

**DEPARTMENT OF STATISTICS**  
**FACULTY OF SCIENCE**  
**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**  
**M.A. /M.Sc. STATISTICS (CBCS)**

**Eligibility for Admission:** Any candidate who has obtained bachelor's degree in Statistics or Mathematics or Computer Science under 10+2+3 scheme of examination or bachelor's degree in Engineering or Technology from the recognized University will be eligible for Admission.

**Semester- I :** There will be four core courses and two core course Practical.

Course no.	Course Code	Title of the Course	L-T-P	Credits	Max. Marks		Total
					Ext. Exam.	Int. Exam.	
I	STA 611	Measure and Integration	4-1-0	5	70	30	100
II	STA 612	Matrices and Linear Algebra	4-1-0	5	70	30	100
III	STA 613	Probability Theory	3-1-0	4	70	30	100
IV	STA 614	Theoretical Distributions	3-1-0	4	70	30	100
V	STA 615	Practical Based on Statistical Methods Using MS-Excel & SPSS	0-0-6	3	70	30	100
VI	STA 616	Practical Based on STA 613 & STA 614	0-0-6	3	70	30	100

**Semester- II:** There will be four core courses, two core course practical and one skill course elective

Course no.	Course Code	Title of the Course	L-T-P	Credits	Max. Marks		Total
					Ext. Exam.	Int. Exam.	
I	STA 621	Sampling Distributions	4-1-0	5	70	30	100
II	STA 622	Statistical Inference	3-1-0	4	70	30	100
III	STA 623	Design of Experiments	4-1-0	5	70	30	100
IV	STA 624	Statistical Computing with R	3-1-0	4	70	30	100
V	STA 625	Practical Based on STA 621 & STA 622	0-0-6	3	70	30	100

VI	STA 626	Practical Based on STA 623 & STA 624	0-0-6	3	70	30	100
VII	STA 627X	Skill Course-STA 627X	2-0-0	2	70	30	100

### Skill Course (SC) for Semester II

**Note:** Students can opt one SC course with the permission of the Head of the Department.

Course no.	Course Code	Title of the Course	L-T-P	Credits	Max. Marks		Total
					Ext. Exam.	Int. Exam.	
I	STA 627	English Language Communication and Presentation	0-0-2	2	70	30	100
II	STA 627A	Measurable functions and Lebesgue Integral	2-0-0	2	70	30	100
III	STA 627B	Official Statistics-I	2-0-0	2	70	30	100
IV	STA 627C	Statistical Methods For Total Quality Management-I	2-0-0	2	70	30	100
V	STA 627D	Investments Under Uncertainty-I	2-0-0	2	70	30	100
VI	STA 627E	Actuarial Statistics-I	2-0-0	2	70	30	100
VII	STA 627F	Information and Communication Technology Skills	0-0-2	2	70	30	100

**Semester- III:** There will be Two core courses, Two elective courses, one core course practical and one Discipline specific elective practical.

Course no.	Course Code	Title of the Course	L-T-P	Credits	Max. Marks		Total
					Ext. Exam.	Int. Exam.	
I	STA 631	Multivariate Analysis	4-1-0	5	70	30	100
II	STA 632	Theory of Sample surveys	3-1-0	4	70	30	100

III	STA 633	Practical Based on STA 631 & STA 632	0-0-6	3	70	30	100
IV	STA 63X	DSE- 0 X	3-1-0	4	70	30	100
V	STA 63X	DSE- 0 X	3-1-0	4	70	30	100
VI	STA 63X	DSE- 0 X	2-0-4	4	70	30	100

### **Discipline Specific Elective Course (DSE) for Semester III**

**Note:** Students are to opt any three DSE courses among the following as per the availability of faculty and with the permission of the Head of the Department.

Course no.	Course Code	Title of the Course	L-T-P	Credits	Max. Marks		Total
					Ext. Exam.	Int. Exam.	
I	STA 634	Operations Research	3-1-0	4	70	30	100
II	STA 635	Stochastic Processes	3-1-0	4	70	30	100
III	STA 636	Practical Based on two papers selected as DSE STA 634 & STA 635	2-0-4	4	70	30	100
IV	STA 637	Mathematical Economics	3-1-0	4	70	30	100
V	STA 638	Statistical Quality Control	3-1-0	4	70	30	100
VI	STA 639	Information Theory	3-1-0	4	70	30	100

**Semester- IV:** There will be one core course, one core project work, one core course practical and three Discipline specific elective papers.

Course no.	Course Code	Title of the Course	L-T-P	Credits	Max. Marks		Total
					Ext. Exam.	Int. Exam.	
I	STA 641	Demography	4-1-0	5	70	30	100

II	STA 642	Project Work and Viva- Voce/ Dissertation	1-1- 2	4	70	30	100
III	STA 643	Practicals Based on STA641	0-0- 6	3	70	30	100
IV	STA 64X	DSE- 0 X	3-1- 0	4	70	30	100
V	STA 64X	DSE- 0 X	3-1- 0	4	70	30	100
VI	STA 64X	DSE- 0 X	2-0- 4	4	70	30	100
VII	STA 647X	Skill Course- STA 647X	2-0- 0	2	70	30	100

### **Discipline Specific Elective Course (DSE) for Semester IV**

**Note:** Students are to opt any three DSE courses among the following as per the availability of faculty and with the permission of the Head of the Department.

Course no.	Course Code	Title of the Course	L-T-P	Credits	Max. Marks		Total
					Ext. Exam.	Int. Exam.	
I	STA 644	Econometrics	3-1-0	4	70	30	100
II	STA 645	Linear Models & Regression Analysis	3-1-0	4	70	30	100
III	STA 646	Practical Based on two papers STA 644 & STA 645	2-0-4	4	70	30	100
IV	STA 648	Advanced Statistical Inference	3-1-0	4	70	30	100
V	STA 649	Theory of Reliability	3-1-0	4	70	30	100
VI	STA 644A	Advance Theory of Sample Surveys	3-1-0	4	70	30	100
VII	STA 645A	Sequential Analysis	3-1-0	4	70	30	100

VIII	STA 646A	Economic Statistics	3-1-0	4	70	30	100
IX	STA 648A	Computer-Intensive Statistical Methods	3-1-0	4	70	30	100
X	STA 649A	Knowledge Discovery and Data Mining	3-1-0	4	70	30	100
XI	STA 644B	Survival Analysis	3-1-0	4	70	30	100
XII	STA 645B	<b>Statistical Computing using Python</b>	3-1-0	4	70	30	100
XIII	STA 646B	Practical Based on paper STA 645B	2-0-4	4	70	30	100

### **Skill Course (SC) for Semester IV**

**Note:** Students can opt one SC course with the permission of the Head of the Department.

Course no.	Course Code	Title of the Course	L-T-P	Credits	Max. Marks		Total
					Ext. Exam.	Int. Exam.	
I	STA 647A	Numerical Analysis	2-0-0	2	70	30	100
II	STA 647B	Official Statistics-II	2-0-0	2	70	30	100
III	STA 647C	Statistical Methods For Total Quality Management-II	2-0-0	2	70	30	100
IV	STA 647D	Investments Under Uncertainty-II	2-0-0	2	70	30	100
V	STA 647E	Actuarial Statistics-II	2-0-0	2	70	30	100

**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**  
**SEMESTER I M. Sc. STATISTICS**

**STA 611**  
**MEASURE AND INTEGRATION**

L-T-P	4-1-0
-------	-------

**TIME: 3 hours**

**External Assessment 70**  
**Internal Assessment 30**

**UNIT I**

Set operations, Limit of sequence of sets, Classes of sets (rings,  $\sigma$ -rings, fields,  $\sigma$ -fields), Monotone classes, Borel sets, Additive set functions.

**UNIT II**

Measure, Properties of measure (monotonicity, countable, sub additivity and continuity), Extension of measure, Outer measures. Measurable sets.

**UNIT III**

Probability measure, Lebesgue, stieltjes measure, Measurable and measure spaces.

**UNIT IV**

Measurable Functions and its properties. Simple functions, sequence of measurable functions. Integrability of simple and measurable functions.

**UNIT V**

Properties of integrals, Lebesgue monotone and dominant convergence theorems, Fatou's lemma, Lebesgue-stieltjes integrals.

**Books Recommended:**

1. Kingman, J.F. and Taylor, S.J. : Introduction to Measure and Probability.
2. Halmos, P.R. : Measure Theory.
3. Ash R.B. : Real Analysis and Probability.
4. Rao, C.R. : Linear statistical Inference and Its Applications.
5. Goldberg R. : Methods of Real Analysis.

**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**

**SEMESTER I M. Sc. STATISTICS**

**STA 612**

**MATRICES AND LINEAR ALGEBRA**

L-T-P	4-1-0
-------	-------

**TIME: 3 hours**

**External Assessment 70**

**Internal Assessment 30**

### **UNIT I**

Inverse and partitioning of matrices, Diagonal reduction, Normal form, Vector space, Linear dependence and independence

### **UNIT II**

Basis, Dimension, Inner product spaces, Orthonormal basis, Gram-Schmidt orthogonalization process and orthogonal projection of a vector.

### **UNIT III**

Characteristic equation, Eigen values and Eigen vectors, Cayley - Hamilton theorem. Minimal polynomial, similar matrices, Algebraic and geometric multiplicity of a characteristic root.

### **UNIT IV**

Bilinear and quadratic forms, Definiteness of quadratic forms, Reduction to canonical forms. Concept of Generalized Inverse, Moore-penrose Generalized Inverse.

### **UNIT V**

Singular values and singular value decomposition, Jordan decomposition, extrema of quadratic forms, vector and matrix differentiation.

#### **Books Recommended:**

1. Rao, C.R. : Linear statistical Inference and Its Applications.
2. Kolman, B. : Elementary Linear Algebra.
3. Dutta, K.B. : Matrix and Linear Algebra.
4. Graybill, F.A. (1983) : Matrices with applications in Statistics, IInd Ed., Wadsworth.
5. Biswas, S. (1984) : Topics in Algebra of matrices, Academic publications.
6. Hadley, G. (1987) : Linear Algebra, Narosa publishing House.
7. Roa, A.R. and Bhimasankaram, P. (1992) : Linear Algebra, Tata McGraw Hill.
8. Roa, C.R. and Mitra, S.K. (1971) : Generalized inverse of Matrices and its applications, John Wiley & sons.

**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**

**SEMESTER I M. Sc. STATISTICS**

**STA 613**

**PROBABILITY THEORY**

L-T-P	3-1-0
-------	-------

**TIME: 3 hours**

**External Assessment 70**

**Internal Assessment 30**

**UNIT I**

Role of random experimentation in science Axiomatic approach to probability, sample space. Probability laws for combination of two or more events and its applications. Discrete Probability.

