SIES College of Arts, Science & Commerce
(Autonomous)

Department of Statistics

Faculty: Science
Program: B.Sc.
Course: Statistics

Syllabus for F.Y.B.Sc.
(Credit Based Semester and Grading System with effect from the academic year 2018–2019)

SEMESTER I

THEORY

TITLE OF COURSE	DESCRIPTIVE STATISTICS I			
COURSE CODE	**UNIT**	**TOPICS**	**LECTURES/ WEEK**	**CREDITS**
PAPER I SIUSSTA11	**I**	**TYPES OF DATA AND DATA CONDENSATION**	**1**	**2**
	II	**MEASURES OF CENTRAL TENDENCY**	**1**	
	III	**MEASURES OF DISPERSION, SKEWNESS & KURTOSIS**	**1**	
TITLE OF COURSE	**STATISTICAL METHODS I**			
COURSE CODE	**UNIT**	**TOPICS**	**LECTURES/ WEEK**	**CREDITS**
PAPER II SIUSSTA12	**I**	**ELEMENTARY PROBABILITY THEORY**	**1**	**2**
	II	**DISCRETE RANDOM VARIABLES AND PROBABILITY DISTRIBUTIONS**	**1**	
	III	**STANDARD DISCRETE DISTRIBUTIONS**	**1**	

PRACTICAL

COURSE CODE	PRACTICALS BASED ON	LECTURES/ WEEK	CREDITS
SIUSSTAP1	**SIUSSTA11**	**3**	**2**
	SIUSSTA12	**3**	

SEMESTER II

THEORY

TITLE OF COURSE	DESCRIPTIVE STATISTICS II			
COURSE CODE	**UNIT**	**TOPICS**	**LECTURES/ WEEK**	**CREDITS**
PAPER I SIUSSTA21	**I**	**CORRELATION AND REGRESSION ANALYSIS**	**1**	**2**
	II	**TIME SERIES**	**1**	
	III	**INDEX NUMBERS**	**1**	
TITLE OF COURSE	**STATISTICAL METHODS II**			
COURSE CODE	**UNIT**	**TOPICS**	**LECTURES/ WEEK**	**CREDITS**
PAPER II SIUSSTA22	**I**	**CONTINUOUS RANDOM VARIABLES**	**1**	**2**
	II	**STANDARD CONTINUOUS DISTRIBUTIONS**	**1**	
	III	**ESTIMATION AND TESTING OF HYPOTHESIS**	**1**	

PRACTICAL

COURSE CODE	PRACTICALS BASED ON	LECTURES/ WEEK	CREDITS
SIUSSTAP2	**SIUSSTA21**	**3**	**2**
	SIUSSTA22	**3**	

SYLLABUS FOR F.Y.BSc. UNDER AUTONOMY
SEMESTER I
PAPER I

Objectives :

- To be well versed with data collection techniques.
- To effectively use data visualization and summarization techniques to understand data.

Course Code	Title	Credits
SIUSSTA11	**DESCRIPTIVE STATISTICS I**	**2 Credits (45 lectures)**
UNIT I: TYPES OF DATA AND DATA CONDENSATION Types of data: Qualitative and Quantitative data, Time series data and cross section data, discrete and continuous data. Different types of scales: nominal, ordinal, interval and ratio. Concept of population and sample. Census and Sample survey. Relative merits and demerits. Statistical Organizations and their functions (CSO, NSSO). Survey findings. Primary data: Concept of a questionnaire and a schedule. Secondary data: Sources. Case studies illustrating use of Statistics in different sectors. Diagrams: Bar diagrams, Pie diagram Classification and Tabulation of categorical data up to order three. Association of attributes: Yule's coefficient of association (Q), Yule's coefficient of Colligation (Y).		**15 Lectures**
UNIT II: MEASURES OF CENTRAL TENDENCY Univariate frequency distribution of discrete and continuous variables. Cumulative frequency distribution. Graphical representation of frequency distribution by Histogram, Frequency curve, Cumulative frequency curves, Stem and leaf diagram. Central tendency of data. Requisites of a good measure of central tendency. Positional averages: Median, Mode, Partition Values: Quantiles. Mathematical averages: Arithmetic mean (Simple mean, trimmed mean, weighted mean, combined mean), Geometric mean, Harmonic mean. Merits and demerits of different measures.		**15 Lectures**
UNIT III: MEASURES OF DISPERSION, SKEWNESS & KURTOSIS Concept of dispersion. Requisites of good measure of dispersion. Absolute measures of dispersion: Range, Quartile Deviation, Mean absolute deviation, Standard deviation and corresponding relative measures of dispersion. Combined variance. Raw & Central moments and relationship between them. Concept of Skewness and Kurtosis: Absolute and Relative measures of Skewness: Karl Pearson's, Bowley's and Measure based on moments. Measure of Kurtosis based on moments. Box &Whisker Plot.		**15 Lectures**

SEMESTER I : PRACTICALS BASED ON COURSE SIUSSTA11

1. Tabulation and Classification of Data
2. Theory of attributes
3. Data Visualization (Excel)
4. Measures of central tendency I
5. Measures of central tendency II (Excel)
6. Measures of dispersion I
7. Measures of dispersion II (Excel)
8. Moments, Measures of Skewness and Kurtosis I
9. Moments, Measures of Skewness and Kurtosis II (Excel)

PAPER II

Objectives :

- To understand the concepts of probability and probability distribution
- To fit an appropriate distribution using MS excel to data sets

Course Code	Title	Credits
SIUSSTA12	**STATISTICAL METHODS I**	**2 Credits (45 lectures)**
UNIT I: ELEMENTARY PROBABILITY THEORY Random experiment, Sample space, Event, Operation of events, mutually exclusive and exhaustive events. Classical (Mathematical), Empirical (Statistical) definitions of Probability and their properties. Subjective probability. Theorems on Addition and Multiplication of probabilities. Independence of events, pair-wise and mutual independence of three events. Conditional probability, Bayes' theorem.		**15 Lectures**
UNIT II: DISCRETE RANDOM VARIABLES AND PROBABILITY DISTRIBUTIONS Concept of discrete random variable. Probability distribution and cumulative distribution function, definition and their properties. Expectation of a random variable. Theorems on Expectation & Variance. Raw and Central moments and their relationships (up to order four). Concepts of Skewness and Kurtosis. Joint (Bivariate) probability distribution of two discrete random variables. Marginal and conditional distributions. Coefficient of Correlation. Independence of two random variables.		**15 Lectures**
UNIT III: STANDARD DISCRETE DISTRIBUTIONS Discrete Uniform, Hypergeometric, Binomial and Poisson distributions: mean, variance and recurrence relation for probability, fitting of distribution. Binomial approximation to Hypergeometric distribution. Poisson approximation to Binomial distribution.		**15 Lectures**

SEMESTER I: PRACTICALS BASED ON COURSE SIUSSTA12

1. Probability
2. Conditional Probability
3. Discrete Probability distributions
4. Bivariate probability distributions
5. Standard Discrete distributions I
6. Standard Discrete distributions II
7. Use of MS Excel

SYLLABUS FOR F.Y.BSc. UNDER AUTONOMY

SEMESTER II
PAPER I

Objectives:

- To understand forecasting techniques to predict future trend in time series
- To understand concept of index numbers to calculate real income and dearness allowance,

Course Code	Title	Credits
SIUSSTA21	**DESCRIPTIVE STATISTICS II**	**2 Credits (45 lectures)**
UNIT I: CORRELATION AND REGRESSION ANALYSIS Bivariate frequency distribution, marginal and conditional distribution, Scatter Diagram, Bubble chart. Product moment correlation coefficient and its properties. Spearman's Rank correlation (with and without ties). Linear regression. Fitting a straight line by method of least squares. Coefficient of determination .Relation between regression coefficients and correlation coefficient. Fitting of curves reducible to linear form by transformation. Fitting a quadratic curve by method of least squares.		**15 Lectures**
UNIT II: TIME SERIES Definition of time series. Its components. Models of time series. Exponential Smoothing method. Estimation of trend by: Freehand curve, Method of semi averages, Method of Moving averages, Method of least squares (linear trend only). Merits and demerits of these methods. Estimation of seasonal component by, Method of simple averages, Ratio to moving average method, Ratio to trend method.		**15 Lectures**
UNIT III: INDEX NUMBERS Index numbers as a comparative tool. Stages in the construction of Index Numbers. Simple and Composite Index Numbers. Simple and weighted aggregate index numbers. Simple and weighted average of relatives. Special index numbers: Laspeyre's, Paasche's, Marshal-Edgeworth's, Dorbisch & Bowley's and Fisher's Index Numbers. Quantity Index Numbers and Value Index Number. Time reversal test, Factor reversal test, Circular test. Fixed base Index Numbers, Chain base Index Numbers, Base shifting, Splicing. Cost of living index number, Concept of real income.		**15 Lectures**

SEMESTER II: PRACTICALS BASED ON COURSE SIUSSTA21

1. Correlation analysis
2. Regression analysis
3. Correlation & Regression analysis (Excel)
4. Curve fitting (Excel)
5. Time series I
6. Time series II (Excel)
7. Index number-I
8. Index number-II

PAPER II

Objectives:

- To understand the importance of Bell curve and other distributions used in data analysis in industry.
- To assess population characteristics on the basis of sample using estimation and testing theory.

