Choice Based Credit System (CBCS)

UNIVERSITY OF GAUHATI

DEPARTMENT OF STATISTICS

UNDERGRADUATE PROGRAMME

(Courses effective from Academic Year 2019 - 20)

SYLLABUS OF COURSES TO BE OFFERED

Core Courses, Elective Courses & Ability Enhancement Courses

Declaration of Conformity

I / We certify that the syllabus for the stream **B.Sc. (Honours)** in the subject **Statistics** is as per guidelines laid down in the UG-CBCS Regulations of GU and the Sequence and Nomenclature of the Core Papers are maintained as per model syllabus published by the UGC, which is also a mandate of the UG-CBCS Regulations of GU.

Signature of the Head of the Department/Chairperson of UG-CCS
Department of **Statistics**, Gauhati University
Date 17-05-2019

Course Structure for B.Sc. in Statistics (Honours) under CBCS

May 2019

Semester	Type	Core	AECC	SEC	DSE	GE
	Credits	14×6 = 84	2×4 = 8	2×4 = 8	4×6 = 24	4×6 = 24
I		STA –HC – 1016	ENG– AE – 1014			STA – HG – 1016
		STA – HC – 1026				
II		STA – HC – 2016	ENV – AE – 2014			STA – HG – 2016
		STA – HC – 2026				
III		STA – HC – 3016		STA - SE – 3YY4		STA – HG – 3016
		STA – HC – 3026				
		STA – HC – 3036				
IV		STA – HC – 4016		STA - SE – 4YY4		STA – HG – 4016
		STA – HC – 4026				
		STA – HC – 4036				
V		STT – HC – 5016			STA - HE – 5YY6	
		STA – HC – 5026			STA - HE – 5YY6	
VI		STA – HC – 6016			STA - HE – 6YY6	
		STA – HC – 6026			STA - HE – 6YY6	

Total Credit: 148

Legends

HC: Core Papers for **Honours**
HE: Discipline Specific Elective Papers for **Honours**
AE: Ability Enhancement Compulsory Course
RE: Discipline Specific Elective Papers for **Regular**
SE: Skill Enhancement Papers
HG: Generic Elective Papers for **Honours**
RC: Core Papers for **Regular**
RG: Generic Elective for Regular
YY: Serial No. of Paper: Two-digit numerical number (within the Semester)

Directives & Advisory

a) A student majoring (honours) in Statistics MAY take **HG** papers from any available discipline in the college, except Statistics.
b) It is also advisable that a student majoring (honours) in Statistics take at least one **HG** paper from Mathematics.
c) A student majoring (honours) in Statistics MAY choose any four papers out of eight papers mentioned in **HE**.
d) A student majoring (honours) in Statistics MAY choose any two papers out of four papers mentioned in **SE**.
e) The Generic Elective Papers prepared HERE for other disciplines/Departments.
f) Red FONTS stands for Regular Courses

List of Papers

Core Papers

Total Lectures for each Theory papers: 60
Credits: 6 (Theory: 04, Practical/Lab: 02)

Semeste	Paper Code	Course name	Paper code for DSE for Regular
I	STA–HC–1016	Descriptive Statistics	
	STA–HC–1026	Calculus	
II	STA–HC–2016	Probability and Probability Distributions	
	STA–HC–2026	Algebra	
III	STA–HC–3016	Sampling Distributions	
	STA–HC–3026	Survey Sampling & Indian Official Statistics	STA-RE-5046
	STA–HC–3036	Mathematical Analysis	
IV	STA–HC–4016	Statistical Inference	
	STA–HC–4026	Linear Models	
	STA–HC–4036	Statistical Quality Control	
V	STA–HC–5016	Stochastic Processes and Queuing Theory	
	STA–HC–5026	Statistical Computing Using C/C++ Programming	
VI	STA–HC–6016	Design of Experiments	STA-RE-6036
	STA–HC-- 6026	Multivariate Analysis and Nonparametric Methods	

Discipline Specific Elective (DSE) Papers for Honours

Total Lectures for each Theory papers: 60
Credits: 6 (Theory: 04, Practical/Lab: 02)
(Any **TWO** papers **MUST** be chosen from given **FOUR** options papers in each Semester)

Semester	Paper Code	Course name	Paper code for DSE for Regular
V	STA – HE – 5016	Operations Research	STA – RE – 5016
	STA – HE – 5026	Time Series Analysis	STA – RE – 5026
	STA – HE – 5036	Survival Analysis and Biostatistics	STA – RE – 5036
	STA – HE – 5046	Financial Statistics	
VI	STA – HE – 6016	Econometrics	STA – RE – 6016
	STA – HE – 6026	Demography and Vital Statistics	STA – RE – 6026
	STA – HE – 6036	Actuarial Statistics	STA – RE – 6046
	STA – HE – 6046	Project Work	

Skill Based (SEC) Papers for Honours

Total Lectures for each Theory papers: 30
Credits: 4 (Theory: 02, Practical/Lab: 02)

(Any **ONE** paper **MUST** be chosen from given **TWO** options papers in each Semester)

Semester	Paper Code	Course name	Paper code for SEC for Regular
III	STA – SE – 3014	Statistical-Data Analysis Using Software Packages	STA – SE – 3014
	STA – SE – 3024	Data Base Management Systems	STA – SE – 4014
IV	STA – SE – 4014	Statistical Data Analysis Using R	STA – SE – 5014
	STA – SE – 4024	Statistical Techniques for Research Methods	STA – SE – 6014

Generic Elective (GE) Papers for Honours

Total Lectures for each Theory papers: 60
Credits: 6 (Theory: 04, Practical/Lab: 02)

Semester	Paper Code	Course name	Paper code for Regular Core (RC) for Regular
I	STA – HG – 1016	Statistical Methods	STA – RC – 1016
II	STA – HG – 2016	Introductory Probability	STA – RC – 2016
III	STA – HG – 3016	Basics of Statistical Inference	STA – RC – 3016
IV	STA – HG – 4016	Applied Statistics	STA – RC – 4016

Regular Core (RC) Papers for Regular

Total Lectures for each Theory papers: 60
Credits: 6 (Theory: 04, Practical/Lab: 02)

Semester	Paper Code	Course name
I	STA – RC – 1016	Statistical Methods
II	STA – RC – 2016	Introductory Probability
III	STA – RC – 3016	Basics of Statistical Inference
IV	STA – RC – 4016	Applied Statistics

Discipline Specific Elective (DSE) Papers for Regular

Total Lectures for each Theory papers: 60
Credits: 6 (Theory: 04, Practical/Lab: 02)

Semester	Paper Code	Course name
V	STA – RE – 5016	Operations Research
	STA – RE – 5026	Time Series Analysis
	STA – RE – 5036	Survival Analysis and Biostatistics
	STA – RE – 5046	Survey Sampling & Indian Official Statistics
VI	STA – RE – 6016	Econometrics
	STA – RE – 6026	Demography and Vital Statistics
	STA – RE – 6036	Design of Experiments
	STA – RE – 6046	Actuarial Statistics

Skill Based (SEC) Papers for Regular

Total Lectures for each Theory papers: 30
Credits: 4 (Theory: 02, Practical/Lab: 02)

Semester	Paper Code	Course name
III	STA – SE – 3014	Statistical-Data Analysis Using Software Packages
IV	STA – SE – 4014	Data Base Management Systems
V	STA – SE – 5014	Statistical Data Analysis Using R
VI	STA – SE – 6014	Statistical Techniques for Research Methods

Contents

STA-HC-1016

Descriptive Statistics

Total Lectures: 60 Credits: 6 (Theory: 04, Practical/Lab: 02)

1.1 Theory

1.1.1 Unit I: *Statistical Methods*: (Lectures: 10)

Definition and scope of Statistics, concepts of statistical population and sample. Data: quantitative and qualitative, attributes, variables, scales of measurement- nominal, ordinal, interval and ratio. Presentation: tabular and graphical, including histogram and ogives, box plot, consistency and independence of data with special reference to attributes.

1.1.2 Unit 2: *Measures of Central Tendency*: (Lectures: 20)

Mathematical and positional. Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation, Moments, absolute moments, factorial moments, skewness and kurtosis, Sheppard's corrections.

Collection and Scrutiny of Data: Primary data-designing a questionnaire and a schedule; checking their consistency; Secondary data-their major sources including some government publications. Complete enumeration, controlled experiments, observational studies and sample surveys. Scrutiny of data for internal consistency and detection of errors of recording. Ideas of cross-validation.

1.1.3 Unit 3: *Bivariate data*: (Lectures: 15)

Definition, scatter diagram, simple, partial and multiple correlation (3 variables only), rank correlation. Simple linear regression, principle of least squares and fitting of polynomials and exponential curves.

1.1.4 Unit 4: *Index Numbers*: (Lectures: 15)

Definition, construction of index numbers and problems thereof for weighted and unweighted index numbers including Laspeyre's, Paasche's, Edgeworth-Marshall and Fisher's. Chain index numbers, conversion of fixed based to chain based index numbers and vice-versa. Consumer price index numbers.

1.2 Practical/Lab

List of Practical

1. Graphical representation of data.
2. Problems based on measures of central tendency.
3. Problems based on measures of dispersion.
4. Problems based on combined mean and variance and coefficient of variation.
5. Problems based on moments, skewness and kurtosis.
6. Fitting of polynomials, exponential curves.

