

BODOLAND UNIVERSITY

Curriculum Structures for NEP 4 Year UG Programme B.A/B.SC STS (Bachelor of Statistics)

Year 2023

PROGRAMME STRUCTURE AND DETAILED CURRICULUM



BODOLAND UNIVERSITY
DEBARGAON, KOKRAJHAR
Assam

BODOLAND UNIVERSITY

Curriculum Structures for NEP 4 Year under Graduate Syllabus for Statistics

No. of papers=37, Total Credits=142, Total Marks = 5254

Structure of Syllabus for Four Year Under Graduate Programme for NEP 2020, Bodoland University

SEM-I	STSMJ1014 (Descriptive Statistics)	STSMIN1014 (Descriptive Statistics)	STS IDC1013 (Descriptive Statistics)	AEC1012	STSSEC1013 (Statistical-Data Analysis Using Excel) (Hands on Training)	VAC1014			Total Credit 20
SEM-II	STSMJ2014 (Calculus-I and Probability-I)	STSMIN2014 (Probability and Probability Distribution)	STS IDC2013 (Probability and Probability Distribution)	AEC2012	STSSEC2013 (Statistical Data Analysis Using R) (Hands on Training)	VAC2014			Total Credit 20
Exit with a Certificate (40 Credits and Internship of 4 Credits)									
SEM-III	STSMJ3014 (Calculus-II) STSMJ3024 (Probability-II and Probability Distributions)	STSMIN3014 (Statistical Inference)	STS IDC3013 (Applied Statistics and Test of Significance)	AECC3012	STSSEC3013 (Statistical-Data Analysis Using SPSS) (Hands on Training)				Total Credit 20
SEM-IV	STSMJ4014 (Algebra) STSMJ4024 (Sampling Distribution-I) STSMJ4034 (Survey Sampling & Official Statistics)	STSMIN4014 (Sample Surveys and Design of Experiments)		AEC4012			Internship(2)		Total Credit 20
Exit with a Diploma (80 Credits and Internship of 4 Credits)									
SEM-V	STSMJ5014 (Mathematical Analysis) STSMJ5024 (Applied Statistics) STSMJ5034 (Statistical Quality Control) STSMJ5044 (Statistical Computing Using C Programming)	STSMIN5014 (Time series and demand Analysis)							Total Credit 20
SEM-VI	STSMJ6014 (Design of Experiments) STSMJ6024 (Time Series Analysis) STSMJ6034 (Demography and Vital Statistics) STSMJ6044 (Numerical and Computational Techniques)	STSMIN6014 (Vital Statistics and Index Numbers)							Total Credit 20
Exit with a Bachelor Degree in the Subject Studied (120 Credits)									
SEM-VII	STSMJ7014 STSMJ7024 STSMJ7034 STSMJ7044/REM7044	STSMIN7014 (Statistical Quality Control and Econometrics)							Total Credit 20
SEM-VIII	STSMJ8014	STSMIN8014 (Introduction to operation Research)						Dissertation / Research Project(12)/ STSMJ8024 STSMJ8034 STSMJ8044	Total Credit 20
	80	32	9	8	9	8	2	12	160
Exit with Degree in Honours and Research (160 Credits)									



BODOLAND UNIVERSITY
KOKRAJHAR-783370, BTC, ASSAM
(ACADEMIC SECTION)

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Memo No: BU/ACA/SP/NEP-2020/2023/120/184

Date: 17/05/2023

To,


1. Mrs. Smritimoyee Sarma (Convenor), Deptt. of Statistics, Kokrajhar Govt. College, Kokrajhar.
2. Mr. Ashok Kr. Saha, Deptt. of Statistics, Kokrajhar Govt. College, Kokrajhar.
3. Mr. Dinesh Kalita, Deptt. of Statistics, Tangla College, Tangla.
4. Dr. Anjali Chakraborty, Deptt. of Statistics, Tangla College, Tangla.
5. Dr. Hedayat Ullah, Asstt. Prof. Deptt. of Statistics, B.B. Kishan College, Jalah.

Sub: Appointment as member of syllabus Preparation Committee-Regarding.

Dear Sir/Madam,

The undersigned is pleased to inform you that you have been selected as one of the members of the Syllabus preparation Committee for the preparation of syllabus for Four year under graduate programme to be implemented from the academic session 2023-24 in connection with NEP-2020.

You are therefore, requested to accept the appointment and help in framing the syllabi of the programme.


Academic Registrar
Bodoland University
Academic Registrar
Bodoland University

Memo No: BU/ACA/SP/NEP-2020/2023/120/
Copy to:

Date: 17/05/2023

1. The P. S. to the Vice Chancellor, BU for kind information.
2. The P. S. to the Registrar, BU for kind information.
3. The Controller of Examination, B.U.
4. The P.S. to Finance Officer, B.U.
5. Persons concerned.
6. Concerned file, B.U.

Academic Registrar
Bodoland University

LIST OF PAPERS

Major Papers Credit: 4 each (Theory 3 + Practical 1) (20+3=23 papers)

- STSMAJ1014 Descriptive Statistics (Theory+ Practical)
- STSMAJ2014 Calculus-I and Probability-I (Theory+Tutorial)
- STSMAJ3014 Calculus-II(Theory +Tutorial)
- STSMAJ3024 Probability-II & Probability Distribution (Theory+Practical)
- STSMAJ4014 Algebra (Theory +Practical)
- STSMAJ4024 Sampling Distribution-I(Theory+Practical)
- STSMAJ4034 Survey Sampling & Official Statistics (Theory+Practical)
- STSMAJ5014 Mathematical Analysis (Theory+ Tutorial)
- STSMAJ5024 Applied Statistics (Theory+Practical)
- STSMAJ5034 Statistical Quality Control(Theory+Practical)
- STSMAJ5044 Statistical Computing Using C Programming (Theory+Practical)
- STSMAJ6014 Design of Experiments (Theory+Practical)
- STSMAJ6024 Time Series Analysis (Theory+Practical)
- STSMAJ6034 Demography and Vital Statistics(Theory+Practical)
- STSMAJ6044 Numerical and Computational Techniques (Theory+ Practical)
- STSMAJ7014 Econometrics
- STSMAJ7024 Operation Research
- STSMAJ7034 Stochastic Processes and Queuing Theory
- STSMAJ7044 Non-Parametric Statistical Inference and Decision Theory
- STSMAJ8014 Linear Models
- STSMAJ8024 Statistical Inference
- STSMAJ8034 Linear Algebra
- STSMAJ8044 Multivariate Analysis

PROGRAM OBJECTIVE

PO (1): To make the students acquainted with the philosophy behind statistics, objectives of statistics, various concepts as well as theories (both fundamental/basic & applied) of statistical science.

PO (2): To enable the students in collection, handling and analysis of real data.

PO (3): To enable the students qualified, efficient and fit for higher learning in Statistics and statistics-related fields.

PO (4): To make the students acquainted with the various concepts as well as theories of mathematics which are essential in learning the theory of statistics as well as in applications of statistics.

PO (5): To make the students acquainted with the various concepts as well as theories of Computer Science, running of software which is essential in learning the art of application of statistical theory in data analysis.

PO (6): To make the students qualified, efficient and fit for serving the society by doing works in the fields like research, economics, business, education, trade & commerce, medical & health science, agriculture, survey, census and many others.

PO (7): To enable the students to earn quality (efficiency) in composing article/paper/project report, delivering speech/talk, presenting article/paper/project report in meeting/seminar/conference.

PROGRAM SPECIFIC OUTCOME (PSOs):

PSO (1): Demonstrate the various concepts and theories of the core branches of statistics like Probability, Descriptive Statistics, Distribution Theory, Sampling Theory, Statistical Inference and Design of Experiment, Non-Parametric test etc.