Course Code	Title	Credits
SIUSSTA22	**STATISTICAL METHODS II**	**2 Credits (45 lectures)**
UNIT I: CONTINUOUS RANDOM VARIABLES Definition of continuous random variable, probability density function and cumulative distribution function. Graphical representation and properties. Expectation of a continuous random variable, Properties. Raw and central moments, Relationship between them (up to order 4). Measures of location, dispersion, skewness and kurtosis.		**15 Lectures**
UNIT II: STANDARD CONTINUOUS DISTRIBUTIONS Uniform, Exponential (with location, scale parameter) and Normal distribution. Derivations of mean, median and variance of Uniform and Exponential distribution. Lack of memory property of exponential distribution. Properties of Normal distribution. Use of normal tables. Normal approximation to Binomial and Poisson distribution.		**15 Lectures**
UNIT III: ESTIMATION AND TESTING OF HYPOTHESIS Parameter, statistic, estimator and estimate, sampling distribution, bias and standard error of an estimator. Central Limit theorem (statement only). Sampling distributions of sample mean and sample proportion. (For large sample only) Point and Interval estimate of mean and proportion based on single sample of large size and difference between two means and proportions based on large sample sizes. Null and alternate hypotheses, Simple and composite hypothesis. Type I and II errors, Critical region, Size of the test, Level of significance. Power of the test Applications of Normal Distribution: Tests for specified value of population mean and population proportion. Tests for equality of two population means and population proportions.		**15 Lectures**

SEMESTER II: PRACTICALS BASED ON COURSE SIUSSTA22

1. Continuous distributions
2. Standard Continuous distributions
3. Normal distribution
4. Point and Interval Estimation
5. Large sample tests
6. Demonstration of Central limit theorem (Excel)
7. Use of MS Excel

REFERENCES:

1. Agarwal B.L. (1978). *Basic Statistics*: New Age International Ltd.
2. David S.(1994). *Elementary Probability* : Cambridge University Press.
3. Goon A.M., Gupta M.K.& Dasgupta B. (1968). *Fundamentals of Statistics,* Volume II: The World Press Private Limited, Calcutta.
4. Gupta S.C.& Kapoor V.K.(2007).*Fundamentals of Mathematical Statistics*: Sultan Chand &Sons
5. Gupta S.C.& Kapoor V.K.(2014). *Fundamentals of Applied Statistics*: Sultan Chand & Sons
6. Hoel P.G.(1947). *Introduction to Mathematical Statistics*: Asia Publishing House
7. Hogg R.V. & Tannis E.P.(1977). *Probability and Statistical Inference*: McMillan Publishing Co. Inc.
8. Kothari C.R.(1985). *Research Methodology:* Wiley Eastern Limited.
9. Medhi, J. (2013).*Statistical Methods, An Introductory Text*. Second Edition: New Age International Ltd.
10. Pitan Jim. (1977) .*Probability*: Narosa Publishing House.
11. Spiegel M.R. (1961).*Theory and Problems of Statistics*. Schaum's Publications series: Tata McGraw-Hill.

EXAMINATION PATTERN

Internal Assessment of Theory per Course per Semester

1. Class Test	20 Marks.
2. Project / Assignment / Presentation etc.	20 Marks.

Semester End Theory Examination per Course

At the end of the semester, examination of 2 hours duration and 60 marks based on the three units shall be held for each course.

Pattern of Theory question paper:
There shall be four compulsory questions of 15 marks each (with Internal Option).
Question 1 based on Unit I, Question 2 based on Unit II, Question 3 based on Unit III. Question 4 based on all three units.

Semester End Practical Examination per Course

1. Journal	10 Marks.
2. Practical Examination	40 Marks.

At the end of the semester, practical examination of 1 hour 30 minutes duration and 40 marks shall be held for each course.

Pattern of Practical question paper:
There shall be four compulsory questions of 10 marks each (with Internal Option).
Question 1 based on Unit I, Question 2 based on Unit II, Question 3 based on Unit III. Question 4 based on all three units.

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SEMESTER III

THEORY

TITLE OF COURSE	PROBABILITY DISTRIBUTIONS			
COURSE CODE	**UNIT**	**TOPICS**	**LECTURES/WEEK**	**CREDITS**
PAPER I SIUSSTA31	**I**	**UNIVARIATE RANDOM VARIABLES (DISCRETE AND CONTINUOUS)**	**1**	**2**
	II	**STANDARD DISCRETE PROBABILITY DISTRIBUTIONS**	**1**	
	III	**STANDARD CONTINUOUS PROBABILITY DISTRIBUTIONS**	**1**	
TITLE OF COURSE	**THEORY OF SAMPLING**			
COURSE CODE	**UNIT**	**TOPICS**	**LECTURES/WEEK**	**CREDITS**
PAPER II SIUSSTA32	**I**	**CONCEPTS OF SAMPLING & SIMPLE RANDOM SAMPLING**	**1**	**2**
	II	**STRATIFIED SAMPLING**	**1**	
	III	**RATIO & REGRESSION ESTIMATION AND SAMPLING METHODS**	**1**	
TITLE OF COURSE	**OPERATIONS RESEARCH I**			
COURSE CODE	**UNIT**	**TOPICS**	**LECTURES/WEEK**	**CREDITS**
PAPER III SIUSSTA33	**I**	**LINEAR PROGRAMMING PROBLEM**	**1**	**2**
	II	**TRANSPORTATION PROBLEM**	**1**	
	III	**ASSIGNMENT PROBLEM & SEQUENCING**	**1**	

PRACTICALS

COURSE CODE	PRACTICALS BASED ON	LECTURES/ WEEK	CREDITS
SIUSSTAP3	**SIUSSTA31**	**3**	**3**
	SIUSSTA32	**3**	
	SIUSSTA33	**3**	

SEMESTER IV

THEORY

TITLE OF COURSE	PROBABILITY AND SAMPLING DISTRIBUTIONS			
COURSE CODE	**UNIT**	**TOPICS**	**LECTURES/ WEEK**	**CREDITS**
PAPER I SIUSSTA41	**I**	**NORMAL DISTRIBUTION**	**1**	**2**
	II	**BIVARIATE PROBABILITY DISTRIBUTIONS**	**1**	
	III	**EXACT SAMPLING DISTRIBUTIONS**	**1**	
TITLE OF COURSE	**ANALYSIS OF VARIANCE & DESIGN OF EXPERIMENTS**			
COURSE CODE	**UNIT**	**TOPICS**	**LECTURES/ WEEK**	**CREDITS**
PAPER II SIUSSTA42	**I**	**ANALYSIS OF VARIANCE**	**1**	**2**
	II	**DESIGN OF EXPERIMENTS**	**1**	
	III	**LATIN SQUARE DESIGN & FACTORIAL EXPERIMENTS**	**1**	
TITLE OF COURSE	**OPERATIONS RESEARCH II**			
COURSE CODE	**UNIT**	**TOPICS**	**LECTURES/ WEEK**	**CREDITS**
PAPER III SIUSSTA43	**I**	**CPM AND PERT**	**1**	**2**
	II	**GAME THEORY**	**1**	
	III	**DECISION THEORY**	**1**	

PRACTICALS

COURSE CODE	PRACTICALS BASED ON	LECTURES/ WEEK	CREDITS
SIUSSTAP4	**SIUSSTA41**	**3**	**3**
	SIUSSTA42	**3**	
	SIUSSTA43	**3**	

SYBSc SYLLABUS UNDER AUTONOMY
SEMESTER III

PAPER I

Objectives:

- To study characteristics of discrete and continuous distributions.
- To learn R software to study distributions.

Course Code	Title	Credits
SIUSSTA31	**PROBABILITY DISTRIBUTIONS**	**2 Credits (45 lectures)**
UNIT I: UNIVARIATE RANDOM VARIABLES (DISCRETE AND CONTINUOUS) Moment Generating Function, Cumulant generating Function and Characteristic function-Definition and properties: Effect of change of origin and scale, MGF, CGF and Characteristic function of sum of n independent random variables, moments from MGF, CGF and Characteristic function. Relationship between moments and cumulants. Transformation of univariate random Variable.		**15 Lectures**
UNIT II :STANDARD DISCRETE PROBABILITY DISTRIBUTIONS Degenerate, Uniform, Two point, Bernoulli, Binomial, Poisson, Geometric, Negative Binomial, Hypergeometric, Truncated Binomial, Truncated Poisson (point of truncation 0) distributions. The following aspects (wherever applicable) of the above distributions to be discussed: Probability mass function, Cumulative distribution function, Mean, Mode and Standard deviation. Moment Generating Function, Cumulant Generating Function, Additive property, Recurrence relation for Central Moments, Skewness and Kurtosis, Limiting distribution, Fitting of Distribution.		**15 Lectures**
UNIT III : STANDARD CONTINUOUS PROBABILITY DISTRIBUTIONS Rectangular, Triangular with parameters (a, b, c), Exponential, Gamma (with one & two parameters), Beta (Types I & II). Cauchy (with one & two parameters) The following aspects of the above distributions(wherever applicable) to be discussed: Mean, Median, Mode & Standard deviation. Moment Generating Function,		**15 Lectures**

Additive property, Cumulant Generating Function. Skewness and Kurtosis (without proof). Fitting of Distribution. Interrelations between the distributions.	