7. Karl Pearson correlation coefficient.
8. Correlation coefficient for a bivariate frequency distribution.
9. Lines of regression, angle between lines and estimated values of variables.
10. Spearman rank correlation with and without ties.
11. Partial and multiple Correlations.
12. Planes of regression and variances of residuals for given simple correlations.
13. Planes of regression and variances of residuals for raw data.
14. Calculate price and quantity index numbers using simple and weighted average of price relatives.
15. To calculate the Chain Base index numbers.
16. To calculate consumer price index number.

SUGGESTED READING:

1. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.
2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
3. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co. Ltd.

STA-HC-1026

Calculus

Total Lectures: 60 Credits: 6 (Theory: 04, Tutorial: 02)

2.1 Theory

2.1.1 Unit 1: *Differential Calculus*: (Lectures: 18)

Limits of function, continuous functions, properties of continuous functions, partial differentiation and total differentiation. Indeterminate forms: *L*- Hospital's rule, Leibnitz rule for successive differentiation. Euler's theorem on homogeneous functions. Maxima and minima of functions of one and two variables, constrained optimization techniques (with Lagrange multiplier) along with some problems. Jacobian.

2.1.2 Unit 2: *Integral Calculus*: (Lectures: 12)

Review of integration and definite integral. Differentiation under integral sign, double integral, change of order of integration, transformation of variables. Beta and Gamma functions: properties and relationship between them.

2.1.3 Unit 3: *Differential Equations*: (Lectures: 25)

Exact differential equations, Integrating factors, change of variables, Total differential equations, Differential equations of first order and first degree, Differential equations of first order but not of first degree, Equations solvable for *x, y, q,* Equations of the first degree in *x* and *y*, Clairaut's equations. Higher Order Differential Equations**:** Linear differential equations of order *n*, Homogeneous and non-homogeneous linear differential equations of order *n* with constant coefficients, Different forms of particular integrals.

2.1.4 Unit 4: *Partial Differential Equations*: (Lectures: 5)

Formation and solution of a partial differential equations**.** Equations easily integrable. Linear partial differential equations of first order.

2.2 Tutorial

SUGGESTED READINGS:

1. Gorakh Prasad: Differential Calculus, Pothishala Pvt. Ltd., Allahabad (14th Edition - 1997).
2. Gorakh Prasad: Integral Calculus, Pothishala Pvt. Ltd., Allahabad (14th Edition -2000).
3. Zafar Ahsan: Differential Equations and their Applications, Prentice-Hall of India Pvt. Ltd., New Delhi (2nd Edition -2004).
4. Piskunov, N: Differential and Integral Calculus, Peace Publishers, Moscow.

STA-HC-2016

Probability and Probability Distributions

Total Lectures: 60 Credits: 6 (Theory: 04, Practical/Lab: 02)

3.1 Theory

3.1.1 Unit 1: *Probability*: (Lectures: 12)

Introduction, random experiments, sample space, events and algebra of events. Definitions of Probability – classical, statistical, and axiomatic. Conditional Probability, laws of addition and multiplication, independent events, theorem of total probability, Bayes' theorem and its applications.

3.1.2 Unit 2: *Random variables*: (Lectures: 18)

Discrete and continuous random variables, p.m.f., p.d.f. and c.d.f., illustrations and properties of random variables, univariate transformations with illustrations. Two dimensional random variables: discrete and continuous type, joint, marginal and conditional p.m.f, p.d.f., and c.d.f., independence of variables, bivariate transformations with illustrations.

3.1.3 Unit 3: *Mathematical Expectation and Generating Functions*: (Lectures: 12)

Expectation of single and bivariate random variables and its properties. Moments and Cumulants, moment generating function, cumulant generating function and characteristic function. Conditional expectations.

3.1.4 Unit 4: *Mathematical Expectation and Generating Functions*: (Lectures: 18)

Standard probability distributions: Binomial, Poisson, geometric, negative binomial, hypergeometric, uniform, normal, exponential, Cauchy, beta and gamma along with their properties and limiting/approximation cases, Log normal, Laplace, Weibull.

3.2 Practical/Lab

List of Practical

1. Fitting of binomial distributions for n and p = q = ½.
2. Fitting of binomial distributions for given n and p.
3. Fitting of binomial distributions after computing mean and variance.
4. Fitting of Poisson distributions for given value of lambda.
5. Fitting of Poisson distributions after computing mean.
6. Fitting of negative binomial.
7. Fitting of suitable distribution.
8. Application problems based on binomial distribution.
9. Application problems based on Poisson distribution.
10. Application problems based on negative binomial distribution.
11. Problems based on area property of normal distribution.
12. To find the ordinate for a given area for normal distribution.
13. Application based problems using normal distribution.

14. Fitting of normal distribution when parameters are given.
15. Fitting of normal distribution when parameters are not given.

SUGGESTED READING:

1. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009): Probability and Statistical Inference, Seventh Ed, Pearson Education, New Delhi.
2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
3. Myer, P.L. (1970): Introductory Probability and Statistical Applications, Oxford & IBH Publishing, New Delhi

STA-HC-2026

Algebra

Total Lectures: 60 Credits: 6 (Theory: 04, Practical/Lab: 02)

4.1 Theory

4.1.1 Unit 1: *Theory of equations*: (Lectures: 15)

Statement of the fundamental theorem of algebra and its consequences. Relation between roots and coefficients or any polynomial equations. Solutions of cubic and biquadratic equations when some conditions on roots of equations are given. Evaluation of the symmetric polynomials and roots of cubic and biquadratic equations. Vector spaces, Subspaces, sum of subspaces, Span of a set, Linear dependence and independence, dimension and basis, dimension theorem.

4.1.2 Unit 2: *Algebra of matrices*: (Lectures: 17)

A review, theorems related to triangular, symmetric and skew symmetric matrices, idempotent matrices, Hermitian and skew Hermitian matrices, orthogonal matrices, singular and non-singular matrices and their properties. Trace of a matrix, unitary, involutory and nilpotent matrices. Adjoint and inverse of a matrix and related properties.

4.1.3 Unit 3: *Determinants of Matrices*: (Lectures: 18)

Definition, properties and applications of determinants for 3rd and higher orders, evaluation of determinants of order 3 and more using transformations. Symmetric and Skew symmetric determinants, Circulant determinants and Vandermonde determinants for n^{th} order, Jacobi's Theorem, product of determinants. Use of determinants in solution to the system of linear equations, row reduction and echelon forms, the matrix equations AX=B, solution sets of linear equations, linear independence, Applications of linear equations, inverse of a matrix.

4.1.4 Unit 4: *Matrices*: (Lectures: 10)

Rank of a matrix, row-rank, column-rank, standard theorems on ranks, rank of the sum and the product of two matrices. Partitioning of matrices and simple properties. Characteristic roots and Characteristic vector, Properties of characteristic roots, Cayley Hamilton theorem, Quadratic forms, Linear orthogonal transformation and their diagonalization.

3.2 Practical/Lab

List of Practical

Practical will done from the Unit 1 to Unit 4.

SUGGESTED READINGS:

1. Lay David C.: Linear Algebra and its Applications, Addison Wesley, 2000.
2. Schaum's Outlines : Linear Algebra, Tata McGraw-Hill Edition, 3rd Edition, 2006.
3. Krishnamurthy, V., Mainra, V.P. and Arora J.L.: An Introduction to Linear Algebra (II, III, IV, V).
4. Jain, P.K. and Khalil Ahmad: Metric Spaces, Narosa Publishing House, New Delhi, 1973
5. Biswas, S. (1997): A Textbook of Matrix Algebra, New Age International, 1997.
6. Gupta, S.C.: An Introduction to Matrices (Reprint). Sultan Chand & Sons, 2008.

7. Artin, M.: Algebra. Prentice Hall of India, 1994.
8. Datta, K.B.: Matrix and Linear Algebra. Prentice Hall of India Pvt. Ltd., 2002.
9. Hadley, G.: Linear Algebra, Narosa Publishing House (Reprint), 2002.
10. Searle, S.R.: Matrix Algebra Useful for Statistics. John Wiley & Sons., 1982.

STA-HC-3016

Sampling Distributions

Total Lectures: 60 Credits: 6 (Theory: 04, Practical/Lab: 02)

5.1 Theory

5.1.1 Unit 1: *Order Statistics*: (Lectures: 8)

Introduction, distribution of the *r*th order statistic, smallest and largest order statistics. Joint distribution of *r*th and *s*th order statistics, distribution of sample median and sample range.

5.1.2 Unit 2: *Sampling Distributions*: (Lectures: 20)

Definitions of random sample, parameter and statistic, sampling distribution of a statistic, sampling distribution of sample mean, standard errors of sample mean, sample variance and sample proportion. Null and alternative hypotheses, level of significance, Type I and Type II errors, their probabilities and critical region. Large sample tests, testing single proportion, difference of two proportions, single mean, difference of two means, standard deviation and difference of standard deviations by classical and *p*-value approaches.

5.1.3 Unit 3: *Exact sampling distributions*: (Lectures: 12)

Definition and derivation of p.d.f. of χ^2 with n degrees of freedom (d.f.) using m.g.f., nature of p.d.f. curve for different degrees of freedom, mean, variance, m.g.f., cumulant generating function, mode, additive property and limiting form of χ^2 distribution. Tests of significance and confidence intervals based on χ^2 distribution.

5.1.4 Unit 4: *Sampling distribution*: (Lectures: 20)

Student's and Fishers *t*-distribution, Derivation of its p.d.f., nature of probability curve with different degrees of freedom, mean, variance, moments and limiting form of t distribution.