PSO (2): Demonstrate the various concepts as well as theories of some branches of mathematics namely Algebra, Mathematical Analysis, Numerical Analysis, Calculus and Linear Programming which are essential in learning the theory of statistics as well as in applications of statistics.

PSO (3): Demonstrate the various concepts as well as theories of the branches related to the Application of Statistics namely Demography, Multivariate Analysis, Time Series Analysis, Demand Analysis, Index Numbers, Financial Statistics, Survival analysis and Bio-Statistics, Statistical Quality Control and Operations Research.

PSO (4): Demonstrate the basic languages of Computer Science like Programming in C and C++ and the technique of writing programs in R for various useful statistical computations.

PSO (5): Demonstrate proficiency in establishing validity of statistical theories with applications.

PSO (6): Investigate and apply statistical techniques in handling with the real problems based on data.

PSO (7): Educate students about the various aspects of data with special emphasis on collection, handling and analysis of real data.

PSO (8): Educate students about the application of data analysis by SPSS and Excel.

COURSE OUTCOME (Cos):

CO (1): Enables the students to learn Data Collection, Tabulation of Data, Data Handling and Data Analysis.

CO (2): Enables the students to learn Statistical Measures of Various characteristics of data.

CO (3): Equipped the students to understand Probability, Expectation and Distribution with applications.

CO (4): Familiarize the students with design of experiment and design of sample survey.

- CO (5):** Familiarize the students with the basic concepts and theories of Basic Algebra and Matrix.
- CO (6):** Familiarize the students with mathematical analysis and there uses in solving problems.
- CO (7):** Enhance the knowledge of students to understand linear programming problem and find optimum solution which are essentially useful in the field of Operations' Research
- CO (8):** Enables the students to learn Numerical Analysis with special emphasis on Calculus to learn Numerical Interpolation, Differentiation and Integration, Theoretical & Numerical solution of Differential Equation and Linear and Non-linear Equation.
- CO (9):** Helps the students in understanding of the art of application of statistics in the fields like Demography (including Vital Statistics Analysis and Epidemiology), Demand Analysis, Time Series Analysis, Quality Control and Operations Research.
- CO (10):** Enables the students to learn the concepts and theories of Estimation and of Hypothesis Testing which are essentially useful in decision making problems.
- CO (11):** Acquaints the students with the use of computer programming in statistical computation.
- CO (12):** Make the students enabled in composing computer programs for various computational purposes.
- CO (13):** Acquaints the students with multivariate data in addition to data on single variable and their analysis.
- CO (14):** Make the students enabled in conducting field work/survey.
- CO (15):** Make the students enabled in identifying & formulate research problem and in conducting minor research study.

STSM AJ1014 Descriptive Statistics (Credit4)

Marks: 100 | In-Sem: 30 + End-Sem: 70 (Theory: 50 & Practical: 20) |

Objective:

- To give the basic concept of importance and limitation of statistics.
- To give an idea about the preparation of questionnaire for the collection of data.
- To have an idea about the tabular and graphical presentation of data.
- To give an idea about the different measures of central tendency and dispersion.
- To give an idea about the relationship between the variables.

Learning Outcomes:

After completing this course, the students should have an idea about:

- Concepts of statistical population and sample.
- Diagrammatic and graphical representation of data.
- Measures of central tendency, Dispersion, Skewness, Kurtosis and moments.
- Correlation and regression.

UNIT I: Statistical Methods:

(Weightage: 5%) (Lecture: 5)

Definition and scope of Statistics, importance and limitation of Statistics, use of Statistics in different fields, concepts of statistical population and Sample.

UNIT II: Collection and presentation of Data:

(Weightage: 10%) (Lecture: 10)

Different types of data, methods of collecting primary data, designing a questionnaire and a schedule, different sources of collecting secondary data including government publications, Scales of measurement: nominal, ordinal, interval and ratio.

Presentation of data: construction of tables with one or more factors of classification. Diagrammatic and graphical representation: histogram, frequency, polygon, ogives, box plot, stem and leaf chart.

UNIT III: Measures of Central Tendency, Location and Dispersion:

(Weightage: 20%) (Lecture: 20)

Measures of Central Tendency: Arithmetic mean, Median, Mode, Geometric mean, Harmonic mean. Measures of Location: Quartiles, Deciles and Percentiles.

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

UNIT IV: Correlation and Regression:

(Weightage: 15%) (Lecture: 10)

Bivariate data: Definition, scatter diagram, simple correlation with properties, partial and multiple correlation (idea only), rank correlation.

Simple linear regression with properties, principle of least squares, fitting of polynomials (up to 2nd degree) and exponential curve.

PRACTICAL/LAB. WORK:

(15 Lecture: 30 class)

List of Practical:

1. Tabular representation of data.
2. Graphical representation of data.
3. Problems based on measures of central tendency.
4. Problems based on measures of dispersion.
5. Problems based on combined mean & variance and coefficient of variation.

6. Problems based on moments, skewness and kurtosis.
7. Karl Pearson's coefficient of correlation.
8. Lines of regression.
9. Spearman rank correlation with and without ties.
10. Fitting of straight line.
11. Fitting of 2nd degree polynomial.
12. Fitting of exponential curves.

SUGGESTED READING:

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

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

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.

Gupta, S.C., Kapoor, V.K. (2006): Fundamentals of Mathematical Statistics, 11th Edn., (Reprint), Sultan Chand & Sons, Daryaganj, New Delhi.

STSMAJ2014 –Calculus-I and Probability-I (Credit4)

Marks: 100 [In-Sem: 30 + End-Sem: 70 (Theory: 50 & Tutorial: 20)]

Objectives:

- To know the preliminary ideas of probability.
- To have the concept of random variables.
- To know the different types of functions of calculus.

Learning Outcomes:

After completing this course, students should have developed a clear understanding of:

- Addition and multiplicative theorem of probability.
- Discrete and continuous random variable.
- Continuity and differentiability in terms of limits.
- The basic concepts of differential & Integral calculus.

UNIT I: Differential Calculus-I:

(Weightage: 10%) (Lecture: 15)

Limits of a function, continuous functions, properties of continuous functions. Indeterminate forms: L-Hospital's rule. Derivatives: Rules of differentiation, composite functions, function of a function, implicit functions, exponential and logarithmic function, function in parametric forms.

UNIT II: Integral Calculus-I:

(Weightage: 10%) (Lecture: 10)

Integration as the reverse of differentiation, method of integration: Substitution, Partial Fractions, by parts. Definite integral, properties of definite integrals.

UNIT III: Probability:

(Weightage: 25%) (Lecture: 13)

Introduction, random experiments, sample space, 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.

UNIT IV: Random variables:

(Weightage: 5%) (Lecture: 7)

Discrete and continuous random variables, p.m.f., p.d.f. and c.d.f., illustrations and properties.

Tutorial:

(15 Lecture: 30 class)

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-Hallof India Pvt. Ltd., New Delhi (2nd Edition - 2004).
4. Piskunov, N.: Differential and Integral Calculus, Peace Publishers, Moscow.
5. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.
6. S. C Gupta, V. K. Kapoor: Fundamentals of Mathematical Statistics, Sultan Chand & Sons, Daryaganj, New Delhi, 2002.

STSMAJ3014 –Calculus-II (Credit4)

Marks: 100 [In-Sem: 30 + End-Sem: 70 (Theory: 50 & Tutorial: 20)]

Objectives:

- To know the use of Calculus in statistics for integrating over sections of a probability distribution.
- To have an idea about the beta and gamma functions.
- To know the solution of differential calculus, integral calculus and differential equations which are useful for advanced statistical application.

Learning Outcomes:

After completing this course, students should have developed a clear understanding of:

- The concept of Successive differentiation, $\square\square\square$ derivative of the product of two functions, total and partial differentiation.
- Differentiation under integral sign, double integral, changes of order of integration, transformation of variables and Jacobian.
- The importance of Beta and Gamma functions, their properties and relationship between them.
- The solution of ordinary and partial differential equation.