**UNIT II**

Independence of experiments, conditional probability and Statistical independence of events Baye's theorem (Heat and future) and its applications.

**UNIT III**

Random variables, Distribution functions Univariate and Multivariate and frequency functions.

**UNIT IV**

Mathematical expectation, Moments and conditional expectation, Tchebyshev inequality, Markov and Jensen inequalities.

**UNIT V**

Modes of convergence, Weak and strong law of Large numbers, various definitions of probability and inter-connections, central limit theorem.

**Recommended Books:**

1. Feller, W. : Introduction to probability Theory and its applications, Vol -I.
2. Rohatgi, V.K. : Introduction to Probability Theory and Mathematical Statistics.
3. Goon and others : An outline of statistical Theory, Vol.-I.
- 4 Kendall M.G. and Stuart, A. : Advanced Theory of Statistics, Vol.-I.
- 5 Kolmogorov A.N. : Foundations of Theory of Probability.
- 6 Parzen, E : Modern Probability Theory and its Applications
7. Gnedenko B.V. : The Theory of Probability.

**Reference Books:**

1. Cramer H : Mathematical Methods of Statistics.
2. Rao, C.R. : Linear Statistical Inference and its Applications.
3. Mukhopadhyay, P. : Mathematical Statistics.
4. Cacoullos, T : Exercises in Probability.



**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**

**SEMESTER I M. Sc. STATISTICS**

**STA 614**

**THEORETICAL DISTRIBUTIONS**

L-T-P	3-1-0
-------	-------

**TIME: 3 hours**

**External Assessment 70**

**Internal Assessment 30**

### **UNIT I**

Generating functions and their applications, Moments and cumulants, Moment generating function and characteristic functions, cumulative function, their properties with proof.

### **UNIT II**

Inversion theorem, derivation of distribution functions from characteristic functions. Central limit theorems for equal and unequal components and applications.

### **UNIT III**

Binomial, Negative-binomial, Poisson, Hyper-geometric and Multinomial distribution with their properties and applications.

### **UNIT IV**

Normal, Rectangular, Cauchy, Laplace, Gamma and Beta distributions. Relation between different distributions.

### **UNIT V**

Compound distributions, Pearsonian System of frequency curves.

#### **Recommended Books:**

1. Feller, W. : Introduction to probability Theory and its applications, Vol -I.
2. Rohatgi, V.K. : Introduction to Probability Theory and Mathematical Statistics.
3. Goon and others : An outline of statistical Theory, Vol.-I.
- 4 Kendall M.G. and Stuart, A. : Advanced Theory of Statistics, Vol.-I.
- 5 Elderton and Johnson : Systems of Frequency Curves.
6. Wilks S.S. : Mathematical Statistics.

#### **Reference Books:**

1. Cramer H : Mathematical Methods of Statistics.
2. Rao, C.R. : Linear Statistical Inference and its Applications.
3. Mukhopadhyay, P. : Mathematical Statistics.
4. Cacoullous, T : Exercises in Probability.

**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**

**SEMESTER I M. Sc. STATISTICS**

**STA 615**

**PRACTICALS BASED ON STATISTICAL METHODS**

**(Using MS-Excel & SPSS)**

L-T-P	0-0-6
-------	-------

**TIME: 4 hours**

**External Assessment 70**

**Internal Assessment 30**

**Note:** Students will be required to do practicals, based on topics listed below, using Excel & SPSS:

**List of Practical:**

1. Presentation of raw data
2. Graphical representation by (i) Histogram (ii) Frequency polygon (iii) Frequency curve and (iv) Ogives.
3. Diagrammatic representation by (i) Bars (ii) Pie diagram.
4. Graphical plots: Box-Whisker plots, Histograms and Population Pyramids.
5. Measures of Central Tendency: Mean Median, Mode, G.M., H.M., Quartiles, and Deciles & Percentiles.
6. Measures of Dispersion (i) Range (ii) Semi interquartile range (iii) Mean Deviation (iv) Standard Deviation and Variance (v) Coefficient of Variation (vi) Lorenz Curve.
7. Moments and various measures of Skewness and Kurtosis.
8. Fitting of curves: (i) Straight line (ii) Parabola (iii) Exponential and Power curves.
9. Computation of simple, multiple, partial and rank correlation coefficients.
10. Computation of simple regression and test for intercept and slope.
11. Calculation of correlation coefficient by  
(i) Karl Pearson's method and (ii) Spearman's rank method.
12. Construction of regression lines.
13. Construction of bivariate frequency distribution, calculation of correlation coefficient and construction of regression lines.
14. Calculation of Multiple and Partial correlation coefficients and construction of multiple regression equations (for three variables only).

**Books for reference:**

1. Goon and others : An outline of Statistical theory, Vol. I.
2. Rohatgi, V. K. : An Introduction to Probability Theory and Mathematical Statistics.

**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**  
**SEMESTER I M. Sc. STATISTICS**  
**STA 616**

PRACTICALS BASED ON STA 613 & STA 614

L-T-P	0-0-6
-------	-------

**Time: 4 Hours**

**External Assessment 70**

**Internal Assessment 30**

Students will be required to do practicals, based on topics listed below, using Excel & SPSS:

**List of Practical:**

1. Random number generation.(i) Binomial, (ii) Poisson, (iii) Normal
2. Fitting of Binomial distribution when p is known and when p is unknown. 3. Fitting of Poisson distribution when parameter is known and unknown. 4. Fitting of Normal and Negative -binomial distributions.
5. Calculation of area under normal curves.
6. Plot probability curves for different sets of parameters.
7. Test for normality: P-P Plot, Q-Q Plot etc.
8. Practical using generating functions such as MGF, PGF, CGF, CFs..
9. Software development of above practical problems in Excell & SPSS and running the same on computers.

**Books for reference:**

1. Goon and others : An outline of Statistical theory, Vol. I.
2. Rohatgi, V. K. : An Introduction to Probability Theory and Mathematical Statistics.

**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**  
**SEMESTER II M. Sc. STATISTICS**

**STA 621**  
**SAMPLING DISTRIBUTIONS**

L-T-P	4-1-0
-------	-------

**TIME: 3 hours**

**External Assessment 70**  
**Internal Assessment 30**

**UNIT-I**

Univariate sampling distributions: Random sampling and sampling distribution, Chi-square distribution (Central and non-central) and their applications, large sample theory.

**UNIT-II**

t and F distributions (central and non-central) and their applications.

**UNIT-III**

Curve fitting and orthogonal polynomials. Standard errors of functions of moments, Order Statistics and their distributions from any continuous population.

**UNIT-IV**

Sampling distributions of median and range from any univariate population. Regression and Correlation. Null and Non-null distributions of sample correlation coefficient.

**UNIT-V**

Bivariate Distributions (discrete and continuous): Bivariate normal distribution– distribution function and its properties, marginal and conditional distributions.

**Recommended Books:**

1. Goon and others : An outline of statistical Theory, Vol. I.
2. Kale B.K : A first course on parametric Inference, Narosa Pub. House, New Delhi.
3. Kendall M.G. and Stuart, A : Advanced Theory of Statistics, Vol.-I & II.
4. Mood, Graybill and Boes : Introduction to the Theory of Statistics.
5. Rohatgi V.K. : An Introduction to Probability Theory and Mathematical Statistics.
6. Hogg and Craig : Introduction to Mathematical Statistics.

**Reference Books:**

1. Cramer, H : Mathematical Methods of Statistics.
2. Weiss, : Statistical Decision Theory.
3. Wald, A : Sequential Analysis.
4. Mukhopadhyay, P : Mathematical Statistics.

**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**  
**SEMESTER II M. Sc. STATISTICS**

**STA 622**

**STATISTICAL INFERENCE**

L-T-P	3-1-0
-------	-------

**TIME: 3 hours**

**External Assessment 70**  
**Internal Assessment 30**

**UNIT-I**

Theory of Estimation: Criterion of good estimators, Sufficient statistics, Factorization theorem, Distributions admitting sufficient statistic, Exponential and Pitman family's procedure for finding minimal sufficient statistic. Complete family of probability distributions, Rao Blackwell and Lehmann-scheffe theorem.

**UNIT-II**

Cramer – Rao (CR) inequality, Generalization of Cramer-Rao Inequality for multi-parametric case, Methods of estimation – method of moments and its properties – method of maximum likelihood and its properties-Large sample properties of MLE. Confidence Interval: Determination of confidence intervals based on large sample & small samples.

**UNIT-III**

Testing of hypothesis: Randomized and non-randomized tests, Neyman – Pearson fundamental lemma, Most powerful tests, Uniformly most powerful test, Unbiased tests, generalized Neyman-Pearson lemma, Similar test and complete sufficient statistics, Similar tests with Neyman structure, Likelihood ratio test, its properties and its asymptotic distribution, Applications of the LR method.

**UNIT-IV**

Non-parametric tests: Goodness of fit test: Chi-square and Kolmogorov Smirnov test - Test for randomness, Sign tests, Wilcoxon Signed rank test – Two sample problems: Kolmogorov Smirnov test, Wald-Wolfowitz run test, Mann-Whitney U test, Median test, Kruskal Wallis test and Friedman's test.

**UNIT V**

Sequential tests: Sequential Probability Ratio Test (SPRT) and its applications – Determination of the boundary constants – Operating Characteristic and expected sample size of SPRT – Optimum properties of SPRT. Applications of SPRT for testing simple v/s simple hypothesis in case of Bernoulli and Normal populations.

**Recommended Books:**

1. Goon and others : An outline of statistical Theory, Vol. I.
2. Kale B.K : A first course on parametric Inference, Narosa Pub. House, New Delhi.
3. Kendall M.G. and Stuart, : Advanced Theory of Statistics, Vol.-I & II.
- 4 Mood, Graybill and Boes : Introduction to the Theory of Statistics.
- 5 Rohatgi V.K. : An Introduction to Probability Theory and Mathematical Statistics.
6. Hogg and Craig : Mathematical Methods of Statistics.

**Reference Books:**

1. Cramer, H : Mathematical Methods of Statistics.
2. Sidney-siegal : Non-parametric Statistics for the Behavioral Sciences.
3. Weiss, : Statistical Decision Theory.
4. Wald, A : Sequential Analysis.
5. Mukhopadhyay, P : Mathematical Statistics.
6. Ferguson, T. : Theory of Mathematical Statistics.

**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**  
**SEMESTER II M. Sc. STATISTICS**  
**STA 623**

**DESIGN OF EXPERIMENTS**

L-T-P	4-1-0
-------	-------

**TIME: 3 hours**

**External Assessment 70**

**Internal Assessment 30**

**UNIT-I**

Analysis of 2<sup>nd</sup> and 3<sup>rd</sup> factorial experiments, Total and partial confounding in 2<sup>nd</sup> and 3<sup>rd</sup> factorial experiments. split-plot designs.