Snedecore's *F*-distribution: Derivation of p.d.f., nature of p.d.f. curve with different degrees of freedom, mean, variance and mode. Distribution of $1/F(n1,n2)$. Relationship between *t, F* and χ^2 distributions. Test of significance and confidence Intervals based on *t* and *F* distributions.

5.2 Practical/Lab

List of Practical

1. Testing of significance and confidence intervals for single proportion and difference of two proportions
2. Testing of significance and confidence intervals for single mean and difference of two means and paired tests.
3. Testing of significance and confidence intervals for difference of two standard deviations.
4. Exact Sample Tests based on Chi-Square Distribution.

5. Testing if the population variance has a specific value and its confidence intervals.
6. Testing of goodness of fit.
7. Testing of independence of attributes.
8. Testing based on 2 X 2 contingency table without and with Yates' corrections.
9. Testing of significance and confidence intervals of an observed sample correlation coefficient.
10. Testing and confidence intervals of equality of two population variances

SUGGESTED READING:

1. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2003): *An Outline of Statistical Theory*, Vol. I, 4th Edn. World Press, Kolkata.
2. Rohatgi V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. 2nd Edn. (Reprint) John Wiley and Sons.
3. Hogg, R.V. and Tanis, E.A. (2009): *A Brief Course in Mathematical Statistics*. Pearson Education.
4. Johnson, R.A. and Bhattacharya, G.K. (2001): *Statistics-Principles and Methods*, 4th Edn. John Wiley and Sons.
5. Mood, A.M., Graybill, F.A. and Boes, D.C. (2007): *Introduction to the Theory of Statistics*, 3rd Edn. (Reprint).Tata McGraw-Hill Pub. Co. Ltd.

STA-HC-3026

Survey Sampling and Indian Official Statistics

Total Lectures: 60 Credits: 6 (Theory: 04, Practical/Lab: 02)

6.1 Theory

6.1.1 Unit 1: *Survey Sampling*: (Lectures: 8)

Concept of population and sample, complete enumeration versus sampling, sampling and non-sampling errors. Types of sampling: non-probability and probability sampling, basic principle of sample survey, simple random sampling with and without replacement, definition and procedure of selecting a sample, estimates of: population mean, total and proportion.

6.1.2 Unit 2: *Stratified random sampling*: (Lectures: 26)

Technique, estimates of population mean and total, variances of these estimates, proportional and optimum allocations and their comparison with SRS. Practical difficulties in allocation, estimation of gain in precision. Systematic Sampling: Technique, estimates of population mean and total, variances of these estimates ($N=n \times k$). Comparison of systematic sampling with SRS and stratified sampling in the presence of linear trend and corrections, introduction to PPS sampling and two stage sampling.

6.1.3 Unit 3: *Ratio and Regression Method of Sampling*: (Lectures: 20)

Introduction to Ratio and regression methods of estimation, first approximation to the population mean and total (for SRS of large size). Cluster sampling (equal clusters only) estimation of population mean and its variance, Concept of sub sampling.

6.1.4 Unit 4: *Official Statistics*: (Lectures: 6)

Present official statistical system in India, Methods of collection of official statistics, their reliability and limitations. Role of Ministry of Statistics & Program Implementation (MoSPI), Central Statistical Office (CSO), National Sample Survey Office (NSSO), and National Statistical Commission. Government of India's Principal publications containing data on the topics such as population, industry and finance.

6.2 Practical/Lab

List of Practical

1. To select a SRS with and without replacement.
2. For a population of size 5, estimate population mean, population mean square and population variance. Enumerate all possible samples of size 2 by WR and WOR and establish all properties relative to SRS.
3. For SRSWOR, estimate mean, standard error, the sample size
4. Stratified Sampling: allocation of sample to strata by proportional and Neyman's methods Compare the efficiencies of above two methods relative to SRS
5. Estimation of gain in precision in stratified sampling.
6. Comparison of systematic sampling with stratified sampling and SRS in the presence of a

linear trend.

7. Ratio and Regression estimation: Calculate the population mean or total of the population. Calculate mean squares. Compare the efficiencies of ratio and regression estimators relative to SRS.
8. Cluster sampling: estimation of mean or total, variance of the estimate, estimate of intra-class correlation coefficient, efficiency as compared to SRS.

SUGGESTED READING

1. Cochran, W.G. (1984): Sampling Techniques (3rd Ed.), Wiley Eastern.
2. Sukhatme, P.V., Sukhatme, B.V. Sukhatme, S. Asok,C.(1984). Sampling Theories of Survey With Application, IOWA State University Press and Indian Society of Agricultural Statistics
3. Murthy, M.N. (1977): Sampling Theory & Statistical Methods, Statistical Pub. Society, Calcutta.
4. Des Raj and Chandhok, P. (1998): Sample Survey Theory, Narosa Publishing House.
5. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2001): Fundamentals of Statistics (Vol.2), World Press.
6. Guide to current Indian Official Statistics, Central Statistical Office, GOI, New Delhi.
7. http://mospi.nic.in/

STA-HC-3036

Mathematical Analysis

Total Lectures: 60 Credits: 6 (Theory: 04, Practical/Lab: 02)

7.1 Theory

7.1.1 Unit 1: *Real Analysis*: (Lectures: 12)

Representation of real numbers as points on the line. Bounded and unbounded sets, neighborhoods and limit points, Superimum and infimum, derived sets, open and closed sets, sequences and their convergence, limits of some special sequences such as r^n, $\left(1+\frac{1}{n}\right)^n$, and $n^{\frac{1}{n}}$ and Cauchy's general principle of convergence, Cauchy's first theorem on limits, monotonic sequences, limit superior and limit inferior of a bounded sequence.

7.1.2 Unit 2: *Infinite Series*: (Lectures: 12)

Infinite series, positive termed series and their convergence; Comparison test, D'Alembert's ratio test, Cauchy's n^{th} root test, Raabe's test (For all the tests, statement only is required, without proof and applications). Absolute convergence of series, Leibnitz's test for the convergence of alternating series, Conditional convergence. Indeterminate form, *L*' Hospital's rule.

7.1.3 Unit 3: *Limits, Continuity and Differentiability*: (Lectures: 16)

Review of limit, continuity and differentiability, uniform Continuity and boundedness of a function. Rolle's and Lagrange's Mean Value theorems. Taylor's theorem with lagrange's and Cauchy's form of remainder (without proof). Taylor's and Maclaurin's series expansions of $\sin(x), \cos(x), e^x, (1+x)^n, \log(1+x)$.

7.1.4 Unit 4: *Numerical Analysis*: (Lectures: 20)

Factorial, finite differences and interpolation. Operators, E and divided difference. Newton's forward, backward and divided differences interpolation formulae. Lagrange's interpolation formulae. Central differences, Gauss and Stirling interpolation formulae. Numerical integration. Trapezoidal rule, Simpson's one-third rule, three-eights rule, Weddle's rule with error terms. Stirling's approximation to factorial *n*. Solution of difference equations of first order.

7.2 Practical/Lab

Practical to be done from topics contained in Unit 4 only.

SUGGESTED READINGS

1. Malik, S.C. and Savita Arora: Mathematical Analysis, Second Edition, Wiley Eastern Limited, New Age International Limited, New Delhi, 1994.
2. Somasundram, D. and Chaudhary, B.: A First Course in Mathematical Analysis, Narosa Publishing House, New Delhi, 1987.
3. Gupta, S.L. and Nisha Rani: Principles of Real Analysis, Vikas Publ. House Pvt. Ltd., New Delhi, 1995.
4. Appostol, T.M.: Mathematical Analysis, Second Edition, Narosa Publishing House, New Delhi, 1987.
5. Shanti Narayan: A course of Mathematical Analysis, 12^{th} revised Edition, S. Chand & Co. (Pvt.) Ltd., New Delhi, 1987.
6. Singal, M.K. and Singal, A.R.: A First Course in Real Analysis, 24^{th} Edition, R. Chand & Co., New Delhi, 2003.
7. Bartle, R. G. and Sherbert, D. R. (2002): Introduction to Real Analysis (3rd Edition), John Wiley and Sons (Asia) Pte. Ltd., Singapore.
8. Ghorpade, Sudhir R. and Limaye, Balmohan V. (2006): A Course in Calculus and Real Analysis, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint.
9. Jain,M. K., Iyengar, S. R. K. and Jain, R. K. (2003): Numerical methods for scientific and engineering computation, New age International Publisher, India.
10. Mukherjee, Kr. Kalyan (1990): Numerical Analysis. New Central Book Agency.
11. Sastry, S.S. (2000): Introductory Methods of Numerical Analysis, 3rd edition, Prentice Hall of India Pvt. Ltd., New Del.

STA-HC-4016

Statistical Inference

Total Lectures: 60 Credits: 6 (Theory: 04, Practical/Lab: 02)

8.1 Theory

8.1.1 Unit 1: *Estimation*: (Lectures: 20)

Concepts of estimation, unbiasedness, sufficiency, consistency and efficiency. Factorization theorem. Complete statistic, Minimum variance unbiased estimator (MVUE), Rao-Blackwell and Lehmann-Scheffe theorems (statement only). Cramer-Rao inequality and MVB estimators.

8.1.2 Unit 2: *Methods of Estimation*: (Lectures: 19)

Method of moments, method of maximum likelihood estimation, method of minimum Chi-square.