UNITI: Differential Calculus-II:

(Weightage: 10%) (Lecture: 10)

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.

UNITII: Integral Calculus-II:

(Weightage: 8%) (Lecture: 5)

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

UNITIII: Differential Equations:

(Weightage: 15%) (Lecture: 15)

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.

UNITIV: Partial Differential Equations:

(Weightage: 17%) (Lecture: 15)

Formation and solution of a partial differential equations, Equations easily integrable, Linear partial differential equations of first order, Non-linear partial differential equation of first order and their different forms, Charpit's method, Homogeneous linear partial differential equations with constant coefficients, Different cases for complimentary functions and particular integrals, Non-homogeneous partial differential equations with constant coefficients.

Tutorial:

(15 Lecture: 30 class)

SUGGESTED READINGS:

Gorakh Prasad: Differential Calculus, Pothishala Pvt. Ltd., Allahabad .

Gorakh Prasad: Integral Calculus, Pothishala Pvt. Ltd., Allahabad.

Zafar Ahsan: Differential Equations and their Applications, Prentic Hall of India Pvt. Ltd., New Delhi(2nd Edition -2004).

Piskunov, N: Differential and Integral Calculus, Peace Publishers, Moscow.

STSMJ3024 Probability-II and Probability Distributions

Marks: 100 [In-Sem: 30 + End-Sem: 70 (Theory: 50 & Practical: 20)]

Objective:

- To know more about two dimensional random variables.
- To have an idea about the mathematical expectation of bivariate random variable along with single random variable
- To familiarize the students about different standard probability distribution for both discrete and continuous random variables.

Learning Outcomes:

After completing this course students would have :

- Knowledge of important discrete distributions such as Binomial, Poisson, Geometric, Negative Binomial and Hypergeometric and their interrelations if any.
- Knowledge of important continuous distributions such as Uniform, Normal, Exponential, Beta and Gamma and relations with some other distributions.
- Clear concept of bivariate transformation.

UNIT I: Random Variable:

(Weightage: 5%) (Lecture: 7)

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.

UNITII: Mathematical Expectation and Generating Functions:

(Weightage: 15%)(Lecture: 18)

Expectation of single and bivariate random variables and their properties, Moments and cumulants, moment generating function, cumulant generating function and characteristic function, Probability generating function, Measures of central tendency and dispersion in terms of expectation, Conditional expectations.

UNIT III: Discrete Probability Distribution:

(Weightage: 15%) (Lecture: 10)

Binomial, Poisson, Geometric, Negative binomial, Hypergeometric, Uniform distribution along with their properties and limiting/ approximation cases.

UNITIV: Continuous Probability Distribution:

(Weightage: 15%) (Lecture: 10)

Uniform, Normal, Exponential, Cauchy, Beta and Gamma along with their properties and limiting/ approximation cases.

PRACTICAL/LAB.WORK:

(15 Lecture: 30 class)

List ofPracticals:

1. Fitting of binomial distributions form and $p = q = 1/2$.
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 λ .
5. Fitting of Poisson distributions after computing mean.

6. Fitting of negative binomial.
7. Application problems based on Binomial distribution.
8. Application problems based on Poisson distribution.
9. Application problems based on negative binomial distribution.
10. Problems based on area property of normal distribution.
11. To find the ordinate for a given area for normal distribution.
12. Application based problems using normal distribution.
13. Fitting of normal distribution when parameters are given.
14. 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
4. Gupta, S. C., Kapoor, V. K.: Fundamentals of Mathematical Statistics, 11th Edn., (Reprint), Sultan Chand & Sons, Daryaganj, New Delhi.

STSMAJ4014 Algebra (Credit4)

Marks: 100 [In-Sem: 30 + End-Sem: 70 (Theory: 50 & Practical: 20)]

Objectives:

- To get an idea about the cubic and biquadratic equation.
- To know different types of matrices.
- To know the different procedure to find the rank of a matrix.

Learning Outcomes:

After completing this course, students should have developed a clear understanding of:

- Theory of Equations,
- The fundamental concepts of Group, Ring, Field, Vector spaces, Sub spaces, Dimension and Basis of vector space.
- The fundamental concepts of matrices and determinants and its properties.
- Echelon form, Linear equations, Rank of a Matrix, Characteristic roots and vectors, Quadratic forms, Partitioning of matrices.

UNITI: Theory of equations:

(Weightage: 10%) (Lecture: 10)

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 (without proof).

UNITII: Algebra of matrices:

(Weightage: 10%) (Lecture: 12)

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.

UNITIII: Determinants of Matrices:

(Weightage: 15%) (Lecture: 13)

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 nth order, Jacobi's Theorem, product of determinants, Adjoint and inverse of a matrix and their related properties. 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.

UNITIV: Matrices:

(Weightage: 15%) (Lecture: 10)

Rank of a matrix, row-rank, column-rank, standard theorems on ranks, rank of the sum and the product of two matrices. Generalized inverse (concept with illustrations), 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 digitalization.

PRACTICAL/LAB. WORK:

(15 Lecture: 30 class)

List of Practicals:

1. Problems based on echelon form of a matrix.
2. Problems based on characteristic roots and vectors of a matrix.
3. Problems based on orthogonal matrix
4. Applications based on systems of linear non - homogeneous equations
5. Problems based on Cayley Hamilton theorem
6. Problems based on quadratic form is positive or negative definite.
7. Reducing a Quadratic Form to its canonical form and finding its rank and index
8. Finding two non-singular matrices P and Q such that PAQ is in normal form.
9. Problems based on systems of linear equations
10. To find whether a given set of vectors is linearly dependent or linearly independent

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.

STSC4024 Sampling Distribution-I

Marks: 100 [In-Sem: 30 + End-Sem: 70 (Theory: 50 & Practical: 20)]

Objective:

- To have the clear concept of basics of sampling distribution.
- To understand the process of hypothesis testing through different tests.
- To give knowledge about various Limit Laws of large numbers.
- To understand about Order Statistics.

Learning Outcomes:

After completing this course, students should have developed a clear understanding of:

- Various tests of hypothesis about population parameters using sample statistics and draw appropriate conclusions from the analysis for large samples and small samples.
- The basic concepts of hypothesis testing, including framing of null and alternative hypothesis.
- Have the idea of some probability inequalities, Laws of convergence, their inter relations and applications law of large numbers.
- Have the knowledge of Order statistics and distribution of sample median and range.

UNIT I: Sampling Distribution:

(Weightage : 10%) (Lecture: 8)

Definition of random sample, parameter and statistic, sampling distribution of a statistic, sample mean, standard error of sample mean, sample variance and sample proportion. Statistical Hypothesis, Null and Alternative Hypotheses, Simple and Composite hypotheses, level of significance, Two types of errors, their probabilities and Critical region.

UNIT II: Order Statistics:

(Weightage: 10%) (Lecture: 7)

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.

UNIT III: Limit laws:

(Weightage: 10%) (Lecture: 10)

convergence in probability, almost sure convergence, convergence in mean square and convergence in distribution and their inter relations, Statement and application of Chebychev's inequality, Weak Law of Large Numbers, Central limit theorem(CLT), Statement of De-Moivre Laplace and Lindeberg-Levy Central Limit Theorem.

UNIT IV: Large test, t-test & chi-square test:

(Weightage: 20%) (Lecture: 20)

Large sample tests for testing single proportion, difference of two proportions, single mean and difference of two means.

t- tests for testing single mean, difference of two means, paired t-test, Chi-square test for goodness of fit, independence of attributes, F-test (idea only).