**UNIT- II**

General Block designs and its Information Matrix (C-matrix), Connectedness and Balance and Orthogonality. Resolvability and affine resolvability. Linear estimation Gauss Markoff theorem, Testing of linear hypothesis (involving several linear functions, test of sub-hypothesis and test involving equality of some of the parameters).

**UNIT- III**

Construction of complete set of mutually orthogonal Latin square for prime and prime powers. Analysis of Balanced Incomplete Block Design, Simple methods of construction of BIB designs, Methods of obtaining residual and derived designs from SBIBD. Complementary design of a given design.

**UNIT IV**

Intra block and inter block analysis of BIBD, Analysis of Lattice and linked block designs. Analysis of Youden square design.

**UNIT V**

Intra block and inter block analysis of Partially Balanced Incomplete Block Design, Concept of association scheme with two associate classes, and relation among the parameters of PBIBD. Group divisible design and its classification.

**Recommended Books:**

1. Anderson R.L and Bancroft, T.A. : Statistical Theory in Research.
2. Kempthorne, O : Design and Analysis of Experiments.
3. Cochran W.G. and Cox G.M. : Experimental Designs.

**Reference Books:**

1. Das, M.N. and Giri N.C. : Construction & Analysis of experiments 2nd edition, Wiley Eastern Ltd.,
2. Chakraborti, M. : Mathematics of Design & Analysis-of Experiments.
3. Joshi, D.D. : Linear estimation & Design of Experiments., Wiley Eastern Ltd., New Delhi, 1987
- 4 Dey, Alok Theory of block designs, Wiley Eastern.

# BHUPAL NOBLES' UNIVERSITY, UDAIPUR

## SEMESTER II M. Sc. STATISTICS

STA 624

### STATISTICAL COMPUTING WITH R

L-T-P	3-1-0
-------	-------

**TIME: 3 hours**

**External Assessment 70**

**Internal Assessment 30**

#### UNIT I

R language Essentials: The R package starting and quitting R. Basic features of R. Expressions and objects, Assignments, creating vectors, vectorized arithmetic, calculating with R Vectors. Logical operations in R. Relational operators. Data input and output. Vector arithmetics. Character vectors. Data Import.

#### UNIT II

Matrices and Arrays: Creating matrices, Operations on matrices: Triangular matrices, Matrix arithmetic, Matrix multiplication and Inverse. Lists.

R Programming: conditional statements – if and if else; loops – for, while, do-while; Repeated loops, break and next statements, Functions – built-in and user defined; Data entry – reading from text file, data editor; examples.

#### UNIT III

Data frames – creation, indexing, sorting and conditional selection; read.table function etc., examples.

Descriptive Statistics and Graphics: Obtaining summary statistics; generating tables; Programming statistical graphics: Bar charts, Pie charts, Histograms, Box plots, Scatter plots, QQ plots, exercises. Measurement of Central Tendencies, Dispersion, Skewness and Kurtosis.

#### UNIT IV

Probability and Distributions: Random sampling and combinatory; obtaining density, cumulative density and quantile values for discrete and continuous distributions; generating samples from discrete and continuous distributions; Generation of pseudo random numbers, Simulation of other random variables- Bernoulli, Binomial, Poisson, Exponential, Normal random variables. Plotting density and cumulative density curves; Q-Q plot. Monte-Carlo Simulations.

#### UNIT V

Correlation and Regression Analysis: Correlation: Pearson, Spearman and Kendall's correlation; Regression – fitting, obtaining residuals and fitted values; Statistical Tests: one and two sample tests for mean and variance – one way and two way ANOVA.

#### **Recommended Books:**

1. Michael J.Crawley (2007), The R Book, John Wiley and Sons Ltd.
2. Peter Dalgaard (2008), Introductory Statistics with R, 2nd edition, Springer.

#### **Reference Books:**

1. Braun, W.J. and Murdoch, D. J. : A First Course in Statistical Progg.with R, Cambridge Univ. Press.
2. Horton, N. J. & Kleinman, Ken: Using R and R Studio for data Management, Statistical Analysis and Graphics, CRC Press, USA.



**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**  
**SEMESTER II M. Sc. STATISTICS**  
**STA 625 – CP 03**  
**PRACTICALS BASED ON STA 621 & STA 622**

L-T-P	0-0-6
-------	-------

**TIME: 4 hours**

**External Assessment 70**  
**Internal Assessment 30**

**Note:** Students will be required to do practicals, based on topics listed below, using R Software:

**List of Practical:**

1. Correlation and regression coefficients for Bivariate frequency distributions.
2. Large sample tests.
3. Small sample tests viz Chi-square, t, F and Z tests.
4. Bartlett's test for homogeneity of Variances.
5. Fitting of Curves and Orthogonal Polynomials.
6. MLE and Standard error of ML estimators.
7. MLE through the method of successive approximation.
8. MLE for truncated distribution.
9. Method of Moments
10. Moment Estimation, Maximum Likelihood Estimation (for discrete, continuous, mixture, truncated distributions.)
11. Interval estimation: Confidence interval for mean, difference of means, variance and ratio of variances.
12. UMP test and LR test
13. Test of significance of sample correlation coefficient.
14. Construction of randomized and nonrandomized MP, UMP and UMPU tests of hypotheses and drawing the power curves.
15. Power curves for testing a simple hypothesis against a composite hypothesis (one sided and two sided).
16. Power curve for testing one sided Null hypothesis against one sided and two sided alternative for Binomial distribution, Poisson distribution, Normal distribution and exponential distribution.
17. Construction of randomized test of a desired size for testing simple null against simple alternative hypothesis for Bernoulli's trial and Poisson distribution.
18. Test of hypothesis using likelihood and generalized likelihood ratio test for testing equality of (i) two means (ii) two variances in normal distribution(s).
19. Non parametric tests: Kolmogorov Smirnov test, Mann-Whitney U test, Median test for k-sample problem, Kruskal Wallis test and Friedman's test
20. Sign, Median and Run tests for small and large samples.
21. Construction of SPRT and its OC and ASN curves.

22. Sequential probability ratio test and calculation of constants and graphical representation for testing simple null against simple alternative for (i) Binomial, (ii) Poisson, (iii) Normal, (iv) Exponential distributions.
23. Software development of above practical problems in R-Software and running the same on computers.

**Books for reference:**

1. Goon & Others : An outline of Statistical Theory, Vol. I.

**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**  
**SEMESTER II M. Sc. STATISTICS**

**STA 626**

**PRACTICALS BASED ON STA 623 & STA 624**

L-T-P	0-0-6
-------	-------

**TIME: 4 hours**

**External Assessment 70**

**Internal Assessment 30**

Students will be required to do practicals, based on topics listed below, using R software:

**LIST OF PRACTICALS:**

1. Yate's method for analysis of a factorial experiment.
2. Analysis of a confounded factorial experiment.
3. Analysis of Split-plot Design.
4. Analysis of BIB Design
5. Analysis of Linked block Design
6. Analysis of simple Lattice Design with 2 or more replicates.
7. Analysis of Youden Square Design
8. Analysis of Group divisible Design
9. Construction of SBIBD.
10. Operations on vectors and matrices
11. Creating and manipulating data frames.
12. Writing user defined functions for finding arithmetic mean, median, factorial, matrix addition and multiplication.
13. Bar and Pie charts.
14. Box plots for single and multiple groups.
15. Density and cumulative density plots for Binomial, Poisson, Normal and exponential distributions.
16. Checking Normality using Histogram and Q-Q plot.
17. Correlation coefficient – Pearson's, Spearman and Kendall's Tau.
18. Fitting simple linear and multiple linear regressions.
19. One sample and two sample t test.
20. One way and two way ANOVA.
21. Analysis of CRD, RBD and LSD.
22. Estimation of single missing value in RBD and LSD.
21. Software development of above practical problems in R-Software and running the same on computers.

**Books for reference:**

1. Goulden C.H. : Methods of statistical Analysis.
2. Snedecor G.W and Cochran,W.G. : Statistical Methods.
3. Laha and others : Hand BooK of Methods of Applied Statistics.
4. Singh, D and Choudhary F.S : Theory and Analysis of sample survey Designs, Wiley Eastern Ltd.
- 5 Michael J.Crawley (2007) : The R Book, John Wiley and Sons Ltd.
- 6 Peter Dalgaard (2008) : Introductory Statistics with R, 2<sup>nd</sup> edition, Springer.

**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**

**SEMESTER III M. Sc. STATISTICS**

**STA 631**

**MULTIVARIATE ANALYSIS**

L-T-P	4-1-0
-------	-------

**TIME: 3 hours**

**External Assessment 70**

**Internal Assessment 30**

**UNIT I**

Multivariate Analysis: Multivariate normal distribution and its properties, density function, marginal and Conditional distribution. Distribution of Quadratic forms.

**UNIT II**

Maximum likelihood estimators of the mean vector and covariance matrix, and related distributions. Null and Non-null distributions of partial and multiple correlation coefficients, Multivariate central limit theorem and asymptotic distribution of  $Z = \tanh^{-1}r$ .

**UNIT III**

Hotelling's  $T^2$  its properties and uses, Mahalanobis  $D^2$

**UNIT IV**

Wishart Distribution and its properties, Classification of observations.

**UNIT V**

Principal components, dimension reduction, canonical variates and canonical correlation—definition, use, estimation and computation.

**Books Recommended**

1. Anderson T.W. : An Introduction to Multivariate statistical Analysis first seven Chapters.
2. Rao, C.R. : Linear statistical Inference and its applications.
3. Kshirsagar, A.M. : Multivariate Statistical Inference
4. Morrison : Multivariate Statistical Methods.
5. Kendall M.G. and Stuart, A. : Advanced Theory of Statistics, Vol. III.
6. Giri, N.C. Multivariate Statistical Inference

**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**  
**SEMESTER III M. Sc. STATISTICS**  
**STA 632**  
**THEORY OF SAMPLE SURVEYS**

L-T-P	3-1-0
-------	-------

**TIME: 3 hours**

**External Assessment 70**

**Internal Assessment 30**

**UNIT-I**

Elements of unistage sampling with varying probabilities with replacement, Successive sampling on two occasions and h-occasions.

Theory of sample surveys: Partition of sample space and definition of T-classes of linear estimators. The wideness of set of seven classes of linear estimators. A unified approach to  $T_2$  class of linear estimators Non-sampling Errors, their sources and elimination.

**UNIT-II**

Two-stage sampling with equal and unequal first stage units. Double sampling The theory of multi-stage sampling with varying probabilities with and without replacement, Des Raj ordered estimators, Murthy's unordered estimators.