8.1.3 Unit 3: *Principles of test of significance*: (Lectures: 18)

Null and alternative hypotheses (simple and composite), Type-I and Type-II errors, critical region, level of significance, size and power, best critical region, most powerful test, uniformly most powerful test, Neyman Pearson Lemma (statement and applications to construct most powerful test). Likelihood ratio test, properties of likelihood ratio tests (without proof).

8.1.4 Unit 4: *Principles of test of significance*: (Lectures: 3)

Sequential Analysis: Introduction to Sequential probability ratio test (SPRT).

8.2 Practical/Lab

List of Practical

1. Unbiased estimators (including unbiased but absurd estimators)
2. Consistent estimators, efficient estimators and relative efficiency of estimators.
3. Cramer-Rao inequality and MVB estimators
4. Sufficient Estimators – Factorization Theorem, Rao-Blackwell theorem, Complete Sufficient estimators
5. Lehman-Scheffe theorem and UMVUE
6. Maximum Likelihood Estimation
7. Estimation by the method of moments, minimum Chi-square
8. Type I and Type II errors
9. Most powerful critical region (NP Lemma)
10. Uniformly most powerful critical region
11. Unbiased critical region
12. Power curves
13. Likelihood ratio tests for simple null hypothesis against simple alternative hypothesis
14. Likelihood ratio tests for simple null hypothesis against composite alternative hypothesis
15. Asymptotic properties of LR tests

SUGGESTED READINGS:

1 Goon, A.M., Gupta, M.K.: Das Gupta, B. (2005), Fundamentals of Statistics, Vol. I, World Press, Calcutta.

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

3. Miller, I. and Miller, M. (2002) : John E. Freund's Mathematical Statistics (6th addition, low price edition), Prentice Hall of India.

4. Dudewicz, E. J., and Mishra, S. N. (1988): Modern Mathematical Statistics. John Wiley & Sons.

5. Mood, A.M, Graybill, F.A. and Boes, D.C,: Introduction to the Theory of Statistics, McGraw Hill.

6. Bhat, B.R, Srivenkatramana, T and Rao Madhava, K.S. (1997) Statistics: A Beginner's Text, Vol. I, New Age International (P) Ltd.

7. Snedecor, G.W and Cochran, W.G.(1967) Statistical Methods. Iowa State University Press.

STA-HC-4026

Linear Models

Total Lectures: 60 Credits: 6 (Theory: 04, Practical/Lab: 02)

9.1 Theory

9.1.1 Unit 1: *Gauss-Markov Set-up*: (Lectures: 12)

Theory of linear estimation, Estimability of linear parametric functions, Method of least squares, Gauss-Markov theorem, Estimation of error variance.

9.1.2 Unit 2: *Regression Analysis*: (Lectures: 15)

Simple regression analysis, Estimation and hypothesis testing in case of simple regression models.

9.1.3 Unit 3: *Analysis of Variance*: (Lectures: 18)

Definitions of fixed, random and mixed effect models, analysis of variance and covariance in one-way classified data for fixed effect models, analysis of variance and covariance in two-way classified data with one observation per cell for fixed effect models.

9.1.4 Unit 4: *Model Checking*: (Lectures: 15)

Prediction from a fitted model, Violation of assumptions of AOV and their remedies by transformation.

9.2 Practical/Lab

List of Practical

1. Estimability when X is a full rank matrix and not a full rank matrix
2. Distribution of Quadratic forms
3. Simple Linear Regression
4. Multiple Regression
5. Tests for Linear Hypothesis
6. Bias in regression estimates
7. Lack of fit
8. Orthogonal Polynomials
9. Analysis of Variance of a one way classified data
10. Analysis of Variance of a two way classified data with one observation per cell
11. Analysis of Covariance of a one way classified data
12. Analysis of Covariance of a two way classified data

SUGGESTED READINGS:

1. Weisberg, S. (2005). Applied Linear Regression (Third edition). Wiley.
2. Wu, C. F. J. And Hamada, M. (2009). Experiments, Analysis, and Parameter Design Optimization (Second edition), John Wiley.
3. Renchner, A. C. And Schaalje, G. B. (2008). Linear Models in Statistics (Second edition), John Wiley and Sons.

STA-HC-4036

Statistical Quality Control

Total Lectures: 60 Credits: 6 (Theory: 04, Practical/Lab: 02)

10.1 Theory

10.1.1 Unit 1: *Statistical Process Control*: (Lectures: 18)

Quality: Definition, dimensions of quality, historical perspective of quality control and improvements starting from World War II, historical perspective of Quality Gurus and Quality Hall of Fame. Quality system and standards: Introduction to ISO quality standards, Quality registration. Statistical Process Control - Seven tools of SPC, chance and assignable Causes of quality variation. Statistical Control Charts- Construction and Statistical basis of 3-σ Control charts, Rational Sub-grouping.

10.1.2 Unit 2: *Control Charts for Variables*: (Lectures: 18)

X-bar & *R*-chart, *X*-bar & *s*-chart. Control charts for attributes: *np*-chart, *p*-chart, *c*-chart and *u*-chart. Comparison between control charts for variables and control charts for attributes. Analysis of patterns on control chart, estimation of process capability.

10.1.3 Unit 3: *Acceptance Sampling Plan*: (Lectures: 20)

Principle of acceptance sampling plans. Single and Double sampling plan their OC, AQL, LTPD, AOQ, AOQL, ASN, ATI functions with graphical interpretation, use and interpretation of Dodge and Romig's sampling inspection plan tables.

10.1.4 Unit 4: *Six-Sigma*: (Lectures: 4)

Introduction to Six-Sigma: Overview of Six Sigma.

10.2 Practical/Lab

List of Practical

1. Construction and interpretation of statistical control charts *X*-bar & *R*-chart
   - *X*-bar & *s*-chart
   - *np*-chart
   - *p*-chart
   - *c*-chart
   - *u*-chart
2. Single sample inspection plan: Construction and interpretation of OC, AQL, LTPD, ASN, ATI, AOQ, AOQL curves
3. Calculation of process capability and comparison of 3-sigma control limits with specification limits.

SUGGESTED READING:

1. Montogomery, D. C. (2009): Introduction to Statistical Quality Control, 6th Edition, Wiley India Pvt. Ltd.
2. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.
3. Mukhopadhyay, P (2011): Applied Statistics, 2nd edition revised reprint, Books and Allied(P) Ltd.
4. Montogomery, D. C. and Runger, G.C. (2008): Applied Statistics and Probability for Engineers, 3rd Edition reprint, Wiley India Pvt. Ltd.
5. Ehrlich, B. Harris (2002): Transactional Six Sigma and Lean Servicing, 2nd Edition, St. Lucie Press.
6. Hoyle, David (1995): ISO Quality Systems Handbook, 2nd Edition, Butterworth Heinemann Publication.

STA-HC- 5016

Stochastic Processes and Queuing Theory

Total Lectures: 60 Credits: 6 (Theory: 04, Practical/Lab: 02)

11.1 Theory

11.1.1 Unit 1: *Probability Distributions*: (Lectures: 8)

Generating functions, Bivariate probability generating function. Stochastic Process: Introduction, Stationary Process.

11.1.2 Unit 2: *Markov Chains*: (Lectures: 18)

Definition of Markov Chain, transition probability matrix, order of Markov chain, Markov chain as graphs, higher transition probabilities. Generalization of independent Bernoulli trials, classification of states and chains.

11.1.3 Unit 3: *Poisson Process*: (Lectures: 18)

Postulates of Poisson process, properties of Poisson process, inter-arrival time.

11.1.4 Unit 4: *Queuing System*: (Lectures: 16)

General concept, steady state distribution, queuing model, M/M/1 with finite and infinite system capacity, waiting time distribution (without proof).

11.2 Practical/Lab

List of Practical

1. Calculation of transition probability matrix
2. Identification of characteristics of reducible and irreducible chains.
3. Identification of types of classes
4. Identification of ergodic transition probability matrix
5. Stationarity of Markov chain and graphical representation of Markov chain
6. Computation of probabilities in case of generalizations of independent Bernoulli trials.
7. Computation of inter-arrival time for a Poisson process.
8. Calculation of Probability and parameters for (*M/M*/1) model and change in behaviour of queue as N tends to infinity.
9. Calculation of generating function and expected duration for different amounts of stake.

SUGGESTED READING:

1. Medhi, J. (2009): Stochastic Processes, New Age International Publishers.
2. Basu, A.K. (2005): Introduction to Stochastic Processes, Narosa Publishing.
3. Bhat, B.R.(2000): Stochastic Models: Analysis and Applications, New Age International Publishers.
4. Taha, H. (1995): Operations Research: An Introduction, Prentice- Hall India.
5. Feller, William (1968): Introduction to probability Theory and Its Applications, Vol I, 3rd Edition, Wiley International.

STA-HC- 5026

Statistical Computing Using C/C++ Programming

Total Lectures: 60 Credits: 6 (Theory: 04, Practical/Lab: 02)

12.1 Theory

12.1.1 Unit 1: *C Programming*: (Lectures: 30)

History and importance of C. Components, basic structure programming, character set, C tokens, Keywords and Identifiers and execution of a C program. Data types: Basic data types, Enumerated data types, derived data types. Constants and variables: declaration and assignment of variables, Symbolic Constants, overflow and underflow of data.

Operators and Expressions: Arithmetic, relational, logical, assignment, increment/decrement, operators, precedence of operators in arithmetic, relational and logical expression. Implicit and explicit type conversions in expressions, library functions. Managing input and output operations: reading and printing formatted and unformatted data

12.1.2 Unit 2: *Decision making and Arrays*: (Lectures: 30)

Decision making and branching - if…else, nesting of if…else, else if ladder, switch, conditional (?) operator. Looping in C: for, nested for, while, do…while, jumps in and out of loops.