SEMESTER III: PRACTICALS BASED ON COURSE SIUSSTA31

1. Moment Generating Function, Cumulant Generating Function.
2. Characteristic Function, Transformation of univariate discrete & continuous random variables.
3. Standard Discrete Distributions.
4. Fitting of Standard Discrete Distributions.
5. Standard Continuous distributions.
6. Fitting of Standard Continuous Distributions.
7. Use of R.

REFERENCES:

1. Goon A.M., Gupta M.K & Dasgupta B. (2013). *An Outline of Statistical Theory*,
2. Gupta S.C.& Kapoor V.K. (2007).*Fundamentals of Mathematical Statistics*: Sultan Chand & Sons
3. Hoel P. G. (1966). *Introduction to Mathematical Statistics*, Fourth Edition : John Wiley & Sons Inc.
4. Hogg R. V.& Craig A.T.(2012) *Introduction to Mathematical Statistics*, Seventh Edition: Collier McMillan Publishers.
5. Hogg R. V.& Tannis E. A. (1988). *Probability and Statistical Inference*, Third Edition: Collier McMillan Publishers.
6. Kapur J. N.& Saxena H.C. *Mathematical Statistics*, Fifteenth Edition : S. Chand & Company Ltd.
7. Medhi J. (2013). *Statistical Methods*; *An Introductory Text*, Second Edition: Wiley Eastern Ltd.

8. Miller I., Miller M.& Freund J.E.(1999)*John E. Freund's Mathematical Statistics*, Sixth Edition: Pearson Education Inc.
9. Mood A. M., Graybill F.A., & Boyes D. C. (2001). *Introduction to the theory of Statistics,* Third Edition: McGraw-Hill Book Company.

Vol. 1, Third Edition: The World Press Pvt. Ltd.

PAPER II

Objectives:

- To learn different methods of data collection.
- To analyse the collected data using sampling techniques.

Course Code	Title	Credits
SIUSSTA32	**THEORY OF SAMPLING**	**2 Credits (45 lectures)**
UNIT I: CONCEPTS OF SAMPLING & SIMPLE RANDOM SAMPLING Population, Population unit, Sample, Sample unit, Parameter, Statistic, Estimator, Bias, Unbiasedness, Mean square error & Standard error. Census survey, Sample Survey. Steps in conducting a sample survey, Designing appropriate Questionnaire. Sampling and Non-sampling errors. NSSO, CSO and functions. Methods of Probability and Non Probability sampling. Definition, Sampling with & without replacement (WR/WOR). Lottery method & use of Random numbers to select Simple random sample. Estimation of population mean & total. Expectation & Variance of the estimators, Unbiased estimator of variance of these estimators. (WR/WOR).Estimation of population proportion and total. Expectation & Variance of the estimators, Unbiased estimator of variance of these estimators. (WR/WOR).Estimation of Sample size based on a desired accuracy in case of SRS for variables & attributes. (WR/WOR).		**15 Lectures**
UNIT II: STRATIFIED SAMPLING Need for Stratification of population. Definition of Stratified Sample. Advantages of Stratified Sampling. Estimation of population mean & total in case of Stratified Random Sampling (WOR within each strata). Expectation & Variance of the unbiased estimators, Unbiased estimators of variances of these estimators. Proportional allocation, Optimum allocation with and without varying costs. Comparison of Simple Random Sampling, Stratified Random Sampling using Proportional allocation & Neyman allocation. Estimation of population proportion & total in case of Stratified Random Sampling (WOR within each strata).		**15 Lectures**
UNIT III: RATIO & REGRESSION ESTIMATION AND SAMPLING METHODS Ratio Estimators for population Ratio, Mean & Total. Expectation & MSE of the Estimators. Estimators of MSE.		**15 Lectures**

Regression Estimators for population Mean & Total. Expectation & Variance of the Estimators assuming known value of regression coefficient 'b'. Estimation of 'b'. Resulting variance of the estimators. Comparison of Ratio, Regression & mean per unit estimators. Introduction to Systematic sampling, Cluster sampling & Two Stage sampling.	

SEMESTER III: PRACTICALS BASED ON COURSE SIUSSTA32

1. Designing of Questionnaire.
2. Simple Random Sampling for Variables.
3. Simple Random Sampling for Attributes.
4. Estimation of Sample Size in Simple Random Sampling.
5. Stratified Random Sampling.
6. Ratio Estimation.
7. Regression Estimation.

REFERENCES:

1. Cochran. W.G. (1978). *Sampling Techniques*, Third Edition: Wiley Eastern Limited
2. Daroga Singh & F.S .Chaudhary. (1986).*Theory and Analysis of Sample Survey Design :* Wiley Eastern Ltd
3. Des Raj. (1968).*Sampling Theory*: McGraw Hill Series in Probability and Statistics.
4. Gupta S.C.& Kapoor V.K. (2007).*Fundamentals of Mathematical Statistics*: Sultan Chand & Sons
5. Mukhopadhyay P. (1998). *Theory and Methods of Survey Sampling*: Prentice Hall of India
6. Murthy M.N.(1967). *Sampling Theory and methods*: Statistical Publishing Society.
7. P.V. Sukhatme & B.V. Sukhatme. (1984). *Sampling Theory of Surveys with Applications*, Third Edition: Iowa State University Press.

   Pvt. Ltd.
8. Sampath S.(2005). *Sampling Theory and Methods,* Second Edition: Narosa Publishing House

PAPER III

Objectives:

- To understand typical industry problems like transportation, assignment etc.
- To learn MS Excel to solve problems related to optimization.

Course Code	Title	Credits
SIUSSTA33	**OPERATIONS RESEARCH I**	**2 Credits (45 lectures)**
UNIT I: LINEAR PROGRAMMING PROBLEM Mathematical Formulation: Maximization & Minimization. Solution, Feasible Solution, Basic Feasible Solution, Optimal solution. Graphical Solution for problems with two variables. Simplex method of solving problems with two or more variables. Big M method. Concept of Duality. Its use in solving L.P.P. Relationship between optimum solutions of Primal and Dual. Economic interpretation of Dual.		**15 Lectures**
UNIT II: TRANSPORTATION PROBLEM Mathematical Formulation, Solution, Feasible Solution. Initial Basic Feasible Solution by North-West Corner Rule, Matrix Minima Method, Vogel's Approximation Method. Optimal Solution by MODI Method. Optimality test, Improvement procedure. Variants in Transportation Problem: Unbalanced, Maximization, Prohibited route type.		**15 Lectures**

UNIT III: ASSIGNMENT PROBLEM & SEQUENCING Assignment: Mathematical Formulation. Solution by Complete Enumeration Method and Hungarian method. Variants in Assignment Problem: Unbalanced, Maximization type, Restricted (prohibited) route. Travelling Salesman Problem. Sequencing Problem: Processing n Jobs through 2 and 3 Machines & 2 Jobs through m Machines.	**15 Lectures**

SEMESTER III: PRACTICALS BASED ON COURSE SIUSSTA33

1. Formulation and Graphical Solution of L.P.P.
2. Simplex Method.
3. Duality.
4. Transportation.
5. Assignment.
6. Sequencing.
7. Use of TORA & MS Excel Solver

REFERENCES:

1. Bronson R. (1997). *Schaum Series book in Operations Research.* Second edition: Tata McGraw Hill Publishing Company Ltd.
2. Kantiswaroop & Gupta M. (2010). *Operations Research*, Twelfth Edition: S Chand & Sons.
3. Sasieni M., Yaspan A.& Friedman L. (1959).*Operations Research; Methods and Problems*: John Wiley & Sons.
4. Sharma J. K. (1989). *Mathematical Models in Operations Research* :Tata McGraw Hill Publishing Co. Ltd.
5. Sharma J.K. (2001). *Quantitative Techniques for Managerial Decisions*: MacMillan India Ltd.
6. Sharma S.D. *Operations Research*. Eleventh Edition: Kedar Nath Ram Nath & Company.
7. Taha H. A.(2010). *Operations Research*. Ninth Edition: Prentice Hall of India.
8. Wagner H. M. (1970). *Principles of Operations Research with Applications to Management Decisions*, Second Edition : Prentice Hall of India Ltd.

SYBSc SYLLABUS UNDER AUTONOMY
SEMESTER IV
PAPER I

Objectives:

- To study normal distribution and its applications.
- To use sampling distributions in testing equality of means, independence of attributes, goodness of fit, etc.