PRACTICAL/LABWORK:

(15 Lectures: 30 Class)

List of practical:

1. Problem based on Type-I & Type-II error
2. Problem based on Large sample test for testing single mean.
3. Problem based on Large sample test for testing difference between two means.
4. Problem based on Small sample test for testing single mean.
5. Problem based on Small sample test for testing difference between two means.

6. Problem based on Chi-square test of goodness-of-fit.

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.

STSMJ4034 Survey Sampling and Indian Official Statistics (Credit 4)

Marks : 100 [In-sem : 30 + End Sem. : 70 (Theory : 50 & Practical : 20]

Objective:

- *To obtain the maximum information about the population through sampling techniques.*
- *It also accommodates with the functions of official statistical system in India.*

Learning Outcomes:

After completing this course, students should have developed a clear understanding of:

- *The basic concepts of complete enumeration, sample survey and related terminologies.*
- *Functionality of Indian Official Statistical system and Government of India's Principal publications containing data on the topics such as population, industry and finance.*

UNIT I: Survey Sampling:

(Weightage: 10% , Lecture: 10)

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, variances of these estimates, estimates of their variances and sample size determination.

UNIT II: Stratified & Systematic random sampling:

(Weightage: 20%, Lecture: 15)

Stratified random sampling:

Technique, estimates of population mean and total, variances of these estimates, proportional and optimum allocations and their comparison with SRS, estimation of gain in precision, post stratification and its performance.

Systematic random 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, Sampling with probability proportional to size.

UNIT III: Ratio and Regression Method of Sampling:

(Weightage: 10%, Lecture: 13)

Introduction to Ratio and regression methods of estimation, first approximation to the population mean and total (for SRS of large size), variances of these estimates and estimates of these variances, variances in terms of correlation coefficient for regression method of estimation and their comparison with SRS. Cluster sampling (equal clusters only) estimation of population mean and its variance, comparison (with and without randomly formed clusters), Relative efficiency of cluster sampling with SRS in terms of intra class correlation.

UNIT IV: Official Statistics:

(Weightage: 10%, Lecture: 7)

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.

PRACTICAL/LAB. WORK:

(15 Lectures: 30 Class)

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. Chaudhary F.S. and Singh D. (2020): Theory and Analysis of Sample Survey Designs, New Age International Publishers, New Delhi.
7. Guide to current Indian Official Statistics, Central Statistical Office, GOI, New Delhi.

STSMAJ5014-Mathematical Analysis (Credit4)

Marks: 100 [In-Sem: 30 + End-Sem: 70 (Theory: 50 & Tutorial: 20)]

Objective:

- To study the Real Analysis, analytical properties of real functions and sequences.
- To study the Numerical Analysis and use of numerical approximation for the problems of mathematical analysis.

Learning Outcomes:

After completing this course, students should have developed a clear understanding of:

- Clear understanding of Fundamental properties of real number and real-valued functions.
- Have the analytical properties of sequences, Infinite series, their properties and different tests.
- Limits, continuity, differentiability and mean value theorems, Taylor's and Maclaurin's series for expansion of functions.
- Fundamentals of numerical analysis, interpolation, inverse interpolation, numerical integration and difference equation, Roots of polynomial equations

UNIT-I: Real Analysis:

(Weightage: 10%) (Lecture: 10)

Representation of real numbers as points on the line and the set of real numbers as complete ordered field, Bounded and unbounded sets, neighborhoods and limit points, Suprimum and infimum, derived sets, open and closed sets.

UNIT-II: Real Sequences:

(Weightage: 10%) (Lecture: 11)

Sequences and their convergence, limits of some special sequences such as and Cauchy's general principle of convergence, Cauchy's first theorem on limits, monotonic sequences, limit superior and limit inferior of a bounded sequence.

UNIT-III: Infinite series:

(Weightage: 15%) (Lecture: 12)

Infinite series, positive termed series and their convergence, Comparison test, D'Alembert's ratio test, Cauchy's nth root test, Raabe's test, Gauss test, Cauchy's condensation test and integral test(Statements and Examples only), Absolute convergence of series, Leibnitz's test for the convergence of alternating series, Conditional convergence.

UNIT-IV: Limit, Continuity and Differentiability:

(Weightage: 15%) (Lecture: 12)

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 $\sin x$, $\cos x$, $\log(1+x)$.

Tutorial:

(15 Lecture: 30 class)

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, 12th revised Edition, S. Chand & Co. (Pvt.) Ltd., New Delhi, 1987.
6. Singal M.K. and Singal A.R.: A First Course in Real Analysis, 24th 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.

STSMAJ5024 Applied Statistics

Marks: 100 [In-Sem: 30 + End-Sem: 70 (Theory: 50 & Practical: 20)]

Objective:

- To know the use of weighted and unweighted index number in different time periods.
- To study demand function and consumption, elasticity of demand and income distribution.
- To know more about categorical data.

Learning Outcomes:

After completing this course, students should have developed a clear understanding of:

- Different index numbers like chain index number, consumer price index number.
- Different laws of income distribution.
- Association of attributes.
- Knowledge of use of chi-square distribution for the goodness of fit.

UNIT I: Index Number:

(Weightage: 20%) (Lecture: 15)

Definition, construction of index numbers and problems of 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, various tests of index numbers, Base Shifting, Splicing and Deflating of index number.

Unit II: Demand Analysis:

(Weightage: 20%) (Lectures: 15)

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

Unit III: Theory of Attributes:

(Weightage: 5%) (Lectures: 7)

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

Unit IV: Categorical Data Analysis:

(Weightage: 5%) (Lectures: 8)

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

PRACTICAL/LABWORK:

(15 Lectures: 30 Class)

List of Practical:

1. Calculate price and quantity index numbers using simple and weighted average of price relatives.
2. To calculate the Chain Base index numbers.
3. To calculate consumer price index number.
4. Independence of attributes.
5. Construction of Contingency table.
6. Test of association.
7. Test of goodness of fit.
8. Test of proportion.
9. Yates' correction.

SUGGESTED READING:

1. Goon A.M., Gupta M.K. and Dasgupta B.(2002): Fundamentals of Statistics, Vol. I

&II, 8th Edn. TheWorldPress, 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.

4. Gupta, S.C. and Kapoor, V.K. (2011): Fundamentals of Applied Statistics, 4th Edn., (Reprint), Sultan Chand & Sons, New Delhi.

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

STSMAJ5034 Statistical Quality Control (Credit 4)

Marks : 100 [In-sem : 30 + End Sem. : 70 (Theory : 50 Practical : 20)]

Objective:

- *To learn techniques and approach of SQC to be applied in industry to manufacture goods and services of high quality at low cost.*
- *To know the improvement of quality and productivity by process control and experimentation.*

Learning Outcomes:

After completing this course, students should have developed a clear understanding of:

- *The concept and utility of SQC techniques.*
- *Different charts for variables and attributes.*
- *Single and double sampling inspection plans, OC and ASN functions and use and interpretation of Dodge and Romig's sampling inspection plan tables.*

UNIT I: Statistical Process Control:

(Weightage: 15%, Lecture: 10)

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.

UNIT II: Control charts for variables:

(Weightage: 15%, Lecture: 15)

Control charts for variables: 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.

UNIT III: Acceptance sampling plan:

(Weightage: 15%, Lecture: 15)

Acceptance sampling plan: 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.

UNIT IV: Introduction to Six-Sigma:

(Weightage: 5%, Lecture: 5)

Introduction to Six-Sigma: Overview of Six Sigma, Lean Manufacturing and Total Quality Management (TQM).

PRACTICAL/LAB. WORK:

(15 Lectures: 30 Class)

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.
4. Use a case study to apply the concept of six sigma application in DMAIC: practical application.

SUGGESTED READING:

1. Montgomery, 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. Montgomery, 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.