Arrays: Declaration and initialization of one-dim and two-dim arrays. Character arrays and strings: Declaring and initializing string variables, reading and writing strings from Terminal (using scanf and printf only).

12.2 Practical/Lab

List of Practical

1. Plot of a graph y = f(x)
2. Roots of a quadratic equation (with imaginary roots also)
3. Sorting of an array and hence finding median
4. Mean, Median and Mode of a Grouped Frequency Data
5. Variance and coefficient of variation of a Grouped Frequency Data
6. Preparing a frequency table
7. Value of n! using recursion
8. Random number generation from uniform, exponential, normal (using CLT) and gamma distribution, calculate sample mean and variance and compare with population parameters.
9. Matrix addition, subtraction, multiplication Transpose and Trace
10. Fitting of Binomial, Poisson distribution and apply Chi-square test for goodness of fit
11. Chi-square contingency table
12. t-test for difference of means
13. Paired t-test
14. F-ratio test
15. Multiple and Partial correlation.

16. Compute ranks and then calculate rank correlation(without tied ranks)
17. Fitting of lines of regression

SUGGESTED READING:

1. Kernighan, B.W. and Ritchie, D. (1988): C Programming Language, 2nd Edition, Prentice Hall.
2. Balagurusamy, E. (2011): Programming in ANSI C, 6th Edition, Tata McGraw Hill.
3. Gottfried, B.S. (1998): Schaum's Outlines: Programming with C, 2nd Edition, Tata McGraw Hill.

STA-HC- 6016

Design of Experiments

Total Lectures: 60 Credits: 6 (Theory: 04, Practical/Lab: 02)

13.1 Theory

13.1.1 Unit 1: *Design of Experiments*: (Lectures: 25)

Role, historical perspective, terminology, experimental error, basic principles, uniformity trials, choice of size and shape of plots and blocks.

Basic designs: Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD) – layout, model and statistical analysis, relative efficiency, analysis with missing observations, Greaco Latin Square Design.

13.1.2 Unit 2: *Design of Experiments*: (Lectures: 15)

Split Plot Design, Strip Plot Design, Incomplete Block Designs, Introduction to Balanced Incomplete Block Design (BIBD).

13.1.3 Unit 3: *Factorial Experiments*: (Lectures: 20)

Factorial experiments: advantages, notations and concepts, 2^2, 2^3…2^n and 3^2 factorial experiments, design and analysis, Total and Partial confounding for 2^n ($n \leq 5$), idea of 3^2 experiment.

13.2 Practical/Lab

List of Practical

1. Analysis of a CRD
2. Analysis of an RBD
3. Analysis of an LSD
4. Analysis of an RBD with one missing observation
5. Analysis of an LSD with one missing observation
6. Analysis of 2^2 and 2^3 factorial in CRD and RBD
7. Analysis of a completely confounded two level factorial design in 2 blocks
8. Analysis of a completely confounded two level factorial design in 4 blocks
9. Analysis of a partially confounded two level factorial design.

SUGGESTED READINGS:

1. Cochran, W.G. and Cox, G.M. (1959): Experimental Design. Asia Publishing House.
2. Das, M.N. and Giri, N.C. (1986): Design and Analysis of Experiments. Wiley Eastern Ltd.
3. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2005): Fundamentals of Statistics. Vol. II, 8th Edn. World Press, Kolkata.
4. Kempthorne, O. (1965): The Design and Analysis of Experiments. John Wiley.
5. Montgomery, D. C. (2008): Design and Analysis of Experiments, John Wiley.

STA-HC- 6026

Multivariate Analysis and Nonparametric Methods

Total Lectures: 60 Credits: 6 (Theory: 04, Practical/Lab: 02)

14.1 Theory

14.1.1 Unit 1: *Bivariate and Multivariate Distributions*: (Lectures: 20)

Bivariate Normal Distribution (BVN): p.d.f. of BVN, properties of BVN, marginal and conditional p.d.f. of BVN.

Multivariate Data: Random Vector: Probability mass/density functions, Distribution function, Mean vector & Dispersion matrix, Marginal & Conditional distributions.

14.1.2 Unit 2: *Multivariate Normal Distributions*: (Lectures: 20)

Multivariate Normal distribution and its properties. Sampling distribution for mean vector and variance- covariance matrix. Multiple and partial correlation coefficient and their properties, Basic idea of Principal Component Analysis, Hotelling T^2 – concept and applications.

14.1.3 Unit 3: *Non-parametric Tests*: (Lectures: 20)

Nonparametric Tests: Introduction and Concept, Test for randomness based on total number of runs, Empirical distribution function, Kolmogrov Smirnov test for one sample, Sign tests- one sample and two samples, Wilcoxon-Mann-Whitney test, Kruskal-Wallis test.

14.2 Practical/Lab

List of Practical

1. Multiple Correlation
2. Partial Correlation
3. Bivariate Normal Distribution,
4. Multivariate Normal Distribution
5. Principal Components Analysis
6. Test for randomness based on total number of runs,
7. Kolmogrov Smirnov test for one sample.
8. Sign test: one sample, two samples, large samples.
9. Wilcoxon-Mann-Whitney U-test,
10. Kruskal-Wallis test.

SUGGESTED READING:

1. Anderson, T.W. (2003): An Introduction to Multivariate Statistical Analysis, 3rd Edn., John Wiley
2. Muirhead, R.J. (1982): Aspects of Multivariate Statistical Theory, John Wiley.
3. Kshirsagar, A.M. (1972) :Multivariate Analysis, 1st Edn. Marcel Dekker.
4. Johnson, R.A. and Wichern, D.W. (2007): Applied Multivariate Analysis, 6th Edn., Pearson & Prentice Hall.
5. Mukhopadhyay, P. : Mathematical Statistics.
6. Gibbons, J. D. and Chakraborty, S (2003): Nonparametric Statistical Inference. 4th Edition. Marcel Dekker, CRC.

STA-HE- 5016

Operations Research

Total Lectures: 60 Credits: 6 (Theory: 04, Practical/Lab: 02)

15.1 Theory

15.1.1 Unit 1: *Operations Research*: (Lectures: 20)

Introduction to Operations Research, phases of O.R., model building, various types of O.R. problems. Linear Programming Problem, Mathematical formulation of the L.P.P, graphical solutions of a L.P.P. Simplex method for solving L.P.P.

15.1.2 Unit 2: *Transportation Problem*: (Lectures: 15)

Transportation Problem: Initial solution by North West corner rule, Least cost method and Vogel's approximation method (VAM).

15.1.3 Unit 3: *Game theory*: (Lectures: 10)

Game theory: Rectangular game, minimax-maximax principle.

15.1.4 Unit 4: *Inventory Management*: (Lectures: 15)

Inventory Management: ABC inventory system, characteristics of inventory system. EOQ Model and its variations, with and without shortages, Quantity Discount Model with price breaks.

15.2 Practical/Lab (Using TORA/WINQSB/LINGO)

List of Practical

1. Mathematical formulation of L.P.P and solving the problem using graphical method, Simplex technique and Charne's Big M method involving artificial variables.
2. Identifying Special cases by Graphical and Simplex method and interpretation
   a. Degenerate solution
   b. Unbounded solution
   c. Alternate solution
   d. Infeasible solution
3. Allocation problem using Transportation model
4. Networking problem
   a. Minimal spanning tree problem
   b. Shortest route problem
5. Problems based on game matrix
   a. Graphical solution to mx 2 / 2xn rectangular game
   b. Mixed strategy
6. Mathematical formulation of L.P.P and solving the problem using graphical method, Simplex technique and Charne's Big M method involving artificial variables.
7. Networking problem
   a. minimal spanning tree problem
   b. Shortest route problem
8. Problems based on game matrix
   a. Graphical solution to mx2 / 2xn rectangular game
   b. Mixed strategy

9. To find optimal inventory policy for EOQ models and its variations
10. To solve all-units quantity discounts model

SUGGESTED READING:

1. Taha, H. A. (2007): Operations Research: An Introduction, 8th Edition, Prentice Hall of India.
2. KantiSwarup, Gupta, P.K. and Manmohan (2007): Operations Research, 13th Edition, Sultan Chand and Sons.
3. Hadley, G: (2002) : Linear Programming, Narosa Publications
4. Hillier, F.A and Lieberman, G.J. (2010): Introduction to Operations Research- Concepts and cases, 9th Edition, Tata McGraw Hill.

STA-HE- 5026

Time Series Analysis

Total Lectures: 60 Credits: 6 (Theory: 04, Practical/Lab: 02)

16.1 Theory

16.1.1 Unit 1: *Introduction to Time Series*: (Lectures: 15)

Introduction to times series data, application of time series from various fields, Components of a times series, Decomposition of time series. Trend: Estimation of trend by free hand curve method, method of semi averages, fitting a various mathematical curve, and growth curves.

16.1.2 Unit 2: *Introduction to Time Series*: (Lectures: 18)

Trend Cont.: Method of moving averages. Detrending. Effect of elimination of trend on other components of the time series. Seasonal Component: Estimation of seasonal component by Method of simple averages, Ratio to Trend.

16.1.3 Unit 3: *Moving averages*: (Lectures: 15)

Seasonal Component continued: Ratio to Moving Averages and Link Relative method, Deseasonalization.