Course Code	Title	Credits
SIUSSTA41	**PROBABILITY AND SAMPLING DISTRIBUTIONS**	**2 Credits (45 lectures)**

UNIT I: NORMAL DISTRIBUTION Mean, Median, Mode, Standard deviation, Moment Generating function, Cumulant Generating function, Moments & Cumulants (up to fourth order). Recurrence relation for central moments, skewness & kurtosis, Mean absolute deviation. Distribution of linear function of independent Normal variables. Fitting of Normal Distribution. Central Limit theorem for iid random variables. Log Normal Distribution: Mean, variance, distribution of product of independent log normal variables.	**15 Lectures**
UNIT II: BIVARIATE PROBABILITY DISTRIBUTIONS Joint Probability mass function for Discrete random variables**,** Joint Probability density function for continuous random variables and properties. Marginal and conditional Distributions. Independence of Random Variables. Conditional Expectation & Variance. Regression Function. Coefficient of Correlation. Transformation of Random Variables and Jacobian of transformation.	**15 Lectures**
UNIT III: EXACT SAMPLING DISTRIBUTIONS Chi-Square Distribution: Concept of degrees of freedom. Mean, Median, Mode & Standard deviation. Moment generating function, Cumulant generating function. Additive property, Distribution of the sum of squares of independent Standard Normal variables. Sampling distributions of sample mean and sample variance and their independence for a sample drawn from Normal distribution (without	**15 Lectures**

proof).Applications of Chi-Square: Confidence interval for the variance of a Normal population, Test of significance for specified value of variance of a Normal population. Test for goodness of fit, Test for independence of attributes, Yates' correction. t-distribution: Derivation of p.d.f. of t ,Mean, Median, Mode & Standard deviation.. Asymptotic properties. Students's t, Applications of t: Confidence interval for: Mean of Normal population, difference between means of two independent Normal populations having the same variance. Test of significance of: mean of a Normal population, difference in means of two Normal populations (based on independent samples with equal variances & dependent samples). F-distribution: Mean, Mode & Standard deviation. Distribution of Reciprocal of an F variate, Ratio of two independent Chi-squares divided by their respective degrees of freedom. Interrelationship of F with t-distribution, Chi-square distribution & Normal distribution. Applications of F .Confidence interval for ratio of variances of two independent Normal populations. Test for equality of variances of two independent Normal populations.	

SEMESTER IV: PRACTICALS BASED ON COURSE SIUSSTA41

1. Normal Distribution
2. Fitting of Normal distribution, Central Limit Theorem.
3. Bivariate Probability Distributions.
4. Transformation of bivariate continuous random variables.
5. Chi Square distribution.
6. t distribution.
7. F distribution.
8. Use of R

REFERENCES:

1. Goon A.M., Gupta M.K & Dasgupta B. (2013). *An Outline of Statistical Theory*. Vol. 1, Third Edition: The World Press Pvt. Ltd.
2. Gupta S.C.& Kapoor V.K. (2007). *Fundamentals of Mathematical Statistics*: Sultan Chand & Sons
3. Hoel P. G. (1966). *Introduction to Mathematical Statistics*, Fourth Edition : John Wiley & Sons Inc.
4. Hogg R. V. & Tannis E. A. (1988). *Probability and Statistical Inference*, Third Edition: Collier McMillan Publishers.
5. Hogg R. V. &Craig A.T. (2012) *Introduction to Mathematical Statistics*. Seventh Edition: Collier McMillan Publishers.
6. Kapur J. N.& Saxena H.C. *Mathematical Statistics*, Fifteenth Edition : S. Chand & Company Ltd.
7. Medhi J. (2013). *Statistical Methods*: *An Introductory Text*. Second Edition: Wiley Eastern Ltd.

8. Miller I., Miller M., Freund J.E. (1999) *John E. Freund's Mathematical Statistics*, Sixth Edition: Pearson Education Inc.
9. Mood A. M., Graybill F.A.& Boyes D. C. (2001). *Introduction to the theory of Statistics.* Third Edition: McGraw-Hill Book Company.

PAPER II

Objectives:

- To design an experiment for specified objectives.
- To evaluate the data collected using ANOVA techniques.

Course Code	Title	Credits
SIUSSTA42	**ANALYSIS OF VARIANCE & DESIGN OF EXPERIMENTS**	**2 Credits (45 lectures)**
UNIT I: ANALYSIS OF VARIANCE Introduction, Cochran's Theorem (Statement only). One way classification with equal & unequal observations per class, Two way classification with one observation per cell. Mathematical Model, Assumptions, Expectation of various sum of squares, F- test, Analysis of variance table. Least square estimators of the parameters, Variance of the estimators, Estimation of treatment contrasts, Standard Error and Confidence limits for elementary treatment contrasts.		**15 Lectures**
UNIT II: DESIGN OF EXPERIMENTS Experiment, Experimental unit, Treatment, Yield, Block, Replicate, Experimental Error, Precision. Principles of Design of Experiments: Replication, Randomization & Local Control. Efficiency of design D1 with respect to design D2. Choice of size, shape of plots & blocks in agricultural & non agricultural experiments. Completely Randomized Design (CRD) & Randomized Block Design (RBD): Mathematical Model, Assumptions, Expectation of various sum of squares, F-test, Analysis of variance table, Advantages. Least square estimators of the parameters, Variance of the estimators, Estimation of treatment contrasts, Standard error and Confidence limits for elementary treatment contrasts. Efficiency of RBD relative to a CRD. Missing plot technique for one missing observation in case of CRD and RBD.		**15 Lectures**

UNIT III: LATIN SQUARE DESIGN & FACTORIAL EXPERIMENTS: Latin Square Design: Mathematical Model, Assumptions, Expectation of various sum of squares, F-test, Analysis of variance table, Advantages. Least square estimators of the parameters, Variance of the estimators, Estimation of treatment contrasts, Standard error and Confidence limits for elementary treatment contrasts. Efficiency of the design relative to RBD, CRD. Missing plot technique for one missing observation in case of LSD Factorial Experiments: Advantages. 2^2, 2^3 Experiments. Definition of Orthogonal Contrast, Calculation of Main & Interaction Effects. Yates' method. Analysis of 2^2& 2^3 factorial Experiments.	**15 Lectures**

SEMESTER IV: PRACTICALS BASED ON COURSE SIUSSTA42

1. One way Analysis of Variance.
2. Two way Analysis of Variance.
3. Completely Randomized Design.
4. Randomized Block Design.
5. Latin Square Design.
6. Missing Observations in CRD, RBD & LSD.
7. Factorial Experiments.
8. Use of R

REFERENCES:

1. Cochran W.G.& Cox G.M.(1992). *Experimental Designs*, Second Edition: John Wiley and Sons.
2. Das M.N.& Giri N.C. (1986). *Design and Analysis of Experiments.* Second Edition: New Age International (P) Limited.
3. Federer W.T.(1955). *Experimental Design, Theory and Application*: Oxford & IBH Publishing Co. Pvt. Ltd.

4. Gupta S.C.& Kapoor V. K. (2001) *Fundamentals of Applied Statistics*, Third Edition: Sultan Chand and Sons.

5. Kempthorne O.(1994). *The Design and Analysis of Experiments*: John Wiley and Sons.

6. Montgomery D.C.(2012).*Design and Analysis of Experiments*, Sixth Edition :John Wiley & Sons.

7. Winer B.J. (1962). *Statistical Principles in Experimental Design* : McGraw Hill Book Co.

PAPER III

Objectives:

- To understand planning and evaluation of project.
- To acquire skills in strategy planning and decision making.

Course Code	Title	Credits
SIUSSTA43	**OPERATIONS RESEARCH II**	**2 Credits (45 lectures)**
UNIT I: CPM AND PERT Objective and Outline of the techniques. Diagrammatic representation of activities in a project: Gantt Chart and Network Diagram. Slack time and Float times. Determination of Critical path. Probability consideration in project scheduling. Project cost analysis. Updating.		**15 Lectures**
UNIT II: GAME THEORY Definitions of two person zero sum game, saddle point, value of the game, pure and mixed strategy, optimal solution of two person zero sum game, dominance property, derivation of formulae for 2x2 game. Graphical solution of (2 x n) and (m x 2) game. Reduction of game theory to LPP.		**15 Lectures**

UNIT III: DECISION THEORY Decision making under uncertainty: Laplace criterion, Maximax (Minimin) criterion, Maximin (Minimax) criterion, Hurwitz α criterion, Minimax Regret criterion. Decision making under risk: Expected Monetary Value criterion, Expected Opportunity Loss criterion, Expected Payoff of Perfect Information (EPPI), Expected Value of Perfect Information (EVPI). Bayesian Decision rule for Posterior analysis. Decision tree analysis along with Posterior probabilities.	**15 Lectures**

SEMESTER IV: PRACTICALS BASED ON COURSE SIUSSTA43

1. Gantt chart and CPM
2. PERT
3. Project cost analysis
4. Updating
5. Game Theory I
6. Game Theory II

7. Decision Theory I
8. Decision Theory II
9. QM for windows

REFERENCES:

1. Bronson R. (1997). *Schaum Series book in Operations Research.* Second edition: Tata McGraw Hill Publishing Company Ltd.
2. Kantiswaroop & Gupta M. (2004). *Operations Research*. Fourth Edition: S Chand & Sons.
3. Sasieni M., Yaspan A.& Friedman L. (1959).*Operations Research; Methods and Problems*: John Wiley & Sons.
4. Sharma J. K. (1989). *Mathematical Models in Operations Research:* Tata McGraw Hill Publishing Co. Ltd.
5. Sharma J.K. (2001). *Quantitative Techniques for Managerial Decisions*: MacMillan India Ltd.
6. Sharma S.D. *Operations Research,* Eleventh Edition: Kedar Nath Ram Nath & Company.
7. Srinath L. S. (2001). *PERT and CPM, Principles and Applications*. Third Edition: East-West Press Pvt. Ltd.
8. Taha H. A. (2010). *Operations Research*. Ninth Edition: Prentice Hall of India.