STSMJ5044 Statistical Computing Using C Programming (Credit4)

Marks: 100 | In-Sem: 30 + End-Sem: 70 (Theory: 50 & Practical: 20) |

Objectives:

- *To understand the basic concept of C language and its roles in problem solving.*
- *To understand basic data structures and develop logics using C language.*
- *To learn the basic programming language.*

Learning Outcomes:

After completing this course, students should have developed a clear understanding of:

- *Various data types, operators, library functions, Input/output operations.*
- *Decision making and branching and looping.*
- *Arrays, Outcomes: Character and strings.*

UNIT I: Basic idea of C:

(Weightage: 10%) (Lecture: 10)

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, over flow and under flow of data.

UNIT II: Operators and Expressions:

(Weightage: 10%) (Lecture: 10)

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 formatted data.

UNIT III: Decision making and branching:

(Weightage: 15%) (Lecture: 15)

if...else, nesting of if...else, else if ladder, switch, conditional(?) operator, Looping in C/C++: for, nested for, while, do...while, jumps in and out of loops.

UNIT IV: Arrays:

(Weightage: 15%) (Lecture: 10)

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).

PRACTICAL/LAB. WORK:

(15 Lectures: 30 Class)

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. Matrix addition, subtraction, multiplication Transpose and Trace
9. Fitting of Binomial, Poisson distribution and apply Chi-square test for goodness of fit

10. Chi-square contingency table
11. t-test for difference of means
12. Paired t-test
13. F-ratio test
14. 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 ANSIC, 6th Edition, Tata McGraw Hill.
3. Gottfried, B.S. (1998): Schaum's Outlines: Programming with C, 2nd Edition, Tata McGraw Hill

STSMJ6014 Design of Experiments (Credit 4)

Marks: 100 [In-Sem: 30 + End-Sem: 70 (Theory: 50 & Practical: 20)]

Objective:

- To design and conduct experiments.
- To analyze and interpret data.

Learning Outcomes:

After completing this course, students should have developed a clear understanding of:

- Clear understanding of the fundamental concepts and principles used in design of experiments.
- The appropriate experimental designs to analyze the experimental data viz. Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD).
- Knowledge of the basic designs with one missing observation and their analysis.
- The analysis of factorial experiments viz. 2^n ($n=2, 3, 4, 5$) factorial experiments and 3^2 factorial experiments.
- The concept of total and partial confounding in factorial experiments.
- Knowledge of Incomplete Block Design.

UNIT I: Experimental designs:

(Weightage: 10%) (Lecture: 10)

Role, historical perspective, terminology, experimental error, uniformity trials, fertility contour maps, choice of size and shape of plots and blocks.

Analysis of variance: 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.

UNIT II: Basic designs:

(Weightage: 15%) (Lecture: 12)

Basic principles of design of experiment, Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD) – layout, model and statistical analysis, relative efficiency, analysis with missing observations.

UNIT III: Factorial experiments:

(Weightage: 15%) (Lecture: 13)

Advantages, notations and concepts, 2^2 , $2^3 \dots 2^n$ and 3^2 factorial experiments, design and analysis, Total and Partial confounding for 2^n ($n \leq 5$), 3^2 factorial experiments in a single replicate.

UNIT IV: Incomplete Block Designs:

(Weightage: 10%) (Lecture: 10)

Balanced Incomplete Block Design (BIBD): parameters, relationships among its parameters, incidence matrix and its properties, Symmetric BIBD, Resolvable BIBD, Affine Resolvable BIBD, Intra Block analysis, complimentary BIBD, Residual BIBD, Dual BIBD, Derived BIBD.

PRACTICAL/LAB. WORK:

(15 Lectures: 30 class)

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. Intra Block analysis of a BIBD
7. Analysis of 2^2 and 2^3 factorial in CRD and RBD

8. Analysis of 2^2 and 2^3 factorial in LSD
9. Analysis of a completely confounded two level factorial design in 2 blocks
10. Analysis of a completely confounded two level factorial design in 4 blocks
11. 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 Edition. 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.

STSMJ6024: Time Series Analysis (Credit 4)

Marks : 100 [In-sem : 30 + End Sem : 70 (Theory : 50 Practical : 20)]

Objective:

- To understand the different components and technique of time series analysis.
- To identify the nature of the phenomenon represented by the sequence of observations and forecasting.

Learning Outcomes:

After completion of this course, the students will know about

- Computing and fitting trend by different methods.
- Measurement of Seasonal Indices by various methods.
- Calculation of variance of random component by variate difference method.
- Weak stationarity, autocorrelation and correlogram of Moving average.

UNIT I: Introduction to times series:

(Weightage: 10%, Lecture: 10)

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.

UNIT II: Introduction to times series:

(Weightage: 20%, Lecture: 15)

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.

UNIT III: Moving Averages:

(Weightage: 10%, Lecture: 10)

Seasonal Component cont: Ratio to Moving Averages and Link Relative method, Deseasonalization, Cyclic Component: Harmonic Analysis. Some Special Processes:

Moving-average (MA) process and Autoregressive (AR) process of orders one and two.

UNIT IV: Fore casting and smoothing to Time Series:

(Weightage: 10%, Lecture: 10)

Random Component: Variate component method. Forecasting: Exponential smoothing methods, Short term forecasting methods: Box-Jenkins method. Time series: Weak stationarity, autocorrelation function and correlogram.

PRACTICAL / LAB WORK

(15 Lectures: 30 Class)

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.

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

STSMAJ6034: Demography and Vital Statistics (Credit 4)

Marks: 100 [In-sem : 30 + End Sem. : 70 (Theory : 50 Practical : 20)]

Objective:

- To have an idea about different measures of Mortality.
- To have an idea about different measures of Fertility and Population Growth.
- To have an idea about different methods of construction of life tables.

Learning Outcomes:

After completing this course, students should have developed a clear understanding of:

- Different sources of data collection on Vital Statistics and errors therein.
- Basic measures of Mortality and fertility.
- Concept of Life Tables, their construction and uses.
- Concept of Abridged life tables and their construction by different methods.

UNIT I: Population Theories:

(Weightage: 10%, Lecture: 10)

Population Theories: Coverage and content errors in demographic data, use of balancing equations and Chandrasekharan-Deming formula to check completeness of registration data. Adjustment of age data, use of Myer and UN indices, Population composition, dependency ratio.

UNIT II: Measurements of Mortality:

(Weightage: 15% , Lecture: 12)

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.

UNIT III: Measurements of Fertility:

(Weightage: 15%, Lecture: 13)

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).

UNIT IV: Life Tables:

(Weightage: 10%, Lecture: 10)

Stationary and Stable population, Central Mortality Rates and Force of Mortality, Life (Mortality) Tables: Assumption, description, construction of Life Tables and Uses of Life Tables. Abridged Life Tables; Concept and construction of abridged life tables by Reed-Merrell method and Greville's method.

PRACTICAL/LAB. WORK:

(15 Lectures: 30 Class)

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 and (ii) Greville'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.

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, 9th Edition, World Press.
3. Biswas, S. (1988): Stochastic Processes in Demography & Application, Wiley Eastern Ltd.
4. Croxton, Fredrick E., Cowden, Dudley J. and Klein, S. (1973): Applied General Statistics, 3rd Edition. Prentice Hall of India Pvt. Ltd.
5. Keyfitz N., Beckman John A.: Demogrphy through Problems S-Verlag New york.

STSMJ6044-Numerical and Computational Techniques (Credit4)

Marks: 100 [In-Sem: 30 + End Sem.: 70 (Theory : 50 & Practical : 20)]

Objective:

- To study the appropriate formula for interpolating the missing observation.
- To study different methods of interpolation used for the problems of mathematical analysis.
- To study the different central difference formula.
- To study the different methods to solve difference equations.