16.1.4 Unit 4: *Forecasting and smoothing to Time Series*: (Lectures: 12)

Random Component: Variate component method. Forecasting: Exponential smoothing methods.

SUGGESTED READING:

1. Kendall M.G. (1976): Time Series, Charles Griffin.
2. Chatfield C. (1980): The Analysis of Time Series –An Introduction, Chapman & Hall.
3. Mukhopadhyay P. (2011): Applied Statistics, 2nd ed. Revised reprint, Books and Allied

PRACTICAL / LAB WORK

List of Practical

1. Fitting and plotting of modified exponential curve
2. Fitting and plotting of Gompertz curve
3. Fitting and plotting of logistic curve
4. Fitting of trend by Moving Average Method
5. Measurement of Seasonal indices Ratio-to-Trend method
6. Measurement of Seasonal indices Ratio-to-Moving Average method
7. Measurement of seasonal indices Link Relative method
8. Calculation of variance of random component by variate difference method
9. Forecasting by exponential smoothing
10. Forecasting by short term forecasting methods.

STA-HE- 5036

Survival Analysis and Biostatistics

Total Lectures: 60 Credits: 6 (Theory: 04, Practical/Lab: 02)

17.1 Theory

17.1.1 Unit 1: *Survival Analysis*: (Lectures: 18)

Survival Analysis: Functions of survival times, survival distributions and their applications-exponential, gamma, Weibull, Rayleigh, lognormal, death density function for a distribution having bath-tub shaped hazard function.

Censoring Schemes: Type I, Type II and progressive or random censoring with biological examples.

17.1.2 Unit 2: *Independent and dependent Risk*: (Lectures: 12)

Theory of independent and dependent risks. Bivariate normal dependent risk model.

17.1.3 Unit 3: *Epidemic Model*: (Lectures: 15)

Stochastic Epidemic Models: Simple epidemic models, general epidemic model definition and concept (without derivation). Duration of an epidemic.

17.1.4 Unit 4: *Statistical Genetics*: (Lectures: 15)

Statistical Genetics: Introduction, concepts-Genotype, Phenotype, Dominance, Recessiveness, Linkage and Recombination, Introduction to Clinical Trials.

SUGGESTED READING:

1. Lee, E.T. and Wang, J.W. (2003): Statistical Methods for Survival data Analysis, 3rd Edition, John Wiley and Sons.
2. Biswas, S. (2007): Applied Stochastic Processes: A Biostatistical and Population Oriented Approach, Reprinted 2ndCentral Edition, New Central Book Agency.
3. Kleinbaum, D.G. (1996): Survival Analysis, Springer.
4. Chiang, C.L. (1968): Introduction to Stochastic Processes in Bio Statistics, John Wiley and Sons.
5. Indrayan, A. (2008): Medical Biostatistics, 2nd Edition Chapman and Hall/CRC.

PRACTICAL / LAB WORK

List of Practical

1. To estimate survival function
2. To determine death density function and hazard function
3. To identify type of censoring and to estimate survival time for type I censored data
4. To identify type of censoring and to estimate survival time for type II censored data
5. To identify type of censoring and to estimate survival time for progressively type I censored data
6. Estimation of mean survival time and variance of the estimator for type I censored data
7. Estimation of mean survival time and variance of the estimator for type II censored data
8. Estimation of mean survival time and variance of the estimator for progressively type I censored data
9. To estimate the survival function and variance of the estimator using Non-parametric methods with Actuarial methods
10. To estimate the survival function and variance of the estimator using Non-parametric methods with Kaplan-Meier method
11. To estimate Crude probability of death
12. To estimate Net-type I probability of death
13. To estimate Net-type II probability of death
14. To estimate partially crude probability of death
15. To estimate gene frequencies

STA-HE- 5046

Financial Statistics

Total Lectures: 60 Credits: 6 (Theory: 04, Practical/Lab: 02)

18.1 Theory

18.1.1 Unit 1: *Probability Review*: (Lectures: 15)

Probability review: Real valued random variables, expectation and variance, skewness and kurtosis, conditional probabilities and expectations. Discrete Stochastic Processes, Binomial processes, General random walks.

18.1.2 Unit 2: *Tools for Pricing*: (Lectures: 15)

Tools Needed For Option Pricing: Wiener process, stochastic integration, and stochastic differential equations. Introduction to derivatives: Forward contracts, spot price, forward price, future price. Call and put options, zero-coupon bonds and discount bonds

18.1.3 Unit 3: *Pricing Derivatives*: (Lectures: 15)

Pricing Derivatives: Arbitrage relations and perfect financial markets, pricing futures, put-call parity for European options, relationship between strike price and option price.

18.1.4 Unit 4: *Hedging Portfolios*: (Lectures: 15)

Hedging portfolios: Delta, Gamma and Theta hedging. Binomial Model for European options: Cox-Ross-Rubinstein approach to option pricing. Discrete dividends

SUGGESTED READING:

1. Franke, J., Hardle, W.K. and Hafner, C.M. (2011): Statistics of Financial Markets: An Introduction, 3rd Edition, Springer Publications.
2. Stanley L. S. (2012): A Course on Statistics for Finance, Chapman and Hall/CRC.

PRACTICAL / LAB WORK (Using spreadsheet/ R)

List of Practical

1. To verify “no arbitrage” principle
2. To verify relationship between spot price, forward price, futureprice
3. To price future contracts
4. To verify put-call parity for European options
5. To construct binomial trees and to evaluate options using these trees
6. To price options using black – Scholes formula
7. To hedge portfolios using delta and gamma hedging

8. To hedge portfolios theta hedging
9. Pricing of call options using binomial model
10. Computation of dividends on call options as a percentage of stock price.
11. Computation of dividends on call options as a fixed amount of money.
12. Pricing of put options using binomial model
13. Call-put parity for options following binomial models.
14. Effect of dividends on put options.

STA-HE- 6016

Econometrics

Total Lectures: 60 Credits: 6 (Theory: 04, Practical/Lab: 02)

19.1 Theory

19.1.1 Unit 1: *Economic Models*: (Lectures: 15)

Introduction: Objective behind building econometric models, nature of econometrics, model building, role of econometrics, linear models: two or more variables.

19.1.2 Unit 2: *Estimation*: (Lectures: 18)

Least square assumptions, estimation of regression parameters, tests of significance and confidence intervals.

19.1.3 Unit 3: *Regression*: (Lectures: 15)

Multiple Regression analysis, estimation and inference.

19.1.4 Unit 4: *Collinearity*: (Lectures: 12)

Violations of Least Square assumptions: multicollinearity, autocorrelation and heteroscedasticity.

SUGGESTED READING:

1. Gujarati, D. and Sangeetha, S. (2007): Basic Econometrics, 4th Edition, McGraw Hill Companies.
2. Johnston, J. (1972): Econometric Methods, 2nd Edition, McGraw Hill International.
3. Koutsoyiannis, A. (2004): Theory of Econometrics, 2nd Edition, Palgrave Macmillan Limited,
4. Maddala, G.S. and Lahiri, K. (2009): Introduction to Econometrics, 4th Edition, John Wiley & Sons.

PRACTICAL /LAB WORK

List of Practical

1. Problems based on estimation of General linear model
2. Testing of parameters of General linear model
3. Forecasting of General linear model
4. Problems concerning specification errors
5. Problems related to consequences of Multicollinearity
6. Diagnostics of Multicollinearity
7. Problems related to consequences of Autocorrelation (AR(I))
8. Diagnostics of Autocorrelation
9. Estimation of problems of General linear model under Autocorrelation

10. Problems related to consequences Heteroscedasticity
11. Diagnostics of Heteroscedasticity
12. Estimation of problems of General linear model under Heteroscedastic distance terms
13. Problems related to General linear model under (Aitken Estimation).

STA-HE- 6026

Demography and Vital Statistics

Total Lectures: 60 Credits: 6 (Theory: 04, Practical/Lab: 02)

20.1 Theory

20.1.1 Unit 1: *Population Theory*: (Lectures: 10)

Population Theories: Coverage and content errors in demographic data, use of balancing equations, Population composition, dependency ratio.

20.1.2 Unit 2: *Measurement of Mortality*: (Lectures: 15)

Introduction and sources of collecting data on vital statistics, errors in census and registration data. Measurement of population, rate and ratio of vital events. Measurements of Mortality: Crude Death Rate (CDR), Specific Death Rate (SDR), Infant Mortality, Rate (IMR) and Standardized Death Rates.

20.1.3 Unit 3: *Life Table*: (Lectures: 18)

Stationary and Stable population, Central Mortality Rates and Force of Mortality. Life (Mortality) Tables: Assumption, description.

20.1.4 Unit 4: *Measurement of Fertility*: (Lectures: 17)

Measurements of Fertility: Crude Birth Rate (CBR), General Fertility Rate (GFR), Specific Fertility Rate (SFR) and Total Fertility Rate (TFR). Measurement of Population Growth: Crude rates of natural increase, Pearl's Vital Index, Gross Reproduction Rate (GRR) and Net Reproduction Rate (NRR).

SUGGESTED READING:

1. Mukhopadhyay, P. (1999): Applied Statistics, Books and Allied (P) Ltd.
2. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Vol. II, 9 th
3. Edition, World Press.
4. Biswas, S. (1988): Stochastic Processes in Demography & Application, Wiley Eastern Ltd.
5. Croxton, Fredrick E., Cowden, Dudley J. and Klein, S. (1973): Applied General Statistics, 3rd Edition. Prentice Hall of India Pvt. Ltd.
6. Keyfitz N., Beckman John A.: Demography through Problems S-Verlag New York.