EXAMINATION PATTERN

Internal Assessment of Theory per Course per Semester

1. Class Test 20 Marks.
2. Project / Assignment / Presentation etc. 20 Marks.

Semester End Theory Examination per Course

At the end of the semester, examination of 2 hours duration and 60 marks based on the three units shall be held for each course.

Pattern of Theory question paper:

There shall be four compulsory questions of 15 marks each (with Internal Option).

Question 1 based on Unit I, Question 2 based on Unit II, Question 3 based on Unit III. Question 4 based on all three units.

Semester End Practical Examination per Course

1. Journal 10 Marks.
2. Practical Examination 40 Marks.

At the end of the semester, practical examination of 1 hour 30 minutes duration and 40 marks shall be held for each course.

Pattern of Practical question paper:

There shall be four compulsory questions of 10 marks each (with Internal Option).

Question 1 based on Unit I, Question 2 based on Unit II, Question 3 based on Unit III. Question 4 based on all three units.

SIES College of Arts, Science & Commerce
(Autonomous)
Department of Statistics

Faculty: Science
Program: B.Sc.
Course: Statistics

Syllabus for T.Y.B.Sc.
(Credit Based Semester and Grading System with effect from the academic year 2018–2019)

SEMESTER V

THEORY

Title of Course	**PROBABILITYAND DISTRIBUTION THEORY**			
Course Code	**Unit**	**Topics**	**Lectures/ Week**	**Credits**
PAPER I SIUSSTA51	**I**	**PROBABILITY I**	**1**	**2.5**
	II	**PROBABILITY II**	**1**	
	III	**JOINT MOMENT GENERATING FUNCTION, TRINOMIAL AND MULTINOMIAL DISTRIBUTION**	**1**	
	IV	**BIVARIATE NORMAL DISTRIBUTION**	**1**	
Title of Course	**THEORY OF ESTIMATION**			
Course Code	**Unit**	**Topics**	**Lectures/ Week**	**Credits**
PAPERII SIUSSTA52	**I**	**POINT ESTIMATION AND PROPERTIES OF ESTIMATOR**	**1**	**2.5**
	II	**METHODS OF ESTIMATION**	**1**	
	III	**BAYESIAN ESTIMATION AND CONFIDENCE INTERVAL**	**1**	
	IV	**LINEAR ESTIMATION**	**1**	
Title of Course	**BIOSTATISTICS**			
Course Code	**Unit**	**Topics**	**Lectures/ Week**	**Credits**
PAPER III SIUSSTA53	**I**	**EPIDEMIC MODELS**	**1**	**2.5**
	II	**BIOASSAYS**	**1**	
	III	**CLINICAL TRIALS**	**1**	
	IV	**BIOEQUIVALENCE**	**1**	
Title of Course	**ELEMENTS OF ACTUARIAL SCIENCE**			
Course Code	**Unit**	**Topics**	**Lectures/ Week**	**Credits**
PAPER IV SIUSSTA54	**I**	**MORTALITY TABLES**	**1**	**2.5**
	II	**COMPOUND INTEREST AND ANNUITIES CERTAIN**	**1**	
	III	**LIFE ANNUITIES**	**1**	
	IV	**ASSURANCE BENEFITS**	**1**	

PRACTICALS

Course Code	Practicals based on	Lectures/ Week	Credits
SIUSSTAP51	SIUSSTA51	4	3
	SIUSSTA52	4	
SIUSSTAP52	SIUSSTA53	4	3
	SIUSSTA54	4	

SEMESTER VI

THEORY

Title of Course	DISTRIBUTION THEORY AND STOCHASTIC PROCESSES			
Course Code	Unit	Topics	Lectures/ Week	Credits
PAPER I SIUSSTA61	I	ORDER STATISTICS	1	2.5
	II	GENERATING FUNCTIONS	1	
	III	STOCHASTIC PROCESSES	1	
	IV	QUEUING THEORY	1	
Title of Course	TESTING OF HYPOTHESES			
Course Code	Unit	Topics	Lectures/ Week	Credits
PAPER II SIUSSTA62	I	MOST POWERFUL TESTS	1	2.5
	II	UNIFORMLY MOST POWERFUL & LIKELIHOOD RATIO TESTS	1	
	III	SEQUENTIAL PROBABILITY RATIO TESTS	1	
	IV	NON-PARAMETRIC TESTS	1	
Title of Course	OPERATIONS RESEARCH TECHNIQUES			
Course Code	Unit	Topics	Lectures/ Week	Credits
PAPER III SIUSSTA63	I	INVENTORY CONTROL	1	2.5
	II	REPLACEMENT	1	
	III	SIMULATION	1	
	IV	CAPITAL BUDGETING, SECURITIES MARKET, FUTURES & OPTIONS	1	
Title of Course	PREDICTIVE MODELLING AND INDUSTRIAL STATISTICS			
Course Code	Unit	Topics	Lectures/ Week	Credits
	I	LINEAR REGRESSION I	1	2.5
	II	LINEAR REGRESSION II	1	

PAPER IV SIUSSTA64	**III**	**CLASSIFICATION**	**1**	
	IV	**CONTROL CHARTS & ACCEPTANCE SAMPLING**	**1**	

PRACTICALS

Course Code	Practicals based on	Lectures/ Week	Credits
SIUSSTAP61	**SIUSSTA61**	**4**	
	SIUSSTA62	**4**	**3**
SIUSSTAP62	**SIUSSTA63**	**4**	**3**
	SIUSSTA64	**4**	

TYBSc SYLLABUS UNDER AUTONOMY

SEMESTER V
PAPER I

Objectives:

- To acquire in-depth knowledge of probability theory.
- To understand significance of correlation using bivariate normal distribution.

Course Code	Title	Credits
SIUSSTA51	**PROBABILITY AND DISTRIBUTION THEORY**	**2.5 Credits (60 lectures)**
Unit I : PROBABILITY I Basic definitions: Random Experiment, Outcome, Event, Sample Space, Complementary, Mutually Exclusive, Exhaustive and Equally Likely Events. Mathematical, Statistical, Axiomatic and Subjective probability. Sub populations and partitions. Probabilities based on Maxwell Boltzmann, Bose Einstein and Fermi Dirac Statistics. Ordered samples and runs. Addition Theorem for two & three events.		**15 Lectures**
Unit II :PROBABILITY II Theorems on Probability of realization of : At least one, Exactly m, At least m of N events A_1, A_2, A_3…A_N. Matching and Guessing problems. Conditional Probability: Multiplication Theorem for two and three events. Independence of two and three events - complete and pair wise. Polya's urn model Bayes' theorem.		**15 Lectures**

Unit III: JOINT MOMENT GENERATING FUNCTION, TRINOMIAL AND MULTINOMIAL DISTRIBUTION Definition and properties of Moment Generating Function (MGF) of two random variables of discrete and continuous type. Necessary condition for independence of two random variables. Concept and definition of Multivariate MGF. Trinomial distribution**:** Definition of joint probability distribution of (X, Y). Joint moment generating function, moments μ_{rs} where r=0, 1, 2 and s=0, 1, 2. Marginal & Conditional distributions. Means & Variances. Correlation coefficient between (X, Y). Distribution of the Sum X+Y. Extension to Multinomial distribution with parameters (n, p_1, p_2, …p_{k-1}) where $p_1+ p_2,+\ldots p_{k-1}+ p_k= 1$. Expression for joint MGF. Derivation of: joint probability distribution of (X_i, X_j). Conditional probability distribution of X_i given $X_j = x_j$	**15 Lectures**
Unit IV: Unit I : BIVARIATE NORMAL DISTRIBUTION Definition of joint probability distribution (X, Y). Joint Moment Generating function, moments μ_{rs} where r=0, 1, 2 and s=0, 1, 2. Marginal & Conditional distributions. Means & Variances. Correlation coefficient between the random variables. Necessary and sufficient condition for the independence of X and Y. Distribution of aX+bY, where 'a' and 'b' are constants. Distribution of sample correlation coefficient when $\rho = 0$. Testing the significance of a correlation coefficient. Fisher's z – transformation. Tests for H_0: $\rho = \rho_0$ & H_0: $\rho_1 = \rho_2$ Confidence interval for ρ.	**15 Lectures**

SEMESTER V: PRACTICALS BASED ON COURSE SIUSSTA51

1. Probability-1
2. Probability -2
3. Probability -3
4. Joint Moment Generating function
5. Trinomial & Multinomial Distribution
6. Bivariate Normal Distribution
7. Tests for correlation and Interval estimation

REFERENCES

1. Biswas S.(1991). *Topics in Statistical Methodology*, First edition: Wiley Eastern Ltd.
2. Chandra T.K.& Chatterjee D.(2005). *A First Course in Probability*, Third Edition: Narosa Publishing House.
3. Feller W. (1968). *An introduction to probability theory and it's applications,* Volume 1, Third edition :Wiley Eastern Limited.
4. Gupta S C & Kapoor V K. (2014). *Fundamentals of Mathematical Statistics*, Eleventh edition, Sultan Chand & Sons.
5. Hogg R V. & Craig A. T. (2012).*Introduction to Mathematical Statistics*, Seventh edition: Pearson Education (Singapore) Pvt. Ltd.
6. Hogg R. V. &Tanis E.A..(2014). *Probability and Statistical Inference*, Ninth edition: McMillan Publishing Company
7. Kapur J. N.& Saxena H. C.(2010). *Mathematical Statistics*, Fifteenth edition: S. Chand and Company.
8. Mood A. M., Graybill F. A.& Boyes D. C. (1974).*Introduction to the theory of Statistics*, Third edition, McGraw- Hill Series.