**UNIT III**

Ratio and regression methods of estimation: Bivariate extension of the Ratio and Regression Methods of estimation when population means of auxiliary variables are known Varying Probabilities without replacement: Horvitz-Thompson-estimator and its variance, Yates and Grundy form of variance unbiased estimators of variance of Horvitz-Thompson's estimators.

**UNIT-IV**

Quenouille's Techniques of bias reduction and its application to Ratio type estimators, Hartley and Ross Unbiased Ratio type estimator Ratio method of estimation in PPSWR sampling. Ratio method of estimation under Midzuno's scheme of sampling when X is known.

**UNIT-V**

Sen-Midzuno scheme of sampling and simplification of inclusion probabilities for Yates Grundy estimate of variance with advantages. Rao-Hartley-Cochran sampling schemes and their estimation procedures.

**Recommended Books:**

1. Sukhatme P.V and sukhatme B.V. : Sampling Theory of surveys with Applications.
2. Mukhopadhyay, P : Theory & Methods of Survey sampling.
3. Tikkiwal, B.D. Lecture notes on Advanced Theory of sample surveys.

**Reference Books:**

1. Deming W.E. : Some Theory of sampling.
2. Des Raj : Sampling Theory.
3. Hansen Hurwitz and Madow : Sampling surveys Methods I and Theory, Vol. II & I.
4. Murthy M.N. : Sampling Theory and Methods. 6 Cochran, W.G. Sampling Techniques
5. M.N.Murthy: Sampling Theory and Methods
6. Clase, Magus Cassel: Foundations of Inference in Survey Sampling
7. Kish L.: Survey Sampling Syllabus Covered till March 14, 2020

**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**  
**SEMESTER III M. Sc. STATISTICS**

**STA 633**

**PRACTICALS BASED ON STA 631 & STA 632**

L-T-P	0-0-6
-------	-------

**TIME: 4 hours**

**External Assessment 70**

**Internal Assessment 30**

Note: A candidate will have to attempt 3 Practicals.

Students will be required to do practicals, based on topics listed below, using R-Software:

**List of Practicals:**

1. Linear combination of correlated normal variates and evaluation of probabilities.
2. Estimation of mean vector and covariance matrix.
3. Testing of mean vector(s).
4. Estimation and testing of partial and multiple correlation coefficients.
5. Discriminant function.
6. Estimation of mean and variance by (i) ratio and (ii) regression methods of estimation.
7. Estimation of mean & variance in two-stage sampling
8. Estimation in double sampling.
9. Horvitz and Thompson's procedure of estimating mean (total) of the population, variance of estimator and estimate of variance.
10. Yate's and Grundy method.
11. Midzuno's sampling scheme.
12. Rao-Hartley-Cocharan schemes.
13. Two stage sampling method (a) f.s.u being select with pps with replacement (b) s.s.u with equal prob without replacement (c) Estimation of optimum number of f.s.u and s.s.u.
14. Hartley-Ross unbiased Ratio method of estimation.
15. Bivariate Extension of Ratio & regression method of estimation (Olkin's technique).
16. Software development of above practical problems in C-language and running the same on computers.

**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**  
**SEMESTER III M. Sc. STATISTICS**  
**STA 634**

**OPERATIONS RESEARCH**

L-T-P	3-1-0
-------	-------

**TIME: 3 hours**

**External Assessment 70**

**Internal Assessment 30**

**UNIT I**

Operations Research: Definition, scope and general nature of O.R, .

**Linear Programming Problem(LPP):** General Structure of LPP, Formulation of LPP, Solution of LPP by Graphical & Simplex Method, Degeneracy & Unboundedness. Duality in LPP

**UNIT II**

**Transportation and Assignment models:** Transportation problem, General structure of transportation problem, methods of finding initial basic feasible solution (NWCM, LCM & VAM), test for optimality (MODI Method), degeneracy, Assignment problems, Introduction, General structure, Hungarian method of solution, variations of assignment problems: minimization, maximization, unbalanced cases and restrictions, Travelling Salesman Problem.

**UNIT III**

Simulation: Definition, types, uses and limitations, phases of simulation model, Generation of random numbers, Monte-Carlo simulation. Application to inventory control and queuing theory. Game theory: Two-person zero sum game, saddle point, pure & mixed strategies, dominance principle and solution of game by graphical method.

**UNIT IV**

Inventory Control: Deterministic Inventory models with at most one linear restriction and without restriction Probabilistic inventory models.

**UNIT V**

Queuing Theory: Examples of queuing processes, Models of queuing processes M/M/1 and M/M/S with Poisson arrivals; Exponential service time distribution, Length of queue and the queue discipline being F.I.F.O.

**Books Recommended:**

1. Sharma S.D. : Operating Research.
2. Gupta P.K. & Hira D.S. : Operations Research.
3. Kanti Swarup Gupta. P.K. and Manmohan: Operations Research
4. Goel B.S. & Mittal S.K. : Operations Research.
5. Sasieni Yaspan and Friedman : Operations Research



**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**  
**SEMESTER III M. Sc. STATISTICS**

**STA 635**

**STOCHASTIC PROCESSES**

L-T-P	3-1-0
-------	-------

**TIME: 3 hours**

**External Assessment 70**

**Internal Assessment 30**

**UNIT I**

Definition and examples of stochastic process: Stochastic processes and their classification, Markov process and Markov Chain, Transition probabilities and properties of transition functions, Classification of states, transient Markov chain, Determination of higher order transition probability and its limits. Limit theorems for Markov Chains, Discrete time Markov chain, Stationary distribution and its interpretation, Chapman-Kolmogorov equation,

**UNIT II**

Continuous time Markov Chain: Poisson process and related inter-arrival time distribution, compound Poisson process, Pure birth process, pure death process, birth and death process, Problems.

**UNIT III**

Random Walks: One-dimensional, two-dimensional and three-dimensional random walks. Duality in random walk. Simple random walks, Barriers, Gambler ruin problems. Applications from social, biological and physical sciences.

**UNIT IV**

Markov process with continuous state space, Wiener process, Wiener process as a limit of random walk; first-passage time and other problems. Renewal processes, Elementary renewal theorem and its applications. Brownian motion process and its basic properties.

**UNIT V**

Galton -Watson branching processes: Definition and examples of discrete time branching process, Probability generating function and its properties, Offspring mean and probability of extinction. Statistical inference in MC and Markov processes.

**Books Recommended:**

1. Hoel, P.G., Port. S.C. and Stone, C.J.: Introduction to stochastic processes.
2. Feller W. : An Introduction to Probability Theory and its Applications Vol.- 1, 3 Chapters XI-XV.
3. Bailey, N.T.J. : The Elements of stochastic Processes.
4. Takacs : Stochastic Processes Chapters I and II.

**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**  
**SEMESTER III M. Sc. STATISTICS**

**STA 636**

**PRACTICALS BASED ON DSE STA 634 & STA 635**

L-T-P	2-0-4
-------	-------

**TIME: 3 hours**

**External Assessment 70**  
**Internal Assessment 30**

Note: A candidate will have to attempt 3 Practicals.

Students will be required to do practicals, based on topics listed below, using R-Software:

**List of Practicals:**

1. Problem Based on Monte Carlo Simulation
2. Linear Programming Problems
3. Duality Problems
4. Transportation Problems
5. Assignment Problems
6. Simulation Problems based on Inventory Control and Queuing Problems.
7. Calculation of n-step transition probabilities and limiting distribution in Markov chain.
8. Realization of Markov chain.
9. Estimation of transition probability of Markov chain using realization.
10. Operations Research and Stochastic Process and their software development in R-software and running the same on computers.

**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**  
**SEMESTER III M. Sc. STATISTICS**

**STA 637**  
**MATHEMATICAL ECONOMICS**

L-T-P	3-1-0
-------	-------

**TIME: 3 hours**

**External Assessment 70**  
**Internal Assessment 30**

**UNIT I**

Mathematical Economics Use of Mathematics and Statistics in Economics Theory of consumer behavior, indifference curves, equilibrium, of exchange, family budget enquiries, Angles curve, the derivation of slusky's equation for 2 commodity, Elasticity relations in demand theory.

**UNIT II**

Nature of cost, Equalibrium of the firm: Pricing under' conditions of perfect competition and monopoly, Walrasian genral equilibrium of exchange, Leontiefs static input-output analysis.

**UNIT III**

Component of time' series Methods of their determination, variates -difference method Yule-slusky effect Correlogram analysis.

**UNIT IV**

Concept of structure and model: Theoretical models and decision models, Growth models of Harrod and D Mar, Mahalanobis model.

**UNIT V**

The Pareto distribution, the lognormal distribution, Lorenz curve.

**Books Recommended:**

1. Allen R.G. D. : Mathematical Analysis for Economics.
2. Chennery, H.B. : Inter-Industrial Economics.
3. Gicks : Value and Capital.
4. Wold, H. : Demand Analysis.
5. Baumol, W.J. : Economic Dynamics.

**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**  
**SEMESTER III M. Sc. STATISTICS**

**STA 638**  
**STATISTICAL QUALITY CONTROL**

L-T-P	3-1-0
-------	-------

**TIME: 3 hours**

**External Assessment 70**

**Internal Assessment 30**

**UNIT I**

Statistical Quality Control: Meaning of specification limits, item quality, Process and Product Control, Objectives of S.Q.C., Control chart for measurable quality characteristic, Chance variation and assignable variation of a process. Distribution of chance variates. Need for detection of assignable causes of Variation  $\bar{X}$  and R-charts, Determination of control limits and central line in various situations.

**UNIT II**

Meaning of Statistical Control and its relation with specification limits, Modified control limits, warning limits and tolerance limits Rational sub-grouping Control charts for Attributes: p, np and c-charts. Advantages of S.Q.C., comparison of  $\bar{X}$  and R-chart with p-chart when both can be used for same situation.

**UNIT III**

Acceptance sampling by attributes, Need for sampling inspection, methods for acceptance. Lot quality and lot-by-lot acceptances A.Q.L., A.Q.Q.L., producer's risk, consumer's risk, rectification, O.C function, A.S.N and average to inspection of an acceptance procedure.

**UNIT IV**

Single and double sampling plans and their mathematical analysis: Knowledge of standard sampling inspection tables Dodge and Romig table of Military standard 150.

**UNIT V**

Sampling inspection plans for continuous production process where lots cannot be formed. Sampling inspection plans by variables - One-sided specification standard (known and unknown). Two sided specification (standards known).