PRACTICAL/LAB. WORK:

List of Practical

1. To calculate CDR and Age Specific death rate for a given set of data
2. To find Standardized death rate by:- (i) Direct method (ii) Indirect method
3. To construct a complete life table
4. To fill in the missing entries in a life table
5. To calculate probabilities of death at pivotal ages and use it construct abridged life table using (i) Reed-Merrell Method, (ii) Greville's Method and (iii) King's Method
6. To calculate CBR, GFR, SFR, TFR for a given set of data
7. To calculate Crude rate of Natural Increase and Pearle's Vital Index for a given set of data
8. Calculate GRR and NRR for a given set of data and compare them

STA-HE- 6036

Actuarial Statistics

Total Lectures: 60 Credits: 6 (Theory: 04, Practical/Lab: 02)

21.1 Theory

21.1.1 Unit 1: *Probability Distributions*: (Lectures: 15)

Introductory Statistics and Insurance Applications: Discrete, continuous and mixed probability distributions. Insurance applications, sum of random variables. Utility theory: Utility functions, expected utility criterion, types of utility function, insurance and utility theory.

21.1.2 Unit 2: *Premium Calculation*: (Lectures: 15)

Principles of Premium Calculation: Properties of premium principles, examples of premium principles. Individual risk models: models for individual claims, the sum of independent claims, approximations and their applications.

21.1.3 Unit 3: *Survival Distribution*: (Lectures: 18)

Survival Distribution and Life Tables: Uncertainty of age at death, survival function, time- until-death for a person, curate future lifetime, force of mortality, life tables with examples, deterministic survivorship group, life table characteristics.

21.1.4 Unit 4: *Life Insurance*: (Lectures: 12)

Life Insurance: Models for insurance payable at the moment of death, insurance payable at the end of the year of death.

SUGGESTED READING:

1. Dickson, C. M. D. (2005): Insurance Risk And Ruin (International Series On Actuarial Science), Cambridge University Press.
2. Bowers, N. L., Gerber, H. U., Hickman, J. C., Jones, D. A. And Nesbitt, C. J. (1997): Actuarial Mathematics, Society of Actuaries, Itasca, Illinois, U.S.A.

PRACTICAL / LAB WORK (Using Spreadsheet/R)

List of Practical

1 Risk computation for different utility models
2. Discrete and continuous risk calculations
3. Calculation of aggregate claims for collective risks
4. Calculation of aggregate claim for individual risks
5. Computing Ruin probabilities and aggregate losses
6. Annuity and present value of contract
7. Computing premium for different insurance schemes
8. Practical based on life models and tables

STA-HE- 6046

Project Work

Total Lectures: 60 Credits: 6

Objective: The aim of the course is to initiate students to write and present a statistical report, under the supervision of a faculty, on some area of human interest. The project work will provide hands on training to the students to deal with data emanating from some real life situation and propel them to dwell on some theory or relate it to some theoretical concepts.

STA-HG- 1016

Statistical Methods

Total Lectures: 60 Credits: 6 (Theory: 04, Practical/Lab: 02)

23.1 Theory

23.1.1 Unit 1: *Statistical Data*: (Lectures: 12)

Introduction: Definition and scope of Statistics, concepts of statistical population and sample. Data: Univariate Data: quantitative and qualitative, attributes, variables, scales of measurement - nominal, ordinal, interval and ratio. Presentation: tabular and graphic, including histogram and ogives.

23.1.2 Unit 2: *Measures of Central Tendency*: (Lectures: 12)

Measures of Central Tendency: mathematical and positional. Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation, moments, skewness and kurtosis.

23.1.3 Unit 3: *Calculus of Finite Difference*: (Lectures: 12)

Finite Difference: Definition, Operators Δ & E, their properties, Difference table, missing terms, Interpolation: Definition, Newton's Forward and Backward interpolation formula. Divided Difference (DD): Definition, DD table, Newton's DD formula. Lagrange's interpolation formula. Numerical Integration: Introduction, General quadrature formula, Trapezoidal, Simpson's 1/3rd & 3/8th rules, Newton-Raphson method.

23.1.4 Unit 4: *Bivariate Data*: (Lectures: 12)

Bivariate data: Definition, scatter diagram, simple, partial and multiple correlation (3 variables only), rank correlation. Simple linear regression, principle of least squares.

23.1.5 Unit 5: *Theory of Attributes*: (Lectures: 12)

Theory of attributes, consistency of data, independence and association of attributes, measures of association and contingency.

SUGGESTED READING:

1. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.
2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
3. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co.Ltd.

PRACTICAL/ LAB WORK

List of Practical

1. Graphical representation of data
2. Problems based on measures of central tendency
3. Problems based on measures of dispersion
4. Problems based on combined mean and variance and coefficient of variation
5. Problems based on moments, skewness and kurtosis
6. Fitting of polynomials, exponential curves
7. Karl Pearson correlation coefficient
8. Partial and multiple correlations
9. Spearman rank correlation with and without ties.
10. Correlation coefficient for a bivariate frequency distribution
11. Lines of regression, angle between lines and estimated values of variables.
12. Checking consistency of data and finding association among attributes.

STA-HG- 2016

Introductory Probability

Total Lectures: 60 Credits: 6 (Theory: 04, Practical/Lab: 02)

24.1 Theory

24.1.1 Unit 1: *Probability*: (Lectures: 15)

Probability: Introduction, random experiments, sample space, events and algebra of events. Definitions of Probability – classical, statistical, and axiomatic. Conditional Probability, laws of addition and multiplication, independent events, theorem of total probability, Bayes' theorem and its applications.

24.1.2 Unit 2: *Random Variables*: (Lectures: 15)

Random Variables: Discrete and continuous random variables, p.m.f., p.d.f. ,c.d.f. Illustrations of random variables and its properties. Expectation, variance, moments and moment generating function.

24.1.3 Unit 3: *Convergence in Probability*: (Lectures: 12)

Idea of convergence in probability, Chebyshev's inequality, weak law of large numbers, De-Moivre Laplace and Lindeberg-Levy Central Limit Theorem (C.L.T.) (statement only without proof).

24.1.4 Unit 4: *Standard Distributions*: (Lectures: 18)

Standard probability distributions: Binomial, Poisson, geometric, negative binomial, hypergeometric, uniform, normal, exponential, beta, gamma.

SUGGESTED READING:

1. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009): Probability and Statistical Inference, Seventh Ed, Pearson Education, New Delhi.
2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
3. Myer, P.L. (1970): Introductory Probability and Statistical Applications, Oxford & IBH Publishing, New Delhi

PRACTICAL/LAB. WORK:

List of Practical

1. Fitting of binomial distributions for n and p = q = ½ given
2. Fitting of binomial distributions for n and p given
3. Fitting of binomial distributions computing mean and variance
4. Fitting of Poisson distributions for given value of lambda
5. Fitting of Poisson distributions after computing mean

6. Application problems based on binomial distribution
7. Application problems based on Poisson distribution
8. Problems based on area property of normal distribution
9. To find the ordinate for a given area for normal distribution
10. Application based problems using normal distribution
11. Fitting of normal distribution when parameters are given
12. Fitting of normal distribution when parameters are not given.

STA-HG- 3016

Basics of Statistical Inference

Total Lectures: 60 Credits: 6 (Theory: 04, Practical/Lab: 02)

25.1 Theory

25.1.1 Unit 1: *Tests of Hypothesis*: (Lectures: 20)

Estimation of population mean, confidence intervals for the parameters of a normal distribution (one sample).

The basic idea of significance test. Null and alternative hypothesis. Type I & Type II errors, level of significance, concept of p-value. Tests of hypotheses for the parameters of a normal distribution (one sample), Non-parametric tests: Sign test for median, Sign test for symmetry, Wilcoxon two-sample test.

25.1.2 Unit 2: *Categorical Data Analysis*: (Lectures: 18)

Categorical data: Tests of proportions, tests of association and goodness-of-fit using Chi- square test, Yates' correction.

25.1.3 Unit 3: *Analysis of Variance*: (Lectures: 22)

Analysis of variance, one-way and two-way classification. Brief exposure of three basic principles of design of experiments, treatment, plot and block. Analysis of completely randomized design, randomized complete block design. Bioassay.

SUGGESTED READING:

1. Daniel, Wayne W., Bio-statistics: A Foundation for Analysis in the Health Sciences. John Wiley (2005).
2. Goon, A.M., Gupta M.K. & Das Gupta, Fundamentals of statistics, Vol.-I & II (2005).
3. Dass, M. N. & Giri, N. C.: Design and analysis of experiments. John Wiley.
4. Dunn, O.J Basic Statistics: A primer for the Biomedical Sciences. (1964, 1977) by John Wiley.
5. Bancroft, Holdon Introduction to Bio-Statistics (1962) P.B. Hoebar New York.
6. Goldstein, A Biostatistics-An introductory text (1971). The Macmillion New York.

PRACTICAL/LAB WORK

List of Practical

1. Estimators of population mean.
2. Confidence interval for the parameters of a normal distribution (one sample).
3. Tests of hypotheses for the parameters of a normal distribution (one sample).
4. Chi-square test of proportions.
5. Chi-square tests of association.
6. Chi-square test of goodness-of-fit.
7. Test for correlation coefficient.