PAPER II

Objectives:

- To learn methods of estimation and properties of estimators.
- To use Bayesian approach in estimation.

Course Code	Title	Credits
SIUSSTA52	**THEORY OF ESTIMATION**	**2.5 Credits (60 lectures)**
Unit I :POINT ESTIMATION AND PROPERTIES OF ESTIMATOR Notion of a parameter and parameter space. Problem of Estimation, Definitions of Statistic, Estimator and Estimate. Properties of a good estimator. Unbiasedness: Definition of an unbiased estimator, biased estimator, positive and negative bias, Results on unbiased estimators. Consistency: Definition, Condition for consistency Sufficiency: Definition, Neyman Factorization Theorem and Sufficient statistic for Exponential family of probability distributions. Relative efficiency of an estimator. Minimum variance unbiased estimator (MVUE), Uniqueness property of MVUE. Fisher information function**,** Cramer-Rao inequality, Cramer–Rao Lower Bound (CRLB), Definition of Efficient estimator using CRLB.		**15 Lectures**

Unit II :METHODS OF ESTIMATION Method of Maximum Likelihood Estimation (M.L.E.), Definition of likelihood as a function of unknown parameter, Properties of M.L.E. Method of Moments, Method of Minimum Chi-square and Modified Minimum Chi-square.	**15 Lectures**
Unit III: BAYESIAN ESTIMATION AND CONFIDENCE INTERVAL Bayesian Estimation: Prior distribution, Posterior distribution, Loss function, Risk function, Bayes' solution under Squared Error Loss Function (SELF) and Absolute Error Loss function. Interval Estimation: Confidence Interval. Definition of pivotal quantity and its use in obtaining confidence limits. Confidence Intervals based on asymptotic property of M.L.E. Equidistant confidence interval for the parameters of standard distributions.	**15 Lectures**
Unit IV : LINEAR ESTIMATION Linear Regression Model $Y = \alpha + \beta X + e$ where e follows Independent N(0, σ^2). Maximum Likelihood and Least square Estimators of α, β, and σ^2. Properties of the estimators. Confidence Intervals for α, β, and σ^2. Testing Significance of the regression coefficient β. Gauss-Markoff Theorem for Full rank Model. Properties of the Estimator, Estimation of Linear function of parameters $l'\beta$. Mean and variance. Confidence Interval and Testing of significance of $l'\beta$.	**15 Lectures**

SEMESTER V: PRACTICALS BASED ON COURSE SIUSSTA52

1.	Minimum Variance Unbiased Estimator
2,	Method of Estimation -1
3.	Method of Estimation -2
4.	Bayes' Estimation
5.	Confidence Interval
6.	Linear Estimation
7.	Use of R software

REFERENCES:

1. Arora S. & Bansi Lal (1989) *New Mathematical Statistics*: Satya Prakashan, New Delhi
2. Gupta S C & Kapoor V K. (2014). *Fundamentals of Mathematical Statistics*, Eleventh edition, Sultan Chand & Sons
3. Hoel P.G.(1966). *Introduction to Mathematical Statistics*, Fourth Edition: John Wiley & Sons Inc.
4. Hogg R V. & Craig A. T. (2012).*Introduction to Mathematical Statistics*, Seventh edition: Pearson Education (Singapore) Pvt. Ltd.
5. Hogg R. V.& Tannis E. A. (2014). *Probability and Statistical Inference*, Ninth Edition: Collier McMillan Publishers.
6. Kapur J. N.& Saxena H.C. (2010) *Mathematical Statistics*, Fifteenth Edition : S. Chand & Company Ltd.
7. Kshirsagar A.M.(1983) *A course in Linear Models*
8. Pawagi V.R.& Ranade S.*A Statistical Methods Using R Software:* Nirali Publication
9. Rohatgi V.K.& Ehsanes Saleh A.K. Md.(2008). *An introduction to Probability Theory and Mathematical Statistics* , Second Edition: Wiley series in Probability and Statistics. Miller I., Miller M.& Freund J.E. (1999) *John E. Freund's Mathematical Statistics*, Sixth Edition: Pearson Education Inc.

PAPER III

Objectives:

- To appreciate role of Statistics in Biology.
- To understand need, ethics and norms of clinical trials.

Course Code	Title	Credits
SIUSSTA53	**BIOSTATISTICS**	**2.5 Credits (60 lectures)**
Unit I : EPIDEMIC MODELS The features of Epidemic spread. Definitions of various terms involved. Simple mathematical models for epidemics: Deterministic model with and without removals, Host Vector model, Carrier model. Chain binomial models. Reed - Frost and Greenwood models. Distribution of individual chains and total number of cases. Maximum likelihood estimator of 'p' and its asymptotic variance for households of sizes up to 4.		**15 Lectures**

Unit II: BIOASSAYS Meaning and scope of bioassays. Relative potency. Direct assays. Fieller's theorem. Quantal Response assays. Tolerance distribution. Median effective dose ED50 and LD50. Probit analysis. Indirect assays. Dose-response relationship .Condition of similarity and Monotony. Linearizing transformations. Parallel line assays. Symmetrical (2, 2) and (3, 3) parallel line assays. Validity tests using orthogonal contrasts. Point Estimate and Interval Estimate of Relative potency.	**15 Lectures**
Unit III: CLINICAL TRIALS Introduction to clinical trials: The need and ethics of clinical trials. Common terminology used in clinical trials. Over view of phases (I-IV) Study Protocol, Case record/Report form, Blinding (Single/Double) Randomized controlled (Placebo/Active controlled), Study Designs (Parallel, Cross Over). Types of Trials: Inferiority, Superiority and Equivalence, Multi-centric Trial. Inclusion/Exclusion Criteria. Statistical tools: Analysis of Parallel Design using Analysis of Variance. Concept of odds ratio. Sample size estimation.	**15 Lectures**
Unit IV: BIOEQUIVALENCE Definitions of Generic Drug product. Bioavailability, Bioequivalence, Pharmakokinetic (PK) parameters C_{max}, AUC_t, $AUC_{0-\infty}$, T_{max}, K_{el}, T_{half}. Estimation of PK parameters using 'time vs. concentration' profiles. Designs in Bioequivalence: Parallel, Cross over (Concept only). Advantages of Crossover design over Parallel design. Analysis of Parallel design using logarithmic transformation (Summary statistics, ANOVA and 90% confidence interval). Confidence Interval approach to establish bioequivalence (80/125 rule).	**15 Lectures**

SEMESTER V: PRACTICALS BASED ON COURSE SIUSSTA53

1. Epidemic models
2. Direct Assays
3. Quantal Response Assays
4. Parallel line Assay
5. Clinical Trials
6. Bioequivalence

REFERENCES:

1. Bailey N.T.J. (1975). *The Mathematical theory of infectious diseases,* Second edition: Charles Griffin and Co. London.
2. Bolton S. & Bon C. (2009). *Pharmaceutical Statistics,* Fifth edition: Marcel Dekker Inc.
3. Das M.N & Giri N.C.(1986). *Design and Analysis of Experiments,* Second edition: Wiley Eastern
4. Finney D.J. (1964). *Statistical Methods in Biological Assays,* First edition: Charles Griffin and Co. London
5. Fleiss J.L. (1999). *The Design and Analysis of Clinical Experiments*. Second edition: Wiley and Sons
6. Friedman L. M., Furburg C. D. , Demets D. L.(2015). *Fundamentals of Clinical Trials*. Fifth edition: Springer Verlag.
7. Shein-Chung-Chow:(2008)*Design and Analysis of Bioavailability & Bioequivalence studies,* Third Edition: Chapman & Hall/CRC Biostatistics series.
8. Wayne D. W. (2013). *Biostatistics- A Foundation for Analysis in the Health Sciences,* Tenth Edition: Wiley Series in Probability and Statistics.
9. Zar Jerrold H. (2013). *Biostatistical Analysis,* Fifth edition: Pearson's education.