**Books Recommended:**

1. Grant E.L. and Leavenworth, R.S. : Statistical Quality Control.
2. Brooker and Goode : Sampling Inspection by variables.
3. Burr. I.W. : Engineering Statistics and Quality Controls.
4. Montgomery D.C. : Statistical Quality Control.
5. M.Mahajan : Statistical Quality Control Dhanpat Rai & Co. Pvt. Ltd. Nai sarak, Delhi.

**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**  
**SEMESTER III M. Sc. STATISTICS**

**STA 639**  
**INFORMATION THEORY**

L-T-P	3-1-0
-------	-------

**TIME: 3 hours**

**External Assessment 70**  
**Internal Assessment 30**

**UNIT I**

Information Theory: A quantitative measure of information discrete memory-less channel the entropy function.

**UNIT II**

Conditional joint and marginal entropy and relation between them redundancy efficiency and channel capacity.

**UNIT III**

B.S.C. and B.E.C. elements of encoding unique decipherability and noiseless coding theorem.

**UNIT IV**

Minimum distance principle and parity check coding.

**UNIT V**

Shanon-Fano encoding Shanon's binary encoding Huffman's code error correcting codes.

**Books Recommended:**

1. Ash, R. : Information Theory.
2. Reza, F.M. : An Introduction to Information Theory.
3. Hancocd : Principles of communication Theory.

**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**  
**SEMESTER IV M. Sc. STATISTICS**

**STA 641**  
**DEMOGRAPHY**

L-T-P	3-1-0
-------	-------

**TIME: 3 hours**

**External Assessment 70**  
**Internal Assessment 30**

**UNIT I**

Demography: Sources of demographic data, Census, registration and vital statistics data, Coverage and content errors in demographic data, Chandrasekharan—Deming formula to check completeness of registration data, adjustment of age data- use of Whipple, Myer and UN indices. Population transition theory, Basic demographic measures: Ratios, Proportions and percentages, Population Pyramids, Sex ratio Crude rates, Density of population, Probability of dying.

**UNIT II**

Measures of mortality: Crude death rate, Standardized death rates, Age-specific death rates, Infant Mortality rate, Death rate by cause.

Measures of fertility: Crude birth rate, General fertility rate, Age specific birth rate, Total fertility rate, Gross birth rate, Net reproduction rate. Trends and differentials in mortality and fertility.

**UNIT III**

Life Table: Description of life table, Construction of complete and abridged life tables, Complete life table and its main features, Uses of life tables, Makehams and Gompertz curves, National life tables, UN model life tables, Abridged life table (Greville's Formula, Reed-Merrells's Formula and King's Method).

**UNIT IV**

Models of population growth and their fitting to population data: Growth rates, Natural increase rate, Arithmetic, Geometric, Exponential, Logarithmic, Logistic, Gompertz growth rates, Stable and Stationary populations, Stable population theory, Population estimation and projection. Methods for population projection, component method of population projection.

**UNIT V**

Internal migration and its measurement, migration models, concepts of international migration, Net migration, Inter and post censal estimates, Projection method including logistic curve fitting, Decennial population census in India, population projection by component method.

**Books Recommended:**

1. Croxton Cowden and Klein : Applied General Statistics.
2. Goon Gupta and Dasgupta : Fundamentals of Statistics Vol. II.
3. Kendall & Stuart : Advanced Theory of Statistics Vol. II.
4. Chennery H.B. : Inter Industrial Economics.
5. Asthana & Srivastava : Applied Statistics of India.

6. Cox : Demography.
7. Barclay : Techniques of population Analysis.
8. Kamitakar & Bhende : Principles of Populations studies.

**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**  
**SEMESTER IV M. Sc. STATISTICS**

**STA 642**

**Project Work and Viva-Voce/ Dissertation**

L-T-P	1-1-2
-------	-------

**TIME: 3 hours**

**External Assessment 70**

**Internal Assessment 30**

The Project Work will be spread over the whole semester. Project may be undertaken by the group of students and each teacher can guide up to 10 students, which can be relaxed by the Head of the department. However, the project report shall be submitted by each member of the group separately. A project report shall clearly state the problem addressed, the methodology adopted, the assumptions and the hypotheses formulated, any previous reference to the study undertaken, statistical analyses using some advance statistical softwares/ packages such as R/ STATA/ SPSS/ Latex etc. performed and the broad conclusion drawn. There shall be an external examiner and an internal examiner (preferably the supervisor of the student) for the evaluation of the project work. Out of total 100 marks assigned to the project, 70 marks will be assigned on the evaluation of the project work separately by both the examiners and 30 marks will be assigned jointly by the examiners on the oral presentation and viva – voce).

**Guidelines of Project Work**

1. A project work is compulsory and shall be offered in semester IV. Project submission is in Semester IV but the allocation of students should be done at the starting of III<sup>rd</sup> semester.
2. A project work may be taken individually or by a group of students (not more than 10 per batch).
3. Project work shall be supervised by faculty members assigned by the Head/ Incharge of the department, as the case may be at the starting of third semester.
4. The orientation of Project work shall be neither of a theory paper nature nor of a lab/practical nature but shall be in the form of dissertation.
5. Students, will decide Project Topic/ Area in consultation with the supervisor. Project work may be carried out in a group of students depending upon the depth of fieldwork/ problem involved.
6. Review meetings are to be done periodically (fortnightly/monthly) to the allocated students by the respective supervisors.
7. Students may be given 4 to 6 weeks during the semester, for their industrial work/ data collection/ survey or any other fieldwork involved in the project.
8. The project work should be selected in such a way that there is enough scope to apply and demonstrate the statistical techniques learnt in the course.
9. In this project, students should prefer mainly statistical softwares/ packages such as R/ STATA/ SPSS/ Latex etc. for their analysis and writing the reports. However, students may use MS-word/ Excel for their execution too.
10. At the end of the session, a report on the work done should be submitted in two copies. If a team of two students jointly do a project work then they must submit individual reports separately (not copy of the same report).



11. The project report shall clearly state the selected problem, the statistical methodologies employed for data collection and analysis and the conclusions arrived at. Details of previous studies in the area of work and related references should also be given.

12. The project work will be assessed for a maximum of 100 (70+ 30 internal assessment) marks. Each student shall give a presentation at the time of submission of their project work which will be evaluated externally for a maximum of 50 marks. There will be an external viva-voce examination for a maximum of 20 marks by an internal and an external examiner. The parameters for viva voce include (i) Clarity of presentation (ii) Clarity of the content / concept (iii) response to the queries and (iv) Relevance of topic for carrying out the project.

13. If there is found any shortcoming in the project work, then the HOD decision shall be final in this regard.

#### **References :**

1. Kothari, C.R. (1985): Research Methodology: Methods and Techniques, Wiley Eastern.
2. Dominowski, R.L. (1980): Research Methods, Prentice Hall Inc., New Jersey.
3. Mishra, R.P. (1980): Research Methodology, Handbook Concept Publishing Company, New Delhi.
4. IIPS (1996): Research Methodology, IIPS, Mumbai.

**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**  
**SEMESTER IV M. Sc. STATISTICS**

**STA 643- CP 06**  
**PRACTICALS BASED ON STA 641**

L-T-P	0-0-6
-------	-------

**TIME: 4 hours**

**External Assessment 70**  
**Internal Assessment 30**

Students will be required to do practicals, based on topics listed below, using R-Software:

**List of Practical**

1. Calculations of various rate, ratio, percentages etc.
2. Population Pyramids
3. Computations of various Death rates.
4. Computations of various Birth rates, NRR, GRR etc.
5. Construction of Life Tables-Abridged, Lotka Life Tables
6. Constructions of Makehams and Gompertz curves
7. Logistic curve fitting for projection.

**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**  
**SEMESTER IV M. Sc. STATISTICS**

**STA 644**  
**ECONOMETRICS**

L-T-P	3-1-0
-------	-------

**TIME: 3 hours**

**External Assessment 70**  
**Internal Assessment 30**

**Unit I**

Nature and Scope of Econometrics - Review of General Linear Model (GLM) and its extensions, Ordinary Least Squares (OLS) estimation and prediction, Generalized Least Squares (GLS) and prediction, Multicollinearity.

**Unit II**

Heteroscedasticity - Pure and mixed estimation. Autocorrelation, its consequences and tests, Theil BLUS procedure, Ridge regression, Linear regression with stochastic regressors - Instrumental variable estimation - Errors in variables - Autoregressive linear regression, lagged variables, Distributed lag models, Estimation of lags by OLS method, Koyck's geometric lag model.

**Unit III**

Simultaneous linear equations model - Identification problem - Restrictions on structural parameters - rank and order conditions - Restrictions on variances and covariances - Estimation in simultaneous equations model

**Unit IV**

Recursive systems, 2 SLS estimators, limited information estimators, k-class estimators. 3 SLS estimator, full information maximum likelihood method, prediction and simultaneous confidence intervals.

**Unit V**

Definition of causality - Granger causality - testing of causality - Cointegration, Bivariate cointegration tests - multivariate cointegration.

**Books Recommended:**

1. Damodar Gujarati and Dawn Porter (2009): Basic Econometrics, McGraw Hill.
2. Johnston, J. (1984): Econometric methods, 3/e, McGraw Hill.
3. Nachane. D.M. (2006): Econometrics: Theoretical Foundations and Empirical Perspective, Oxford University Press.

**Books for Reference:**

1. Apte, P.G. (1990): Text book of Econometrics. Tata McGraw Hill.
2. Intrulligator, M.D. (1980): Econometric models - Techniques and Applications, Prentice Hall of India.
3. Kleiber, C. and Zeileis, A. (2008): Applied Econometrics with R, Springer, NY.
4. A. Koutsoyiannis (2001): Theory of Econometrics, 2/e, Palgrave Macmillan Ltd.

# BHUPAL NOBLES' UNIVERSITY, UDAIPUR

## SEMESTER IV M. Sc. STATISTICS

### STA 645

#### LINEAR MODELS AND REGRESSION ANALYSIS

L-T-P	3-1-0
-------	-------

**TIME: 3 hours**

**External Assessment 70**

**Internal Assessment 30**

#### **Unit I**

Theory of linear estimation, Gauss-Markov linear models, estimable functions, error and estimation space, least squares estimation, variance and covariance of least squares estimator, estimation of error variance, estimation with correlated observations, properties of least square estimators, generalized inverse of a matrix and solution of normal equations, variances and covariance of least square estimators.

#### **Unit II**

One way and two-way classifications, fixed, random and mixed effects models. Analysis of variance (two-way classification only). Multiple comparison tests due to Tukey, Scheffe and Student-Newmann-Karl.

#### **Unit III**

Simple linear regression, multiple regression model, fit of polynomials and use of orthogonal polynomials, Residuals and their plots as tests for departure from assumptions such as fitness of the model, normality, homogeneity of variances and detection of outliers. Remedies. Multi co-linearity, ridge regression, sub-set selection of explanatory variables, Mallows Cp Statistics.