8. Sign test for median.
9. Sign test for symmetry.
10. Wilcoxon two-sample test.
11. Analysis of Variance of a one way classified data
12. Analysis of Variance of a two way classified data.
13. Analysis of a CRD.
14. Analysis of an RBD.

STA-HG- 4016

Applied Statistics

Total Lectures: 60 Credits: 6 (Theory: 04, Practical/Lab: 02)

26.1 Theory

26.1.1 Unit 1: *Time Series*: (Lectures: 12)

Economic Time Series: Components of time series, Decomposition of time series- Additive and multiplicative model with their merits and demerits, Illustrations of time series. Measurement of trend by method of free-hand curve, method of semi-averages and method of least squares (linear, quadratic and modified exponential).Measurement of seasonal variations by method of ratio to trend.

26.1.2 Unit 2: *Index Numbers*: (Lectures: 12)

Index numbers: Definition, Criteria for a good index number, different types of index numbers. Construction of index numbers of prices and quantities, consumer price index number. Uses and limitations of index numbers.

26.1.3 Unit 3: *Statistical Quality Control*: (Lectures: 12)

Statistical Quality Control: Importance of statistical methods in industrial research and practice. Determination of tolerance limits. Causes of variations in quality: chance and assignable. General theory of control charts, process & product control, Control charts for variables: X- bar and R-charts. Control charts for attributes: p and c-charts

26.1.4 Unit 4: *Demography*: (Lectures: 12)

Demographic Methods: Introduction, measurement of population, rates and ratios of vital events. Measurement of mortality: CDR, SDR (w.r.t. Age and sex), IMR, Standardized death rates. Life (mortality) tables: definition of its main functions and uses. Measurement of fertility and reproduction: CBR, GFR, and TFR. Measurement of population growth: GRR, NRR.

26.1.5 Unit 5: *Demand Analysis*: (Lectures: 12)

Demand Analysis: Theory of consumption and demand, demand function, elasticity of demand, determination of elasticity of demand by family budget method, Lorentz curve and Gini's coefficient, Engel's law and Engel's curve, Pareto's law of income distribution.

SUGGESTED READING:

1 Mukhopadhyay, P. (1999): Applied Statistics, New Central Book Agency, Calcutta.

2 Gun, A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Vol. II, 9th Edition World Press, Kolkata.

3 Gupta, S. C. and Kapoor, V.K. (2008): Fundamentals of Applied Statistics, 4th Edition (Reprint), Sultan Chand & Sons

4 Montogomery, D. C. (2009): Introduction to Statistical Quality Control, 6th Edition, Wiley India Pvt. Ltd.

PRACTICAL/LAB WORK

List of Practical

1. Measurement of trend: Fitting of linear, quadratic trend, exponential curve and plotting of trend values and comparing with given data graphically.
2. Measurement of seasonal indices by Ratio-to-trend method and plotting of trend values and comparing with given data graphically.
3. Construction of price and quantity index numbers by Laspeyre's formula, Paasche's formula, Marshall-Edgeworth's formula, Fisher's Formula. Comparison and interpretation.
4. Construction of wholesale price index number, fixed base index number and consumer price index number with interpretation
5. Construction and interpretation of X bar & R-chart
6. Construction and interpretation p-chart (fixed sample size) and c-chart
7. Computation of measures of mortality
8. Completion of life table
9. Computation of measures of fertility and population growth

STA – SE - 3014

Statistical Data Analysis Using Software Packages

Total Lectures: 30 Credits: 4 (Theory: 02, Practical/Lab: 02)

27.1 Theory/Practical/Lab

This course will review and expand upon core topics in statistics and probability, particularly by initiating the beneficiaries of the course to at least one of the software packages viz., Microsoft Excel, SPSS, Minitab, Matlab, for statistical computing.

27.1.1 Unit 1: *Graphical Representation*: (Lectures: 8)

Learn how to load data, plot a graph viz. histograms (equal class intervals and unequal class intervals), box plot, stem-leaf, frequency polygon, pie chart, ogives with graphical summaries of data

27.1.2 Unit 2: *Report Generation*: (Lectures: 6)

Generate automated reports giving detailed descriptive statistics, correlation and lines of regression.

27.1.3 Unit 3: *Fitting Curves*: (Lectures: 8)

Random number generation and sampling procedures. Fitting of polynomials and exponential curves. Application Problems based on fitting of suitable distribution, Normal probability plot.

27.1.4 Unit 4: *Analysis*: (Lectures: 8)

Simple analysis and create and manage statistical analysis projects, import data, code editing, Basics of statistical inference in order to understand hypothesis testing and compute p-values and confidence intervals.

SUGGESTED READING:

1. Moore, D.S. and McCabe, G.P. and Craig, B.A. (2014): Introduction to the Practice of Statistics, W.H. Freeman
2. Cunningham, B.J (2012): Using SPSS: An Interactive Hands-on approach
3. Cho, M,J., Martinez, W.L. (2014) Statistics in MATLAB: A Primer, Chapman and Hall/CRC

STA – SE - 3024

Data Base Management Systems

Total Lectures: 20 Credits: 4 (Theory: 02, Practical/Lab: 02)

28.1 Theory/Practical/Lab

This skill based course is structured to enhance database handling, data manipulation and data processing skills through SQL. The course will enable its beneficiaries develop data centric computer applications.

28.1.1 Unit 1: *Overview of DBMS*: (Lectures: 8)

Introduction: Overview of Database Management System, Introduction to Database Languages, advantages of DBMS over file processing systems.

28.1.2 Unit 2: *RDBMS*: (Lectures: 8)

Relational Database Management System: The Relational Model, Introduction to SQL: Basic Data Types, Working with relations of RDBMS: Creating relations e.g. Bank, College Database (create table statement)

28.1.3 Unit 3: *RDBMS Continued*: (Lectures: 6)

Modifying relations (alter table statement), Integrity constraints over the relation like Primary Key, Foreign key, NOT NULL to the tables, advantages and disadvantages of relational Database System

28.1.4 Unit 4: *Data Base Structure*: (Lectures: 8)

Database Structure: Introduction, Levels of abstraction in DBMS, View of data, Role of Database users and administrators, Database Structure: DDL, DML, Data Manager (Database Control System).Types of Data Models Hierarchical databases, Network databases, Relational databases, Object oriented databases

SUGGESTED READING:

1. Gruber, M. (1990): Understanding SQL, BPB publication
2. Silberschatz, A, Korth, H and Sudarshan, S (2011) "Database System and Concepts", 6th Edition McGraw-Hill.
3. Desai, B. (1991): Introduction to Database Management system, Galgotia Publications.

STA – SE - 4014

Statistical Data Analysis using R

Total Lectures: 20 Credits: 4 (Theory: 02, Practical/Lab: 02)

29.1 Theory/Practical/Lab

This course will review and expand upon core topics in probability and statistics through the study and practice of data analysis and graphical interpretation using 'R'.

29.1.1 Unit 1: *Plotting Graphs*: (Lectures: 8)

Learn how to load data, plot a graph viz. histograms (equal class intervals and unequal class intervals), box plot, stem-leaf, frequency polygon, pie chart, ogives with graphical summaries of data

29.1.2 Unit 2: *Report Generation*: (Lectures: 6)

Generate automated reports giving detailed descriptive statistics, correlation and lines of regression.

29.1.3 Unit 3: *Generation of Random Numbers*: (Lectures: 8)

Random number generation and sampling procedures. Fitting of polynomials and exponential curves. Application Problems based on fitting of suitable distribution, Normal probability plot.

29.1.4 Unit 4: *Statistical Analysis*: (Lectures: 8)

Simple analysis and create and manage statistical analysis projects, import data, code editing, Basics of statistical inference in order to understand hypothesis testing and compute p-values and confidence intervals.

SUGGESTED READING:

1. Gardener, M (2012) Beginning R: The Statistical Programming Language, Wiley Publications.
2. Braun W J, Murdoch D J (2007): A First Course in Statistical Programming with R. Cambridge University Press. New York

STA – SE - 4024

Statistical Techniques for Research Methods

Total Lectures: 20 Credits: 4 (Theory: 02, Practical/Lab: 02)

30.1 Theory/Practical/Lab

Statistical Techniques provide scientific approaches to develop the domain of human knowledge largely through empirical studies. The course aims at enabling students understand basic concepts and aspects related to research, data collection, analyses and interpretation.

30.1.1 Unit 1: *Research problems*: (Lectures: 7)

Introduction: Meaning, objection and motivation in research, types of research, research approach, significance of research. Research problems: definition, selection and necessity of research problems.

30.1.2 Unit 2: *Survey Methodology*: (Lectures: 7)

Survey Methodology and Data Collection, inference and error in surveys, the target populations, sampling frames and coverage error, methods of data collection, non-response, questions and answers in surveys.

30.1.3 Unit 3: *Data Analysis and Interpretation*: (Lectures: 7)

Processing, Data Analysis and Interpretation: Review of various techniques for data analysis covered in core statistics papers, techniques of interpretation, precaution in interpretation.

30.1.4 Unit 4: *Questionnaire Preparation*: (Lectures: 9)

Develop a questionnaire, collect survey data pertaining to a research problem (such as gender discriminations in private v/s government sector, unemployment rates, removal of subsidy, impact on service class v/s unorganized sectors), interpret the results and draw inferences.

SUGGESTED READING:

1. Kothari, C.R. (2009): Research Methodology: Methods and Techniques, 2nd Revised Edition reprint, New Age International Publishers.
2. Kumar, R (2011): Research Methodology: A Step - by - Step Guide for Beginners, SAGE publications.