Learning Outcomes:

After completing this course, students should have developed a clear understanding of:

- Interpolation technique to compute missing values.
- Fundamentals of numerical analysis, interpolation, inverse interpolation, numerical integration and difference equation.
- Roots of polynomial equations.

UNIT-I: Interpolation:

(Weightage: 20%) (Lecture: 15)

Operators Δ and E , Construction of difference table, Fundamental theorem of finite difference, Estimation of missing term, Newton's forward, backward and divided differences interpolation formulae, Lagrange's interpolation formulae.

UNIT-II: Central Difference:

(Weightage: 10%) (Lecture: 10)

Idea, Operator's, Gauss's forward, backward, Bessel, Stirling, and Everret formulae, Numerical Differentiation.

UNIT-III: Numerical Integration:

(Weightage: 10%) (Lecture: 10)

General quadrature formula, statement, proof and applications of Trapezoidal rule, Simpson's one-third rule, three-eighth rule, Weddle's rule.

UNIT-IV: Numerical Analysis:

(Weightage: 10%) (Lecture: 10)

Linear difference equation with constant coefficient, roots of polynomial equations, and solution of simple problems by Graphical method, Regula Falsi Method, Method of Iteration, Bisection method and Newton- Raphson method.

PRACTICAL/LAB. WORK:

(15 Lectures: 30 Class)

List of Practical

1. Formation of difference table and missing terms for equal interval of differencing.
2. Problem based on Newton's forward, backward and divided difference interpolation formula.
3. Problem based on Lagrange's interpolation formula.
4. Problem based on Gauss forward, Gauss backward central difference interpolation formula.
5. Problem based on Bessel, Stirling and central difference interpolation formula.
6. Problems based on numerical differentiation.
7. Problems based on Trapezoidal Rule, Simpson's one-third rule, Simpson's three-eighth rule, Weddle's rule.

8. Problems based on Bisection method, Regula Falsi method and Newton Raphson Method.

SUGGESTED READING:

1. Jain, M.K., Iyengar, S.R.K. and Jain, R.K. (2003): Numerical methods for scientific and engineering computation, New age International Publisher, India.
2. Mukherjee, Kr. Kalyan (1990): Numerical Analysis. New Central Book Agency.
3. Sastry, S.S. (2000): Introductory Methods of Numerical Analysis, 3rd edition, Prentice Hall of India Pvt. Ltd., New Delhi.

STSM AJ7014: Econometrics (Credit 4)

Marks: 100 [In-sem : 30 + End Sem. : 70 (Theory : 50 Practical : 20)]

Objectives:

To understand regression analysis relevant for analysing economic data.

To gather knowledge regarding the results of violating the assumptions of classical regression model.

Learning Outcomes:

After finishing this course, students should have gained a thorough understanding of the following:

The fundamental concepts of econometrics and specification of the model.

Multiple Linear Regression.

Multicollinearity.

Autocorrelation.

Heteroscedasticity.

UNIT I : Introduction:

(Weightage: 10%) (Lecture: 15)

Objective behind building econometric models, nature of econometrics, model

building, role of econometrics, structural and reduced forms. General linear models: two or more variables.

UNIT II: Multicollinearity:

(Weightage: 13%) (Lecture: 10)

Introduction and concepts, detection of multicollinearity, consequences,

tests and solutions of multicollinearity, specification error.

UNIT III: Autocorrelation:

(Weightage: 13%) (Lecture: 10)

concept, consequences of autocorrelated disturbances, detection and solution of autocorrelation.

UNIT IV: Heteroscedastic disturbances:

(Weightage: 14%) (Lecture: 10)

The nature of heteroscedasticity, OLS estimation in the presence of heteroscedasticity, Consequences of heteroscedasticity. Detection of heteroscedasticity: informal methods and formal methods Park test, Spearman's rank correlation test and solutions of heteroscedasticity.

PRACTICAL /LAB WORK

(15 Lecture: 30 class)

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 disturbance terms.*

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*

STSM AJ7024: Operation Research (Credit 4)

Marks: 100 [In-sem : 30 + End Sem : 70 (Theory : 50 Practical : 20)]

Objectives:

The learning objectives include:

To study various Operational Research Techniques and Models.

Learning Outcomes:

After completing this course, students should have developed a clear understanding of:

The fundamental concepts of Operational Research Techniques.

Mathematical formulation of linear programming problem (LPP), Graphical and simplex method of solving LPP, finding degenerate, unbounded, alternate and infeasible solutions.

Obtaining initial basic feasible solution of a transportation problem by North West corner method, Least cost method, Vogel's method.

Obtaining optimal solution of a transportation problem using MODI's method including some special cases of transportation problem.

Hungarian Method for solving assignment problems.

Game theory for graphical solution of $m \times 2$ or $2 \times n$ rectangular game and mixed strategy.

Networking problem using minimal spanning tree and shortest route.

Optimal inventory policy for EOQ model and its variations.

Solving quantity discounts model with price breaks

UNIT I: Operations Research:

(Weightage: 13%) (Lecture: 10)

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, Feasible solution, Basic solution, Degenerate basic solution, graphical solutions of a L.P.P.

UNIT II: Simplex method:

(Weightage: 15%) (Lecture: 15)

Simplex method for solving L.P.P. Charne's M-technique for solving L.P.P. involving artificial variables.

Concept of Duality in L.P.P: Dual simplex method. Post-optimality analysis.

UNIT III: Transportation Problem:

(Weightage: 15%) (Lecture: 13)

Initial solution by North West corner rule, Lowest Cost Entry method and Vogel's approximation method (VAM). Assignment problem: Hungarian method to find optimal assignment, special cases of assignment problem.

UNIT IV: Game theory:

(Weightage: 7%) (Lecture: 7)

Rectangular game, minimax-maximin principle, solution of rectangular game using graphical method, dominance property to reduce the game matrix.

PRACTICAL/LAB WORK:

(15 Lecture: 30 Class)

List of Practical

Mathematical formulation of L.P.P and solving the problem using graphical method, Simplex technique and Charne's Big M method involving artificial variables.

Identifying Special cases by Graphical and Simplex method and interpretation

Degenerate solution
Unbounded solution
Alternate solution
Infeasible solution
Post-optimality
Addition of constraint
Change in requirement vector
Allocation problem using Transportation model
Allocation problem using Assignment model
Networking problem
Problems based on game matrix

SUGGESTED READING:

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

STSMAJ7034: Stochastic Processes and Queuing Theory

Marks: 100 [In-sem : 30 + End Sem : 70 (Theory : 50 Practical : 20)]

Objectives:

To comprehend fundamental concepts related to stochastic processes.

To explore various types of discrete and continuous time processes.

To gain thorough understanding of Markov chains and processes.

To understand the basic concepts and terminologies in queuing theory.

Learning Outcomes:

Able to explain the key concepts, definitions, and theorems related to stochastic processes.

Able to construct models for various types of stochastic processes and queuing systems.

Have the analytical skills and practical applications.

UNIT I: Probability Distributions:

(Weightage: 10%) (Lecture: 10)

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

UNIT II: Markov Chains:

(Weightage: 20%) (Lecture: 15)

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. Graph theoretic approach.

UNIT III: Poisson Process:

(Weightage: 10%) (Lecture: 10)

Postulates of Poisson process, properties of Poisson process, inter-arrival time. Pure birth and death process, Yule Furry process.

UNIT IV: Queuing System:

(Weightage: 10%) (Lecture: 10)

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

PRACTICAL/LAB WORK:

(15 Lecture: 30 Class)

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 Bernoulli trials.**
- 7. Computation of inter-arrival time for a Poisson process.**
- 8. Calculation of Probability and parameters for (M/M/1) model.**

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.**

STSM AJ7044: Non-Parametric Statistical Inference and Decision Theory

Marks: 100 [In-sem : 30 + End Sem : 70 (Theory : 50 Practical : 20)]

Objective:

To study application of Non-Parametric methods of testing of hypothesis.