#### **UNIT V**

Selection of input variables and model selection – Methods of obtaining the best fit – Stepwise regression, Forward selection and backward elimination – Multicollinearity – Collinearity diagnostics – Causes, Consequences and Remedy –Departure from normality Introduction to general non-linear regression, least squares in non-linear case, Estimating the parameters of a non-linear system.

#### **Unit V**

Robust regression – Linear absolute deviation regression – M estimators – Robust regression with rank residuals – Resampling procedures for regression models – methods and its properties (without proof) - Jackknife techniques and least squares approach based on M estimators.

#### **References :**

1. Goon, A.M., Gupta, M.K. and Das Gupta, B. (1967): An Outline of Statistical Theory, Vol, The World Press Pvt. Ltd., Calcutta.
2. Rao, C.R. (1973); Linear Statistical Inference and its Application, Wiley Eastern.
3. Graybill, I.A. (1961): An Introduction to Linear Statistical Models, Vol. 1, McGraw Hill Book Co. Inc.
4. Draper, N.R. and Smith H. (1998); Applied Regression Analysis, 3rd Ed. Wiley.
5. Weisberg, S. (1985): Applied Linear Regression, Wiley.
6. Cook, R.D. and Weisberg, S. (1982): Residuals and Inference in Regression, Chapman and Hall.

**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**

**SEMESTER IV M. Sc. STATISTICS**

**STA 646**

**PRACTICALS BASED ON DSE STA 644 & STA 645**

L-T-P	2-0-4
-------	-------

**TIME: 4 hours**

**External Assessment 70**

**Internal Assessment 30**

(Practicals based on Econometrics & Linear models and Regression Analysis)

**Note:** Students will be required to do practicals, based on topics listed below, using R Software:

**List of Practical:**

1. OLS estimation and prediction in GLM.
2. Use of dummy variables (dummy variable trap) and seasonal adjustment.
3. GLS estimation and prediction.
4. Tests for Heteroscedasticity: pure and mixed estimation.
5. Tests for autocorrelation. BLUE procedure.
6. Ridge regression.
7. Instrumental variable estimation.
8. Estimation with lagged dependent variables.
9. Identification problems-checking rank and order conditions.
10. Estimation in recursive systems.
11. 2SLS and 3SLS estimation.
12. Fitting of Multiple linear regression models.
13. Estimation of regression coefficient, fitting of multiple linear regressions.
14. Non-linear regression.
15. Logistic Regression.
16. Residual Analysis for model adequacy, detection of outliers and influential observations.
17. Variable Selection procedures.
18. Collinearity Diagnostics.

**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**  
**SEMESTER IV M. Sc. STATISTICS**

**STA 648**  
**ADVANCED STATISTICAL INFERENCE**

L-T-P	3-1-0
-------	-------

**TIME: 3 hours**

**External Assessment 70**

**Internal Assessment 30**

**UNIT I**

Advanced statistical Inference: Unified theory of linear estimation, Estimation of variance components, variance components model MINQUE theory.

**UNIT II**

Admissibility of estimators: Basic theory of Admissibility and complete class, Admissibility of some commonly used estimators.

**UNIT III**

Nature of Bayesian Inference, Baye's estimators for Quadratic and Convex Loss Functions.

**UNIT IV**

Generalized Baye's Estimators, Asymptotic behavior of Baye's Estimators. Asymptotic relative Efficiency.

**UNIT V**

Theoretical basis for calculating ARE, Examples of the calculation of efficiency and ARE.

**Books Recommended:**

1. Rao, C.R. : Linear statistical Inference And its Applications (2<sup>nd</sup> Edition, Chapter 4 pp.204 to 305).
2. Zacks, S. : The Theory of Statistical Inference (Wiley), Articles 6.1 to 6.4 and 8.1 to 8.5.

**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**  
**SEMESTER IV M. Sc. STATISTICS**

**STA 649**  
**THEORY OF RELIABILITY**

L-T-P	3-1-0
-------	-------

**TIME: 3 hours**

**External Assessment 70**

**Internal Assessment 30**

**UNIT I**

Reliability: Reliability growth models probability plotting techniques for Basic ideas of accelerated life testing.

**UNIT II**

Reliability concepts and measures components and systems coherent systems reliability of coherent systems Life distributions reliability function hazard rate.

**UNIT III**

common life distributions-exponential, Weibull, gamma etc Estimation of parameters and tests in these models.

**UNIT IV**

Notions of ageing IFR, IFRA, NBU DMRL and NBUE Classes and their duals.

**UNIT V**

Univariate shock models and life distributions arising out of them.

**Reference Books:**

1. Barlow R.E. and Proschan : Statistical Theory of Reliability and Life Testing; Rinehart and Winston F. (1985).
2. Lowless, J.F. (1982) : Statistical Models and Methods of Life. Time Data; John Wiley.
3. Bain L.J and Engelhard (1991): Statistical Analysis of Reliability and Life Testing. Models; Marcel Dekker
4. Nelson, W. (1982) : Applied Life Data analysis John Wiley.
5. Zacks, S. Reliability Theory; Springer.

**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**  
**SEMESTER IV M. Sc. STATISTICS**  
**STA 644A**  
**ADVANCE THEORY OF SAMPLE SURVEYS**

L-T-P	3-1-0
-------	-------

**TIME: 3 hours**

**External Assessment 70**  
**Internal Assessment 30**

**UNIT I**

Theory of sample surveys: Partition of sample space and definition of T-classes of linear estimators. The wideness of set of seven classes of linear estimators. A unified approach to  $T_2$  class of linear estimators Non-sampling Errors, their sources and elimination.

**UNIT II**

Quenouille's Techniques of bias reduction and its application to Ratio type estimators, Hartley and Ross Unbiased Ratio type estimator Ratio method of estimation in PPSWR sampling. Ratio method of estimation under Midzuno's scheme of sampling when X is known.

**UNIT III**

Bivariate extension of the Ratio and Regression Methods of estimation when population means of auxiliary variables are known. Varying Probabilities without replacement: Horvitz Thompson-estimator and its variance, Yates and Grundy form of variance unbiased estimators of variance of Horvitz-Thompson's estimators.

**UNIT IV**

Sen-Midzuno scheme of sampling and simplification of inclusion probabilities for Yates Grundy estimate of variance with advantages. Rao-Hartley-Cochran sampling schemes and their estimation procedures.

**UNIT V**

The theory of multi-stage sampling with varying probabilities with and without replacement, Des Raj ordered estimators, Murthy's unordered estimators.

**Books recommended:**

1. Sukhatme, P.V. and Sukhatme, B.V.: Sampling Theory of surveys with Applications.
2. Tikkiwal, B.D. : Lecture notes on Advanced Theory of sample surveys.

**Reference Books:**

1. Cochran, W.G. : Sampling Techniques.
2. Murthy, M.N. : Sampling theory and methods.
3. Des Raj Sampling Theory.
4. Mukhopadhyay, P. Theory and methods of survey sampling.



**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**  
**SEMESTER IV M. Sc. STATISTICS**

**STA 645A**  
**SEQUENTIAL ANALYSIS**

L-T-P	3-1-0
-------	-------

**TIME: 3 hours**

**External Assessment 70**  
**Internal Assessment 30**

**UNIT I**

Sequential estimation: Wald's equation, sequential estimation of mean of a normal population  
Wolfowitz Lower bounds to the variance of the sequential estimates.

**UNIT II**

Robbins and stein's procedures, inverse binomial sampling.

**UNIT III**

Sequential Testing: Fundamental ideas about sequential procedures SPRT and its properties.

**UNIT IV**

Fundamental identity of sequential analysis and its applications. Applications of SPRT for testing simple hypothesis against simple alternative in case of exponential families.

**UNIT V**

Application of fundamental identity is finding O.C and A.S.N. functions.

**Books Recommended:**

1. Gibbons, J.D. : Non-Parametric Statistical Inference.
2. Lehmann, E.L. : Testing Statistical Hypotheses.
3. Rohatgi, V.K. : An Introduction to Probability Theory and Mathematical Statistics (Chapter 4).
4. Rao, C.R. : Linear statistical Inference and its Applications (Sec. 7c).
5. Wald, A. Sequential Analysis (Chapters 4, 6, 7, 8, 9, 11).

**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**  
**SEMESTER IV M. Sc. STATISTICS**

**STA 646A**

**ECONOMIC STATISTICS**

L-T-P	3-1-0
-------	-------

**TIME: 3 hours**

**External Assessment 70**  
**Internal Assessment 30**

**UNIT I**

Economic Statistics: Components of time series Methods of their determination, variate difference method Yule Slutsky effect.

**UNIT II**

Correlogram, Autoregressive models of first and second order Periodogram analysis

**UNIT III**

Income distribution - Pareto and Engel curves, Concentration curve Methods of estimating national income Intersectoral flows, Inter Industry table.

**UNIT IV**

Index numbers of prices and quantities and their relative Merits.

**UNIT V**

Construction of index numbers of wholesale and consumer prices.

**Books Recommended:**

1. Croxton Cowden and Klein : Applied General Statistics.
2. Goon Gupta and Dasgupta : Fundamentals of Statistics Vol. II.
3. Kendall & Stuart : Advanced Theory of Statistics Vol. II.
4. Chennery, H.B. : Inter Industrial Economics.
5. Asthana & Srivastava : Applied Statistics of India.
6. Kamitakar & Bhende : Principles of Populations studies.

**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**

**SEMESTER IV M. Sc. STATISTICS**

**STA 648A**

**COMPUTER-INTENSIVE STATISTICAL METHODS**

L-T-P	3-1-0
-------	-------

**TIME: 3 hours**

**External Assessment 70  
Internal Assessment 30**

### **UNIT I**

Computer-Intensive statistical Methods I: Exploratory data analysis -: transforming data, graphical methods of steering, outliers.

### **UNIT II**

Linear regression: influential observations and diagnostics robust methods collinearity variable selection.

### **UNIT III**

Generalized linear models: exponential families and ML estimation- analysis of deviance and variable selection logistic regression.

### **UNIT IV**

Nonlinear regression: estimation hypothesis testing goodness of fit EM algorithm: applications to missing and incomplete data problems mixture models.

### **UNIT V**

Smoothing with kernels: density estimation simple nonparametric regression.

#### **Reference Books:**

1. Gnanadesikan, R. : Methods for statistical Data Analysis of Multivariate Observations second edition (1997) Wiley I.
2. Belsley, D.A., E.Kuh and Welsch, R. E. (1980): Regression Diagnostics Wiley.
3. McCullagh, P. and Nelder, J.A. (1999): Generalized Linear Models Third edition. Chapman and Hall.
4. F.seber, G.E. and Wild, C.J. (1989) : Nonlinear Regression Wiley.
5. McLachlan, G.J.and Krishnan (1997): The EM Algorithms and Extensions Wiley.
6. Slmonoff,J.S.(1996 Springer) : Smoothing Methods in Statistics.