PAPER IV

Objectives:

- To comprehend Vital statistics
- To study formulation of policies in insurance industry

Course Code	Title	Credits
SIUSSTA54	**ELEMENTS OF ACTUARIALSCIENCE**	**2.5 Credits (60 lectures)**

Unit I : MORTALITY TABLES Vital statistics: Meaning, Uses, Methods of obtaining Vital statistics. Various mortality functions. Probabilities of living and dying. The force of mortality. Estimation of μ_x from the mortality table. Central Mortality Rate. Laws of mortality: Gompertz's and Makeham's first law. Select, Ultimate and Aggregate mortality tables. Stationary and stable population. Expectation of life and Average life at death.	**15 Lectures**
Unit II: COMPOUND INTEREST AND ANNUITIES CERTAIN Accumulated value and present value, nominal and effective rates of interest. Varying rates of interest. Equation of value. Equated time of payment. Present and accumulated values of annuity certain (immediate and due) with and without deferment period. Present value for perpetuity (immediate and due) with and without deferment period. Present and accumulated values of increasing annuity, increasing annuity when successive installments form arithmetic progression, annuity with frequency different from that with which interest is convertible. Redemption of loan.	**15 Lectures**
Unit III: LIFE ANNUITIES Present value in terms of commutation functions of Life annuities and Temporary life annuities (immediate and due) with and without deferment period. Present values of variable, increasing life annuities and increasing Temporary life annuities (immediate and due).	**15 Lectures**
Unit IV: ASSURANCE BENEFITS Present value of Assurance benefits in terms of commutation functions of : Pure endowment assurance, Temporary assurance, Endowment assurance, Whole life assurance, Special endowment assurance, Deferred temporary assurance Net premiums: Net level annual premiums (including limited period of payment) for various assurance plans. Office premiums.	**15 Lectures**

SEMESTER V: PRACTICALS BASED ON COURSE SIUSSTA54

1. Mortality tables 1
2. Mortality tables 2

3.	Annuities 1
4.	Annuities 2
5.	Life annuities
6.	Assurance benefits

REFERENCES:

1. Dixit S.P., Modi C.S.& Joshi R.V.(1991). *Mathematical Basis of Life Assurance*, First edition (Reprint): Insurance Institute of India.
2. Gupta S. C. &. Kapoor V. K. (2014). *Fundamentals of Applied Statistics,* Fourth edition: Sultan Chand & Sons.
3. Neill A. (1977). *Life Contingencies,* First edition: Heineman educational books, London

TYBSc SYLLABUS UNDER AUTONOMY

SEMESTER VI
PAPER I

Objectives:

- To study order statistics and generating functions useful in research
- To learn stochastic processes to understand its application in queuing theory

Course Code	Title	Credits
SIUSSTA61	**DISTRIBUTION THEORY AND STOCHASTIC PROCESSES**	**2.5 Credits (60 lectures)**
Unit I : ORDER STATISTICS Definition of Order Statistics based on a random sample. Derivation of: Cumulative distribution function of r^{th}order statistic, Probability density functions of the r^{th} order statistic, Joint Probability density function of the r^{th} and the s^{th} order statistic (r<s),Joint Probability density function of all n ordered statistics, Probability density function of Median (in the case of odd sample sizes) and Range.		**15 Lectures**

Unit II : GENERATING FUNCTIONS Definitions of generating function and probability generating function. Expression for mean and variance in terms of generating functions. Definition of a convolution of two or more sequences. Generating function of a convolution. Generating functions of the standard discrete distributions. Relation between: Bernoulli and Binomial distributions, Geometric and Negative Binomial distributions in terms of convolutions.	**15 Lectures**
Unit III: STOCHASTIC PROCESSES Definition of stochastic process. Postulates and difference differential equations for: Pure birth process, Poisson process with initially 'a' members, for a =0 and a >0,Yule-Furry process, Pure death process, Death process with $\mu_n=\mu$, Death process with $\mu_n=n\mu$, Birth and death process, Linear growth model. Derivation of P_n (t), mean and variance where ever applicable.	**15 Lectures**
Unit IV: QUEUING THEORY Basic elements of the Queuing model. Roles of the Poisson and Exponential distributions. Derivation of Steady state probabilities for birth and death process. Steady state probabilities and various average characteristics for the following models: (M/M/1) : (GD/ ∞ /∞), (M/M/1) : (GD/ N /∞), (M/M/c) : (GD/∞/∞), (M/M/c) : (GD/ N /∞), (M/M/∞) : (GD/ ∞ /∞), (M/M/R) : (GD/ k /k)	**15 Lectures**

SEMESTER VI: PRACTICALS BASED ON COURSE SIUSSTA61

1. Order Statistics – 1
2. Order statistics – 2
3. Generating Function
4. Stochastic Processes
5. Queuing Theory -1
6. Queuing Theory -2

REFERENCES:

1. Biswas S.(1991). *Topics in Statistical Methodology* ,First edition: Wiley Eastern Ltd.
2. Feller W. (1968). *An introduction to probability theory and it's applications,* Volume 1, Third edition :Wiley Eastern Limited.
3. Gupta S. C.& Kapoor V. K. (2014). *Fundamentals of Mathematical Statistics*, Eleventh Edition, Sultan Chand & Sons.

4. Hogg R V. & Craig A. T. (2012).*Introduction to Mathematical Statistics*, Seventh edition: Pearson Education (Singapore) Pvt. Ltd.
5. Hogg R. V. & Tanis E.A..(2014). *Probability and Statistical Inference*, Ninth edition: McMillan Publishing Company
6. Kapur J. N.& Saxena H. C.(2010). *Mathematical Statistics*, Fifteenth edition: S. Chand and company.
7. Medhi J: (2013). *Stochastic Processes,* Second edition: Wiley Eastern Ltd.
8. Mood A. M., Graybill F. A.& Boyes D. C. (1974).*Introduction to the theory of Statistics*, Third edition, McGraw- Hill Series.
9. Taha H.A.(2010). *Operations Research: An introduction*, Ninth edition: Prentice Hall of India Pvt. Ltd.

PAPER II

Objectives:

- To study testing statistical hypotheses for fixed and variable sample sizes
- To understand applications non parametric tests used in social sciences

Course Code	Title	Credits
SIUSSTA62	**TESTING OF HYPOTHESES**	**2.5 Credits (60 lectures)**
Unit I : MOST POWERFUL TESTS Problem of testing of hypothesis. Definitions of Simple hypothesis, Composite hypothesis, Null Hypothesis, Alternative Hypothesis, Test of hypothesis, Critical region, Type I and Type II errors, Level of significance, p-value, size of the test, Power of the test, Power function of a test, Power curve. Definition of most powerful test of size α for a simple hypothesis against a simple alternative hypothesis. Neyman-Pearson fundamental lemma.		**15 Lectures**

Unit II : UNIFORMLY MOST POWERFUL & LIKELIHOOD RATIO TESTS Definition, Existence and Construction of uniformly most powerful (UMP) test. Likelihood ratio principle. Definition of test statistic and its asymptotic distribution (statement only).	**15 Lectures**
Unit III: SEQUENTIAL PROBABILITY RATIO TESTS Sequential test procedure for testing a simple null hypothesis against a simple alternative hypothesis. Its comparison with fixed sample size test procedure. Definition of Wald's SPRT of strength (α, β).	**15 Lectures**
Unit IV: NON-PARAMETRIC TESTS Need for non parametric tests. Distinction between a parametric and a non parametric test .Concept of a distribution free statistic. Single sample and two sample Nonparametric tests: Sign test, Wilcoxon's signed rank test, Run test, Mann–Whitney test, Median test, Kruskal Wallis test, Friedman test, Fisher's exact test. Assumptions, justification of the test procedure for small & large samples.	**15 Lectures**

SEMESTER VI: PRACTICALS BASED ON COURSE SIUSSTA62

1. Testing of Hypothesis 1
2. Testing of Hypothesis 2
3. SPRT
4. Non Parametric test 1
5. Non Parametric test 2
6. Use of R.