To get a preliminary idea of decision theory

Learning Outcomes:

Students should have achieved the knowledge of following:

Understand importance of different non-parametric test procedures, their applications and interpretation. Testing of hypothesis using Non-Parametric tests like Sign test, Median test, Runs test, U test, Kruskal Wallis test etc.

Understanding the basic concept of decision rule.

UNIT I: Non-Parametric Statistical Inference (Weightage: 40%) (Lecture: 35)

Introduction and Concept, advantages and disadvantages of non-parametric test, terms associated with non parametric test, test for randomness based on runs (both one and two sample tests), chi-square test for goodness of fit, chi-square test for independence of attributes, Empirical distribution function, Kolmogrov-Smirnov test for one and two samples, Sign tests-one sample and two samples. Wilcoxon-Mann-Whitney U test, Wilcoxon Signed Rank test for comparing two related samples. Median test, Spearman rank test, Kruskal Wallis test. Kendall's rank correlation test, Friedman's two-way analysis of variance by ranks.

UNIT II: Decision Theory (Weightage: 10%) (Lecture: 10)

Elements of Decision Theory: Introduction, Basic Concepts, Bayes and Minimax Decision rules. Different types of loss function. Estimation of Parameters: Bayes estimate and Minimax estimate. Point estimation, Interval estimation and Testing of Hypothesis as Decision Problem.

PRACTICAL/LAB WORK: (15 Lecture: 30 Class)

List of Practical

Test for randomness based on total number of runs

Chi-square test for goodness of fit

Chi-square test for independence of attributes

Kolmogrov Smirnov test for one sample.

Sign test: one sample, two samples, large samples.

Wilcoxon-Mann-Whitney U-test

Kruskal-Wallis test

Wilcoxon Signed Rank test

Median test

Spearman rank test

Kendall's rank correlation test

Friedman's two-way analysis of variance by ranks.

SUGGESTED READING:

- 1. Gibbons J.D (1985) Non Parametric Statistical Inference 2nd Ed. Marcel Dekker Inc.*
- 2. Mukhopadhyay P (1996) Mathematical Statistics New central Book Agency (Kolkata)*
- 3. Seigel sidney : Non Parametric Statistics fore Behavioural Science Mc. Graw Hill.*
- 4. Alho, J.M and Spencer B.D (2008). Statistical Demography and Forecasling Springer.*
- 5. An outline of Statistical Theory Vol.II: AM Gun, MK Gupta, B Dasgupta. World Press.*
- 6. Mathematical Statistics: Parimal Mukhopadhyay: New Central Book Agency*

STSM AJ8014 Linear Models (Credit 4)

Marks: 100 [In-sem : 30 + End Sem. : 70 (Theory : 50 Practical : 20)]

Objectives:

To develop a clear understanding of the fundamental concepts of linear models.

To learn variety of related skills of linear model that will enable the students to deal with them efficiently.

Learning Outcomes:

Students should have gained a thorough understanding of the following:

Theory and estimation of Linear Models.

Gauss-Markov Theorem and its use.

Simple and Multiple linear regression models and their applications.

Concept of model matrix and its use in estimation.

Techniques of Analysis of Variance with one and more observations per cell.

UNIT I: Gauss-Markov set-up: (Weightage: 10%) (Lecture: 10)

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

UNIT II: Regression analysis: (Weightage: 20%) (Lecture: 15)

Simple regression analysis, Estimation and hypothesis testing in case of simple regression model, The test of goodness of fit. Multiple regression model, Concept of model matrix and its use in estimation.

UNIT III: Analysis of variance: (Weightage: 10%) (Lecture: 10)

The method of analysis of variance, Regression analysis and analysis of variance, Comparison of regression analysis and analysis of variance, Testing the overall significance of a regression, Test the equality between coefficients from different samples.

UNIT IV: Model checking: (Weightage: 10%) (Lecture: 10)

Prediction from a fitted model, Violation of usual assumptions concerning normality, Homoscedasticity and collinearity, Diagnostics using quantile-quantile plots.

PRACTICAL/LAB. WORK: (15 Lecture: 30 Class)

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. Regression analysis and analysis of variance**
- 10. Comparison of regression analysis and analysis of variance**
- 11. Test the equality between coefficients from different samples**

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.

STSMAJ8024: Statistical Inference

Marks: 100 [In-sem : 30 + End Sem : 70 (Theory : 50 Practical : 20)]

Objectives:

To gather the knowledge of theory of estimation.

To draw inference about the unknown population parameters based on random samples.

To have knowledge about various tests for statistical hypotheses.

To construct critical regions.

Learning Outcomes:

After completing this course, students should have developed a clear understanding of:

Different methods of finding point estimators for unknown population parameters, their advantages and disadvantages using the method of maximum likelihood estimation, method of moments and method of minimum chi-square.

The theory and the characteristics of point Estimators.

Different properties of minimum variance unbiased (MVU) estimators and finding the lower bounds for unbiased estimators.

Interval estimation and confidence levels.

The use of Neyman-Pearson Fundamental Lemma and its Generalised form for finding different tests like MP and UMP tests.

The different Principles of statistical tests including Consistency, monotonicity and invariance principle.

Construction of UMPU tests, Type A and Type A1 critical regions, Optimum Regions, and Similar Regions.

UNIT I: Point Estimation:

(Weightage: 23%) (Lectures:18)

Concept of estimation, unbiasedness, consistency, efficiency and sufficiency. Factorization theorem and Invariance property. UMVUE related theorems including Necessary and sufficient condition of UMVUE. Rao- Blackwell theorem and Lehmann- Scheffe theorem.

Cramer- Rao lower bound, Bhattacharyya bound and Chapman- Robins-Kiefer lower bound.

Methods of estimation: Method of Maximum likelihood estimation (with properties and related theorems), Method of moments, Minimum chi square.

UNIT II: Interval Estimation:

(Weightage: 7%) (Lectures: 10)

Interval estimation, confidence level, construction of shortest expected length confidence interval, uniformly most accurate one-sided confidence Interval and its relation to UMP tests for one-sided null against one-sided alternative hypotheses.

UNIT III: Randomised and non-randomised tests:

(Weightage: 10%) (Lectures: 10)

Basic concepts of randomised and non-randomised tests; Neyman-Pearson Lemma and Generalisation, MP and UMP tests, Consistency, monotonicity and invariance principle of tests and their construction.

UMPU- tests, Type A and Type A1 critical regions, Optimum Region and Sufficient statistic, Similar Regions.

UNIT IV: Likelihood ratio Test: (Weightage: 10%) (Lectures: 7)
Likelihood Ratio Tests, Asymptotic distribution of Likelihood ratio. Randomised test: Test function, Neyman-Pearson theorem, Monotone Likelihood Ratio.

PRACTICAL/LAB. WORK: (15 Lecture: 30 Class)

List of Practicals:

Unbiased, Consistent, efficient and relative efficiency of estimator.

Cramer Rao inequality and MVB estimators.

Maximum Likelihood Estimation.

Estimation by the method of moments, minimum chi square.