**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**

**SEMESTER IV M. Sc. STATISTICS**

**STA 649A**

**KNOWLEDGE DISCOVERY AND DATA MINING**

L-T-P	3-1-0
-------	-------

**TIME: 3 hours**

**External Assessment 70  
Internal Assessment 30**

### **UNIT I**

Knowledge discovery and Data Mining: Review of classification methods from multivariate analysis classification and decision trees. Clustering methods from both statistical and data mining view point vector quantization.

### **UNIT II**

Unsupervised learning from univariate and multivariate data dimension reduction and feature selection.

### **UNIT III**

Supervised learning from moderate to high dimensional input spaces artificial neural networks and extensions of regression models regression trees.

### **UNIT IV**

Introduction to databases: Including simple relational databases data warehouses and introduction to nonlinear analytical data processing.

### **UNIT V**

Association rules and prediction data attributes applications to electronic commerce.

### **Reference Books:**

1. A. Berson and S.J. Smith (1997) : Data Warehousing Data Mining and OLAP, McGraw-Hill.
2. Breiman, L., Friedman, J.H., Olshen R.A. and Stone, C.J. (1984) : Classification and Regression Trees, Wadsworth and Brooks/ Cole.
3. Han, J. and Kamber Morgan, M. Data (2000): Concepts and Techniques Mining: Kaufmann.
4. Mitchell, T.M. (1997) : Machine Learning, McGraw-Hill.
5. Ripley, B.D. (1996) : Pattern Recognition and Neural Networks Cambridge University Press.

**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**  
**SEMESTER IV M. Sc. STATISTICS**

**STA 644B**

**SURVIVAL ANALYSIS**

L-T-P	3-1-0
-------	-------

**TIME: 3 hours**

**External Assessment 70**  
**Internal Assessment 30**

**UNIT I**

Survival Analysis: Concepts of time Order and random Censoring likelihood in these cases Life distributions Exponential Gamma Weibull Lognormal Pareto Linear Failure rate parametric inference (Point estimation Confidence intervals Scores LR MLE tests Rao-Willks Waid for these distributions.

**UNIT II**

Life tables, failure rate mean residual life and their elementary properties Ageing classes - and their properties Bathtub Failure rate.

**UNIT III**

Estimation of survival function-Actuarial Estimator Kaplan-Meier Estimator Estimation under the assumption of IFR/DFR.

**UNIT IV**

Tests of exponentiality against non - parametric classes - Total time on test Deshpande test. Two sample problem - Gehan test Log rank test Mantel - Haenszel test Tarone - Ware tests. Semi-parametric regression for failure rate Cox7S proportional hazards model with one and several convarliates Rank test for the regression coefficients.

**UNIT V**

Competing risk model, parametric and non - parametric inference for this model. Multiple decrement life table.

**Reference Books:**

1. Cox, D.R. and Oakes D.(1984). : Analysis of survival Data Chapman and Hall New York.
2. Gross, A.J and Clark, V.A. (1975) : Survival Distribution: Reliability applications in the Biomedical Sciences, John wiley and sons.
3. Wlandt-Johnson R.E, Johnson R.L. : Survival Models and Data Analysis, John Wiley and Sons.
4. Miler, R.G (1981) : Survival Analysis John Wiley.
5. Kalbfieisch, J.D and Prentice R.L (1980).: The statistical Analysis of Failure. Time Data, John Wiley.

**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**  
**SEMESTER IV M. Sc. STATISTICS**  
**STA 645B**  
**STATISTICAL COMPUTING USING PYTHON**

L-T-P	3-1-0
-------	-------

**TIME: 3 hours**

**External Assessment 70**  
**Internal Assessment 30**

**UNIT I**

Installing Python - basic syntax - interactive shell - editing, saving and running a script. The concept of data types - variables - assignments - mutable type - immutable types - arithmetic operators and expressions - comments in the program - understanding error messages - Control statements - operators.

**UNIT II**

Introduction to functions - inbuilt and user defined functions - functions with arguments and return values - formal vs actual arguments - named arguments - Recursive functions - Lambda function - OOP Concepts - classes - objects - attributes and methods - defining classes - inheritance - polymorphism.

**UNIT III**

Introduction to Pandas - Pandas data series - Pandas data frames - data handling - grouping - Descriptive statistical analysis and Graphical representation.

**UNIT IV**

Hypothesis testing - data modelling - linear regression models - logistic regression model.

**UNIT V**

Line graph - Bar chart - Pie chart - Heat map - Histogram - Density plot - Cumulative frequencies - Error bars - Scatter plot - 3D plot.

**Recommended Books:**

1. Lambert, K. A. (2018). Fundamentals of Python: first programs. Cengage Learning.
2. Haslwanter, T. (2016). An Introduction to Statistics with Python. Springer International Publishing.

**Reference Books:**

1. Unpingco, J. (2016). Python for probability, statistics, and machine learning, Vol.1, Springer International Publishing.
2. Anthony, F. (2015). Mastering pandas. Packt Publishing Ltd.

**BHUPAL NOBLES' UNIVERSITY, UDAIPUR**  
**SEMESTER IV M. Sc. STATISTICS**

**STA 646B**  
**PRACTICALS BASED ON STA 645B**  
**(Using PYTHON)**

L-T-P	0-0-6
-------	-------

**TIME: 4 hours**

**External Assessment 70**  
**Internal Assessment 30**

Students will be required to do practical, based on topics listed below, using PYTHON:

**List of Practical:**

1. Exercise on data types
2. Exercise on arithmetic operators and expressions
3. Exercise on Control statements
4. Exercise on inbuilt and user-defined functions
5. Exercise on Recursive and Lambda function
6. Exercise on OOP Concepts.
7. Exercise on Pandas data series, frame, handling and grouping
8. Exercise on statistical analysis
9. Exercise on Hypothesis testing
10. Exercise on regression modelling
11. Exercise on graphical and diagrammatic representation.
12. Exercise on the density plot
13. Exercise on scatter and 3D plot

**Recommended Books:**

1. Lambert, K. A. (2018). Fundamentals of Python: first programs. Cengage Learning.
2. Haslwanter, T. (2016). An Introduction to Statistics with Python. Springer International Publishing.

**Reference Books:**

1. Unpingco, J. (2016). Python for probability, statistics, and machine learning, Vol.1, Springer International Publishing.
2. Anthony, F. (2015). Mastering pandas. Packt Publishing Ltd.

# **Skill Course (SC) for Semester II**

**STA 627A**

**Skill Course Elective 01**

## **Measurable functions and Lebesgue Integral**

### **UNIT I**

Convergence of sequence of Measurable function: Convergence pointwise, uniform Convergence, Convergence almost every where (a.e.).

### **UNIT II**

Convergence in measure of a sequence of measurable functions, characteristic function of a set, simple function, step function, pointwise Convergence, theorem of measure functions.

### **UNIT III**

Lebesgue Integral; Characteristic function of a set; Simple functions, Lebesgue integral of a simple function; Lebesgue integral of a bounded measurable function.

### **UNIT IV**

Lebesgue integral and Riemann integral of a bounded function defined on a closed interval; Lebesgue integral of a non-negative function; Lebesgue integral of a measurable function.

### **UNIT V**

Properties of Lebesgue integral. Convergence Theorems and Lebesgue integral; the bounded convergence theorem; Fatou's Lemma: Monotone convergence theorem; Lebesgue convergence theorem.

#### **Books Recommended:**

1. George F-Simmons : Introduction to Topology and Modern Analysis, McGraw Hill Book Co.
2. S.I.Hu : Elements of Real Analysis
3. H.L. Royden : Real Analysis.
4. G.N. Purohit : Lebesgue Measure and Integration.
5. Bartle, Robert G. : The elements of integration and Lebesgue measure



**STA 627B**  
**Skill Course Elective 02**  
**OFFICIAL STATISTICS-I**

**UNIT I**

Introduction to Indian and International Statistical systems. Role, function and activities of Central and State statistical organizations.

**UNIT II**

Organization of large scale sample surveys. Role of National Sample Survey Organization. General and special data dissemination systems.

**UNIT III**

Population growth in developed and developing countries.

**UNIT IV**

Evaluation of performance of family welfare programmes, projections of labour force and manpower.

**UNIT V**

Scope and content of population census of India.

**References:**

Basic statistics Relating to the Indian Economy (CSO) 1990.

Guide to Official Statistics (CSO), 1999.

Statistical System in India (CSO) 1995).

Principles and Accommodation of National Population Censuses, UNESCO. Panse, V. G.,  
Estimation of Crop Yields (FAO)

Family Welfare Yearbook. Annual Publication of D/0 Family Welfare.

Monthly Statistics of Foreign Trade in India, DGCIS, Calcutta and other Govt. Publications.

## **STA 627C**

### **Skill Course Elective 03**

#### **STATISTICAL METHODS FOR TOTAL QUALITY MANAGEMNET-I**

##### **UNIT I**

Quality System: ISO 9000 standard, QS 9000 standards, Concept of six-sigma and the define measure-analysis-improve-Control Approach.

##### **UNIT II**

Precision and accuracy in measurement systems. Estimation of Measurement Uncertainty.

##### **UNIT III**

Total Quality Management, Process Analysis and Optimization.

##### **UNIT IV**

Quality at Design Stage, Quality Function Deployment, Failure Mode and Effect Analysis.

##### **UNIT V**

Conjoint Analysis, System, Parameter and tolerance designs.

#### **References:**

1. Logothetis, N. (1992)/ Managing Total Quality; Prentice Hall of India.
2. Okland J.S. (1989). Total Quality Management; Butterworth-Heinemann.
3. Mittag H.J. and Rinne H. (1993) Statistical Methods of Quality Assurance.
4. Montgomry D.C. (1985); Statistical Process Control; John Wiley.
5. Montgomery D.C. (1999) Design and Analysis of Experiments; John Wiley.

# **STA 627D**

## **Skill Course Elective 04**

### **INVESTMENTS UNDER UNCERTAINTY-I**

#### **UNIT I**

Main Theme: Risk – Return Trade off.

#### **UNIT II**

Money market, Fixed income, equity, stocks and bonds, Treasury notes, market indexes, Rates of interest.

#### **UNIT III**

Compound interest, inflation, Risk in a portfolio context, law of one price and arbitrage.

#### **UNIT IV**

Risk and risk aversion, mean variance analysis, allocation between risky and risk free portfolios.