REFERENCES:

1. Arora S. & Lal B. (1989) *New Mathematical Statistics*: Satya Prakashan, New Delhi
2. Biswas S.(1991). *Topics in Statistical Methodology* First edition: Wiley Eastern Ltd.
3. Daniel W.W..(2000) *Applied Non Parametric Statistics* Second edition Boston-Houghton Mifflin Company
4. Gupta S C & Kapoor V K. (2014). *Fundamentals of Mathematical Statistics*, Eleventh edition, Sultan Chand & Sons.
5. Hogg R V. & Craig A. T. (2012).*Introduction to Mathematical Statistics*, Seventh edition: Pearson Education (Singapore) Pvt. Ltd.
6. Hogg R. V. &Tanis E.A. .(2014). *Probability and Statistical Inference*, Ninth edition: McMillan Publishing Company
7. Lehmann, E. L.(2008). *Testing of Statistical Hypothesis*, Third edition: Wiley &sons
8. Pawagi V.R.& Ranade S.A. *Statistical Methods Using R Software:*Nirali Publication
9. Rao, C. R. (2001). *Linear Statistical Inference*, Second edition: Wiley Series in Probability & Statistics
10. Siegal S. , Castellan N. J. (1988). *Non Parametric Statistics for Behavioral Science,* Second edition : Mc Graw Hill Publishing Co.
11. Wald A. (1947). *Sequential Analysis* . First edition: John Wiley & Sons , New York

PAPER III

Objectives:

- To comprehend knowledge of industry problems such as inventory, replacement
- To understand use of statistics in investment analysis

Course Code	Title	Credits
SIUSSTA63	**OPERATIONS RESEARCH TECHNIQUES**	**2.5 Credits (60 lectures)**
Unit I : INVENTORY CONTROL Introduction to Inventory Problem Deterministic Models: Single item static EOQ models for Constant rate of demand with instantaneous replenishment, with and without shortages. Constant rate of demand with uniform rate of replenishment, with and without shortages. Constant rate of demand with instantaneous replenishment without shortages, with at most two price breaks. Price break model. Probabilistic models: Single period with Instantaneous demand (discrete and continuous) without setup cost. Uniform demand (discrete and continuous) without set up cost.		**15 Lectures**

Unit II: REPLACEMENT Replacement of items that deteriorate with time and value of money remains constant & changes with time. Replacement of items that fail completely: Individual replacement and Group replacement policies.	**15 Lectures**
Unit III :SIMULATION Scope of simulation applications. Types of simulation. Monte Carlo Technique of Simulation. Elements of discrete event simulation. Generation of random numbers. Sampling from probability distribution. Inverse method. Generation of random observations from standard distributions. Simulation techniques applied to inventory and Queuing models.	**15 Lectures**
Unit IV: CAPITAL BUDGETING, SECURITIES MARKET, FUTURES & OPTIONS Capital budgeting: Payback Method, Net present value method, Internal Rate of Return Method. Methods of incorporating risk into capital budgeting : Certainty equivalent approach, Risk adjusted discount rates, Statistical distribution approach Securities Market: Stock market, share, face value, market value, dividend, equity share, preferential share, bonus and right shares. Initial Public offer, Earning per share, Price earning ratio index, Nifty, Beta value. Options terminology: Index option, Stock option, American option, European option. Strike price, Expiry date, Call option, Put option, Buyer of an option, Writer of an option. Futures & Options: Introduction to F & O market. Difference between Forward and Futures contracts. Factors influencing the market. Hedging, Arbitrage, Open interest. Concept of Mean Reversion theory, Pair trade.	**15 Lectures**

SEMESTER VI : PRACTICALS BASED ON COURSE SIUSSTA63

1. Inventory 1
2. Inventory 2
3. Replacement
4. Simulation
5. Capital Budgeting
6. Securities Market
7. Futures & Options

REFERENCES:

1. Bannerjee B. : *Operation Research Techniques for Management*, First edition, Business Books
2. Bronson R. (1997).*Schaum Series book in Operations Research,* Second edition: Tata McGraw Hill Publishing Company Ltd.
3. Ganapathy Vidyamurthi(2004). *Pairs Trading Quantitative Methods and Analysis*, John
4. Hull John C. (2010). *Futures, Options, and other derivatives,* Seventh edition: Prentice Hall
5. Hull John C. (2017).*Fundamentals of Futures and Options Markets,* Global Edition, Eighth Edition: Pearson Education Limited
6. Kantiswaroop & Gupta M. (2010). *Operations Research*, Twelfth Edition: Sultan Chand & Sons
7. Prasanna Chandra. (2014). *Fundamentals of Financial Management,* Sixth Edition, McGraw Hill Education (India) Private Limited.
8. Sharma J. K. (2013). *Operations Research theory and applications*, Fifth edition : Macmillan India Ltd.
9. Sharma J.K. (2010). *Quantitative Techniques for Managerial Decisions*: MacMillan India Ltd.
10. Sharma S.D. *Operations Research,* Eleventh Edition: Kedar Nath Ram Nath & Co.
11. Tim Lieu. Xin Li. *Optimal Mean Reversion Trading Mathematical Analysis and Practical Applications*, World Scientific.
12. Vora N. D. (2015). *Quantitative Techniques in Management*, Fourth edition: McGraw Hill Co.

Wiley & Sons, Inc.

PAPER IV

Objectives:

- To comprehend modelling techniques used in forecasting
- To study the techniques used to check and control quality of the product

Course Code	Title	Credits
SIUSSTA64	**PREDICTIVE MODELLING AND INDUSTRIAL STATISTICS**	**2.5 Credits (60 lectures)**
Unit I: LINEAR REGRESSION I Linear regression model with one or more explanatory variables. Assumptions of the model, Derivation of Ordinary Least Square (OLS) estimators of regression coefficients, (for one and two explanatory variables models). Properties of least square estimators (without proof). Coefficient of determination R^2 and adjusted R^2. Procedure of testing : Overall significance of the model, Significance of individual coefficients, Significance of incremental contribution of explanatory variable for two explanatory variables model. Confidence intervals for the regression coefficients.		**15 Lectures**
Unit II: LINEAR REGRESSION II Autocorrelation: Concept, Detection using Run Test, Durbin Watson Test, Generalized Least Square (GLS) method. Heteroscedasticity: Detection using Spearman's Rank correlation test, Breusch-Pagan-Godfrey test. Weighted Least Square (WLS) estimators Multicollinearity: Detection using R square & t ratios, Variance Inflation Factor (VIF), Pairwise Correlation between regressors, Consequences of using OLS estimators in presence of autocorrelation, heteroscedasticity and multicollinearity. Multiple Linear Regression with Qualitative Independent Variable.		**15 Lectures**
Unit III: CLASSIFICATION Logistic Regression Models: Introduction to Binary Logistic Regression, Statistical Model, Estimation of Parameters using MLE, Odds Ratio, Hosmer-Lemeshaw Test for goodness of fit, Classification Table. Concept of Multinomial and ordinal logistic regression. K-nearest-neighbor (kNN) Algorithm, Weighted kNN, Naïve Bayes.		**15 Lectures**
Unit IV: CONTROL CHARTS & ACCEPTANCE SAMPLING : Principles of control. Process quality control of variables. Xbar and R, Xbar and Sigma Chart. Exponentially weighted moving average (EWMA) control charts, Cumulative Sum (CUSUM) control chart, Process quality control of attributes : p, c, np charts. P-chart and c-chart with variable sample size. Setting up standards for future use. Concept of Natural Tolerance Limits, Specification Limits and Detection of shift. Acceptance sampling plan- Single Sampling Plans: OC function and OC curves. AQL, LTPD, ASN, ATI, AOQ, Consumer's risk, Producer's risk. Double Sampling Plan: OC function and OC curves. Introduction to Six sigma limits.		**15 Lectures**

SEMESTER VI : PRACTICALS BASED ON COURSE SIUSSTA64

1. Linear regression model 1
2. Linear regression model 2
3. Logistic Regression
4. kNN and Naïve Bayes
4. Control Charts
5. Acceptance Sampling
6. Use of R

REFERENCES:

1. Burr J. T.(2004). *Elementary Statistical Quality Control*, Second Edition ,CRC Press: Taylor & Francis Group.
2. Duncan A.J. (1965). *Quality Control & Industrial Statistics*, Third Edition
3. E.L. Grant. (1988). *Statistical Quality Control*, Second edition: McGraw Hill.
4. Greene W. (2017). *Econometric Analysis*, Eighth edition: McMillan Publishing Company.
5. Gujrathi D.N., Porter D.& Gunasekar S. (2017). *Basic Econometrics*, Fifth edition : McGraw-Hill Co.
6. Hansen B. L., (1973), *Quality Control: Theory and Applications:* Prentice Hall of India Pvt. Ltd
7. Hastie, R. Tibshirani & J. Friedman. (2009) *The Elements of Statistical Learning, Data Mining, Inference and Prediction,*: Springer Series in Statistics.
8. Hosmer D. W., Lemeshow Jr.& Sturdivant S, R. X.(2013). *Applied Logistic Regression*: John Wiley & Sons,
9. Mann N.R., Schafer R.E.& Singapurwalla N.D.(1974). *Methods for Statistical Analysis of Reliability and Life Data,* First edition: John Wiley & Sons.
10. Montgomery D. , (2009) *Statistical Quality Control*, Sixth Edition :Arizona State University. John Wiley & Sons, Inc.

EXAMINATION PATTERN

Internal Assessment of Theory per Course per Semester

1. Class Test	20 Marks.
2. Project / Assignment / Presentation etc.	20 Marks.

Semester End Theory Examination per Course

At the end of the semester, examination of two hours duration and 60 marks based on the four units shall be held for each course.
Pattern of Theory question paper :
There shall be four compulsory questions of 15 marks each (with Internal Option).
Question 1 based on Unit I, Question 2 based on Unit II, Question 3 based on Unit III Question 4 based on Unit IV.

Semester End Practical Examination per Course

1. Journal	5 Marks.
2. Viva Voce	5 Marks.
3. Practical Examination	40 Marks.

At the end of the semester, examination of 1hour 30 minutes duration and 40 marks shall be held for each course.

Pattern of Practical question paper:

There shall be four compulsory questions of 10 marks each (with Internal Option).
Question 1 based on Unit I, Question 2 based on Unit II, Question 3 based on Unit III, Question 4 based on Unit IV.