good estimation procedure are discussed.

Paper Structure:

No of Ques to be set		No of Ques to be answered		Marks	Marks	Total marks
Short	long	short	Long	(short ques)	(long ques)	
4	2	2	1	5x1=5	15x1=15	**25**

Semester: V
Topic: R and Data Analysis using Minitab

Paper Structure: All questions in this paper are compulsory

R: Linear model and time series
Minitab: Statistical Inference 2, Statistical Inference 3, Non Parametric, sample Survey1

Module	Topic	Marks
1	R	20
2	Data Analysis through MINITAB	50
	Viva-Voce	10
	Total	**80**

Semester: VI
Paper Code: ST36121T
Group: A
Topic: Design of Experiments
Lecture hrs: 52 + 8 (tutorials) =60

Design of Experiments

Principles of Experimental Design: Comparative experiments, Randomization, Replication & Local control (Error control by blocking).   (5L)

Standard Designs & Analysis: Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD), Comparison of efficiencies, Missing plot techniques

(one missing observation).   (15L)

Checking of model assumptions: Use of residual plot and its application to CRD. Multiple comparisons.   (5L)

Groups of Experiments: Groups of experiments using RBD & LSD.   (7L)

Factorial Experiments: 2^n experiments- Uses & Advantages, Construction and analysis of total & partial confounded designs. Fractional factorial design. Balancing in factorial design.   (14L)

ANCOVA: Uses in the control of errors in CRD and RBD with one concomitant variable.   (6L)

References:

1.   A.M. Gun, M.K. Gupta & B. Dasgupta : Fundamentals of Statistics (Vol. 2).
2.   M.N. Das & N.C. Giri : Design and Analysis of Experiments.
3.   D.C. Montgomery : Design and Analysis of Experiments.
4.   A. Dean and D. Voss : Design and Analysis of Experiments.

Course Objective: This course deals with controlled experiments where a student is expected to learn the basic principles of designing an experiment and developing simple designs. Opposed to the simple experiments there would arise many practical situations where studying the effect of more than one treatment factor (simultaneously) on the response will be necessary. This would open up the branch on "factorial experiments". There would be a continuation of Gauss Markov model where the explanatory variable is partly qualitative and partly quantitative giving rise to ANCOVA problems.

Paper Structure:

No of Ques to be set		No of Ques to be answered		Marks	Marks	Total marks
short	long	short	long	(short ques)	(long ques)	
4	5	2	3	5x2=10	15x3=45	**55**

Semester: VI
Paper Code: ST36121T
Group: B
Topic: Sample Survey 2
Lecture hrs: 26+ 4(tutorials) =30

Sample Survey 2

Sampling & Estimation Procedures: Linear & Circular Systematic sampling, Interpenetrating Sub-Sampling technique for unbiased variance estimation in systematic sampling. Ratio & Regression methods of estimation in simple random sampling. Hartley-Ross estimator. PPS sampling (with and without replacement). Cumulative total and Lahiri's method. Hansen Harwitz and Desraj estimators. Uses of double sampling in non-response and sampling on successive occasions. Randomized response – Warner's method. (20L)

General Ideas: Planning & Execution of sample surveys, Designing questionnaires & schedules, Types of non-sampling errors. (6L)

References:
1. A.M. Gun, M.K. Gupta & B. Dasgupta : Fundamentals of Statistics (Vol. 2).
2. W.G. Cochran: Sampling Techniques.
3. M.N. Murthy: Sampling Theory and Methods.
4. Des Raj & P. Chandhok : Sample Survey Theory.
5. P. Mukhopadhyay : Theory and Methods of Survey Sampling.
6. S. Sampath : Sampling Theory and Methods.

Course Objective:

This course is in continuation to the course of sample survey-I in semester 5. In this course a student is expected to know different sampling schemes like systematic sampling, double sampling and PPS sampling. Importance of introducing auxiliary variable in the improvement of estimation procedures under certain situations are to be discussed. After completion of this course a student is also expected to know how to tackle the situation when data relates to sensitive questions.

Paper Structure:

No of Ques to be set		No of Ques to be answered		Marks	Marks	Total marks
Short	long	short	Long	(short ques)	(long ques)	
4	2	2	1	5x1=5	15x1=15	**25**

Semester: VI
Paper Code: ST36561P
Topic: R and Data Analysis using Minitab

Paper Structure: All questions in this paper are compulsory

Minitab: Design of Experiments, Sample Survey

Module	Topic	Marks

1	R	20
2	Data Analysis through MINITAB	50
	Viva-Voce	10
	Total	**80**

Semester: VI
Paper Code: ST36112T
Group: A
Topic: Econometrics
Lecture hrs: 52

What is Econometrics: Comparing mathematical and econometric model with illustrative examples – consumption and production function, Stages of econometric methodology, Review of simple linear regression model.   (7L)

Heteroscedasticity: Nature of heteroscedasticity – illustrative examples, OLS method under heteroscedasticity and its consequences, detecting heteroscedasticity – residual plot, Glejser test, Goldfeld-Quandt test, remedial measure through variable transformation and generalized least squares (GLS).   (15L)

Autocorrelation: Nature of autocorrelation – illustrative examples, OLS method under autocorrelation – AR(1) model, detecting autocorrelation – residual plot, Runs test, Durbin-Watson test, GLS method for correcting autocorrelation.   (15L)

Multicollinearity: Nature of multicollinearity – illustrative examples, OLS method under perfect multicollinearity and its consequences, detecting multicollinearity – thumb rules based on R^2, pair-wise and partial correlations, remedial measures via more data, dropping and transformation of variables.   (15L)

References:
1. G.S. Maddala: Introduction to Econometrics
2. D.N. Gujarati: Basic Econometrics
3. J. Johnston and J. Dinardo: Econometric Methods

Course Objective: At the end of the course students should

1.   Understand what Econometrics is and how it can be used for validating Economic models.
2.   Come to know about the Gauss-Markov linear model more closely and the corresponding inferential problems.
3.   Come to know how to detect the violation of the assumptions (in particular, Heteroscedasticity, Autocorrelation and Multicollinearity) of the above model, some of their effects and remedial measures.

Paper Structure:

No of Ques to be set		No of Ques to be answered		Marks	Marks	Total marks
Short	long	short	Long	(short ques)	(long ques)	
6	3	4	2	5x4=20	15x2=30	**50**

Semester: **VI**
Paper Code: **ST36112P**
Group: **B**
Topic: **Practical**
Marks: **25 + 5 (Viva Voce) =30**

All questions in this paper are compulsory. Practical based on theory topics in paper ST36112T