#### **UNIT V**

Diversification and portfolio risk, Markovitz portfolio selection, optimal portfolios.

#### **References:**

Bodie, Z., Kane, A. and Marcus, A.J. (1996), Investments 4<sup>th</sup> Edition, Irwin. (Chapters: 1, 2, 4, 5, 6, 7, 8, 9, 10, 20, 21, 22)

#### **Additional References:**

Arrow, K. J. (1971), Essays in the Theory of Risk Bearing, North Holland. Hull John C. (1993) options, Futures and other Derivative Securities. 2<sup>nd</sup> Ed. Prentice Hall.

**STA 627E**  
**Skill Course Elective 05**  
**ACTUARIAL STATISTICS-I**

**UNIT I**

Probability Models and Life Tables.

**UNIT II**

Utility theory, insurance and utility theory, models for individual claims and their sums, survival function, curtate future lifetime, force of mortality.

**UNIT III**

Life table and its relation with survival function, examples, assumptions for fractional ages, some analytical laws of mortality, select and ultimate tables.

Multiple life functions, joint life and last survivor status, insurance and annuity benefits through multiple life functions evaluation for special mortality laws.

**UNIT IV**

Multiple decrement models, deterministic and random survivorship groups, associated single decrement tables, central rates of multiple decrement, net single premiums and their numerical evaluations.

**UNIT V**

Distribution of aggregate claims, compound Poisson distribution and its applications, Distribution of aggregate claims, compound Poisson distribution and its applications.

**References:**

N.L. Bowers, H.U. Gerber, J.C. Hickman, D.A. Jones and C.J. Nesbitt, (1986), 'Actuarial Mathematics,' Society of Actuaries, Ithaca, Illinois, U.S.A. Second Edition (1997)

**Additional References:**

Spurgeon E.T. (1972), Life Contingencies, Cambridge University Press. Neill, A. (1977). Life Contingencies, Heineman.

**STA 627F**  
**INFORMATION AND COMMUNICATION TECHNOLOGY SKILL (ICT)**  
**(PRACTICAL)**

**TIME: 4 hours**

**External Assessment 70**  
**Internal Assessment 30**

<b>Topics</b>	<b>Lab work and Skills (Video and Online Resource)</b>
<b>Identification of various components of a computer system</b>	Identify Mother board, CPU, Memory, various ports and connectors, drives, keyboards, mouse, types of monitors and its connection to computer, hardware specifications <b>Skill:</b> Identification of various components of a PC and writing specification of a computer.
<b>Operating a computer system</b>	Desktop, using help, My computer, folders and files, word pad, copy, save and print. <b>Skill:</b> Operation of a PC.
<b>Word Processing</b>	Creating New documents, Entering text, saving, closing and opening files, editing & formatting, Cut, Copy and paste, search and replace, insert page number, date, picture, page layout, spell and grammar check, headers and footer, footnoting, table of contents, table, mail merge, mailing labels using Menu items etc. <b>Skill:</b> Preparation of a given document.
<b>Spreadsheet</b>	Creating and editing a Workbook, using charts, managing workbook. Candidates should be trained to create, enter and edit data, save and close workbook, change column width, moving, centering and merging cells, using formulae, using functions, formatting worksheet, creating charts, printing. <b>Skill:</b> Preparation of Invoice, balance sheet, plotting selected columns of a table etc.
<b>Database Management System</b>	Creating a database, modifying table, creating forms, queries and reports Candidates should be trained in creating, data entry, close and open table and database, customizing and inserting fields, sorting, form wizard, adding records, using queries, creating and printing reports. <b>Skill:</b> Prepare Telephone directory, catalogue and making queries and required reports.
<b>Presentation Graphics</b>	Creating, modifying and refining presentation, using advanced presentation features. <b>Skill:</b> Prepare a good presentation on given topic.

<p><b>Internet and Personal Information Management</b></p>	<p>Internet &amp; Intranet, Browsers and finding information, URL's, search services, e-mail, checking internet connection. Using calendar for appointment, creating and managing task, address book and its management.  <b>Skill:</b> Creation of mailing list, preparing appointment and tasks.</p>
<p><b>Web Authoring &amp; IT work</b></p>	<p>Creating a web page using HTML editor, Modifying and refining web page, inserting hyperlink, changing theme and layout, Inserting images, publishing web page.  <b>Skill:</b> Creating and Publishing a web page  Installation of Software including antivirus software, Printer and other devices. Installing and using image Scanner, CD writing, creating PDF files, Using FTP, using Google Drive.  <b>Skill:</b> Preparing a PC for office by installing necessary software.</p>

# **Skill Course (SC) for Semester IV**

**STA 647A**

**Skill Course Elective 01**

**NUMERICAL ANALYSIS**

L-T-P	2-0-0
-------	-------

**TIME: 3 hours**

**External Assessment 70  
Internal Assessment 30**

## **UNIT I**

Theory of Iteration: Simple iteration, Rate of Convergence, Acceleration a convergence, method for multiple and complex roots.

## **UNIT II**

Convergence of iteration process in the case of several unknowns.

## **UNIT III**

Real and complex roots, solution of transcendental and polynomial equations by using bisection method, secant method.

## **UNIT IV**

Regula-Falsi method, Newton Raphson method, Chebyshev method and Muller method.

## **UNIT V**

Concept of synthetic division, the Birge – vita, Bairstow and Graeffe’s root squaring method. System of Simultaneous equations(Linear): Direct method of determinant, Gauss– Elimination.

### **Books Recommended:**

1. Jain, Iyenger and Jain : Numerical Analysis.
2. Jain, M. K. : Numerical solutions of differential equation.
3. Chouhan D.S., Vyas P. & Soni. V.: Studies in Numerical Analysis

**STA 647B**  
**Skill Course Elective 02**  
**OFFICIAL STATISTICS-II**

**UNIT I**

System of collection of Agricultural statistics.

**UNIT II**

Crop forecasting and estimation, productivity.

**UNIT III**

Fragmentation of holdings, support prices, buffer stocks, impact of irrigation projects.

**UNIT IV**

Statistics related to industries, foreign trade.

**UNIT V**

Balance of payment, cost of living, inflation, educational and other social statistics.

**Note:** Candidate will have to undertake both courses I & II in Semester II and Semester IV respectively.

**References:**

Basic statistics Relating to the Indian Economy (CSO) 1990.

Guide to Official Statistics (CSO), 1999.

Statistical System in India (CSO) 1995).

Principles and Accommodation of National Population Censuses, UNESCO. Panse, V. G.,  
Estimation of Crop Yields (FAO)

Family Welfare Yearbook. Annual Publication of D/0 Family Welfare. Monthly Statistics of  
Foreign Trade in India, DGCIS, Calcutta and other Govt. Publications.



# STA 647C

## Skill Course Elective 03

### STATISTICAL METHODS FOR TOTAL QUALITY MANAGEMNET-II

#### UNIT I

Planning and analysis of fractional factorial experiments.

#### UNIT II

Basic ideas of response surface methodology and contour plots.

#### UNIT III

Quality in manufacturing control charts for attribute and variable characteristics process adjustments based on control chart evidences.

#### UNIT IV

Process capability and performance indices. Evolutionary operations.

#### UNIT V

Measuring customer satisfaction, American customer Satisfaction index model.

**Note:** Candidate will have to undertake both courses I & II in Semester II and Semester IV respectively.

#### **References:**

1. Logothetis, N. (1992)/ Managing Total Quality; Prentice Hall of India.
2. Okland J.S. (1989). Total Quality Management; Butterworth-Heinemann.
3. Mittag H.J. and Rinne H. (1993) Statistical Methods of Quality Assurance.
4. Montgomery D.C. (1985); Statistical Process Control; John Wiley.
5. Montgomery D.C. (1999) Design and Analysis of Experiments; John Wiley.

# STA 647D

## Skill Course Elective 04

### INVESTMENTS UNDER UNCERTAINTY-II

#### UNIT I

Capital assets, pricing model, passive strategy, risk premium.

#### UNIT II

index models and diversification, CAPM and index model.

#### UNIT III

Options markets, American and European options, call and put options, open strategies, option like instruments, option valuation.

#### UNIT IV

Binomial option pricing, Black-Scholes option valuation, uses of Black-Scholes formula.

#### UNIT V

Futures markets, Mechanics and strategies, Futures prices, expected spot prices.

**Note:** Candidate will have to undertake both courses I & II in Semester II and Semester IV respectively.

**References:**

Bodie, Z., Kane, A. and Marcus, A.J. (1996), Investments 4<sup>th</sup> Edition, Irwin. (Chapters: 1, 2, 4, 5, 6, 7, 8, 9, 10, 20, 21, 22)

**Additional References:**

Arrow, K. J. (1971), Essays in the Theory of Risk Bearing, North Holland. Hull John C. (1993) options, Futures and other Derivative Securities. 2<sup>nd</sup> Ed. Prentice Hall.

**STA 647E**  
**Skill Course Elective 05**  
**ACTUARIAL STATISTICS-II**

**UNIT I**

Insurance and Annuities

Principles of compound interest: Nominal and effective rates of interest and discount, force of interest and discount, compound interest, accumulation factor, Continuous compounding.

**UNIT II**

Life insurance: Insurance payable at the moment of death and at the end of the year of death level benefit insurance, endowment insurance, deferred insurance and varying benefit insurance, recursions, commutation functions.

**UNIT III**

Life annuities: Single payment, continuous life annuities, discrete life annuities, life annuities with monthly payments, commutation functions, varying annuities, recursions, complete annuities-immediate and apportionable annuities-due.

**UNIT IV**

Net premiums: Continuous and discrete premiums, true monthly payment premiums, apportionable premiums, commutation functions, accumulation type benefits. Payment premiums, apportionable premiums, commutation functions, accumulation type benefits.

**UNIT V**

Net Premium reserves: Continuous and discrete net premium reserve, reserves on a semicontinuous basis, reserves based on true monthly premiums, reserves on an apportionable or discounted continuous basis, reserves at fractional durations, allocations of loss to policy years, recursive formulas and differential equations for reserves, commutation functions. Some practical considerations: Premiums that include expenses-general expenses types of expenses, per policy expenses.

Claim amount distributions, approximating the individual model, stop-loss insurance.

**Note:** Candidate will have to undertake both courses I & II in Semester II and Semester IV respectively.

**References:**

N.L. Bowers, H.U. Gerber, J.C. Hickman, D.A. Jones and C.J. Nesbitt, (1986), 'Actuarial Mathematics,' Society of Actuaries, Ithaca, Illinois, U.S.A. Second Edition (1997)

**Additional References:**

Spurgeon E.T. (1972), Life Contingencies, Cambridge University Press. Neill, A. (1977). Life Contingencies, Heineman