Most Powerful Critical Region (NP Lemma)

Uniformly Most Powerful Critical Region

Likelihood Ratio Test

SUGGESTED READING:

- 1. Bartoszynski, R. and Bugaj, M.N. (2007): Probability and Statistical Inference, John Wiley & Sons.*
- 2. Ferguson, T.S. (1967): Mathematical Statistics, Academic Press. 3. Kale, B.K. (1999). A First Course on Parametric Inference, Narosa Publishing House.*
- 3. George Cassella & Roger L. Berger (1994): Statistical Inference. Wadsworth & Brooks, California.*
- 4. Goon, A. M., Gupta, M. K., and Dasgupta (1987): An Outline of Statistical Theory. Vol.-II, World Press.*
- 5. Kale B. K. (1999): A First Course on Parametric Inference*
- 6. Kendal, M. G. & Stuart, A (1960): The Advanced Theory of Statistics. Vol 2. Charles Griffin, London.*
- 7. Lehman E.L (2011): Theory of Point Estimation, 2nd Edition, Springer*
- 8. Parimal Mukhopadhyay (1996): Mathematical Statistics. New Central Book Agency, Kolkata.*
- 9. Rao, C. R. (1973): Linear Statistical Inference and Its Application, 2/e Wiley Eastern*
- 10. Saxena H & Surendran P (1994): Statistical Inference, S Chand & Company Pvt. Limited*

STSMAJ8034: Linear Algebra (Credit 4)

Marks : 100 [In-sem : 30 + End Sem. : 70 (Theory : 50 Practical : 20)]

Objectives:

To study vector spaces and subspaces, linear transformation, matrix representation of a linear operator and basic matrix theory.

To study generalized inverse of a matrix.

Learning Outcomes:

After completing this course students will have a clear understanding of:

Understand the basics of finite dimensional vector spaces.

Importance of concept of linear algebra in multiple area of science.

Understand the concepts of generalized inverse theory and applications.

Concepts of matrices with Linear Transformations and inner product spaces.

Concepts and detailed theory of Eigen values and Eigen vectors.

Apply the techniques of matrix theory to other branch of statistics and practical problems.

Unit I: Theory of linear equations:

(Weightage: 10%) (Lecture:10)

Concept of groups and fields with examples, Vector spaces and Subspaces with examples, Direct sum and Algebra of subspaces viz. sum, intersection, union etc, Linear combinations, Spanning sets, Linear spans, Row and Column space of a matrix.

Unit II: Linear Transformations:

(Weightage: 12%) (Lecture: 10)

Kernel and Image of a linear transformation, Rank and Nullity, Matrix representation of a linear operator, Change of Basis, Similarity, Inner product spaces with examples, Cauchy-Schwarz inequality with applications, Orthogonality, Orthonormal sets and Bases, Gram Schmidt Orthogonalization Process.

Unit III: Eigenvalues and eigenvectors:

(Weightage: 13%) (Lecture:10)

Spectral decomposition of a symmetrical matrix (Full rank and non-full rank cases), Example of spectral decomposition, Spectral decomposition of asymmetric matrix, Cayley Hamilton theorem, Algebraic and geometric multiplicity of characteristic roots, Diagonalization of matrices, Factorization of a matrix, Eigenvalues and eigenvectors for solution of Differential equations.

Unit IV: Inverse of a Matrix:

(Weightage:15%) (Lecture:15)

Generalized inverse of a matrix, Different classes of generalized inverse, Properties of g-inverse, Reflexive g-inverse, left weak and right weak g-inverse, Moore- Penrose (MP) g-inverse and its properties, Real quadratic form, Linear transformation of quadratic forms, Index and signature, Reduction of quadratic form into sum of squares, Gram matrix with example, Jordan canonical form.

PRACTICAL/LAB. WORK:

(15 Lecture: 30 Class)

List of Practicals:

Problems based on rank and nullity of a matrix.

Problems based on symmetrical matrix.

Problems based on Factorization of a matrix

Applications based on Cauchy-Schwarz inequality

Problems based on orthogonality, orthonormal sets and bases

Problems based on Real quadratic form.

Applications based on Gram matrix

Problems based on Jordan canonical form.

SUGGESTED READINGS:

- Biswas, S. (1997). A Text Book of Matrix Algebra, 2nd ed., New Age International Publishers.*
Golub, G.H. and Van Loan, C.F. (1989). Matrix Computations, 2nd ed., John Hopkins University Press, Baltimore-London.
Hadley, G. (2002). Linear Algebra. Narosa Publishing House (Reprint).
Robinson, D.J.S. (1991). A Course in Linear Algebra with Applications, World Scientific, Singapore.
Rao, C.R. (1973). Linear Statistical Inferences and its Applications, 2nd ed., John Wiley & Sons.
Searle, S.R. (1982). Matrix Algebra useful for Statistics, John Wiley & Sons.
Strang, G. (1980). Linear Algebra and its Application, 2nd ed., Academic Press, London New York.
Graybill, F.A. (1983): Matrices with applications in Statistics, 2nd Ed. Wadsworth.

STSMAJ8044: Multivariate Analysis (Credit 4)

Marks: 100 [In-sem : 30 + End Sem : 70 (Theory : 50 Practical : 20)]

Objectives:

The learning objectives include:

The course provides a deeper knowledge within multivariate statistics, both in theory and applications.

Learning Outcomes:

On completion of the course, students should have achieved the following:

The knowledge of fundamental ideas related to multivariate normal distributions and their properties.

Using data reduction methods such as Principal Component Analysis and Canonical Correlation Analysis to analyse multivariate data Concept of Factor Analysis.

UNIT I: Multivariate normal distribution (Weightage: 10%) (Lecture: 10)

Multivariate normal distribution and its properties, Sampling distribution for mean vector and Variance -covariance matrix. Multiple and partial correlation coefficient and their properties, Maximum likelihood estimators of parameters, Multivariate Central Limit Theorem.

UNIT II: Wishart matrix: (Weightage: 10%) (Lecture: 10)

its distribution and properties. Distribution of sample generalized variance. Hotelling's T² statistic: its distribution and properties. Applications in tests on mean vector for one and more multivariate normal populations and also on symmetry of organs. Mahalanobis D².

UNIT III: Applications of Multivariate Analysis: (Weightage: 15%) (Lecture: 15)

Discriminant Analysis, Principal Components Analysis and Factor Analysis, Distribution of the matrix of sample regression coefficients and the matrix of residual sum of squares and cross products, Rao's U-statistic, its distribution and applications.

UNIT IV: Discrimination procedures: (Weightage: 15%) (Lecture: 10)

Classification and discrimination procedures for discrimination between two multivariate normal populations - sample discriminant function, tests associated with discriminant functions, probabilities of misclassification and their estimation, Classification into more than two multivariate normal populations.

PRACTICAL/LAB. WORK:

(15 Lecture: 30 Class)

List of Practicals:

Multivariate Normal Distribution

Partial correlation

Multiple correlation

Maximum likelihood estimators of parameters

Discriminant Analysis

Principal Components Analysis

Factor Analysis

Rao's U-statistic

discriminant functions

SUGGESTED READING:

1. *Anderson, T.W. (2003): An Introduction to Multivariate Statistical Analysis, 3rd Edition, John Wiley.*
2. *Giri, N. C. (1977): Multivariate Statistical inference, Academic Press.*
3. *Hardle, W. K. and Simar, L. (2015): Applied Multivariate Statistical Analysis, 4th Edition, Springer. Pearson Education India.*
4. *Johnson, R. A. and Wichern, D. W. (2015): Applied Multivariate Statistical Analysis, 6th Edition, Prectice Hall*
5. *Kshirsagar, A. M. (1996): Multivariate Analysis, 2nd Edition, Marcel Dekker.*
6. *Lawley, D. N. and Maxwell, A. E. (1971): Factor Analysis as a Statistical Method, Second Edition, London Butterworths.*
7. *Muirhead, R. J. (1982): Aspects of Multivariate Statistical Theory, Wiley.*
8. *Rao, C. R. (1972): Linear Statistical inference and its Application, John Wiley*
9. *Srivastava, M. S. and Khatri, C. G. (1979): An introduction to Multivariate Statistics, North-Holland.*

Minor Papers (Credit:4each) (Theory 3 + Practical 1)(8papers)

Minor Elective Papers (Credit:4 each)

STSMIN1014: Descriptive Statistics

STSMIN2014: Probability and Probability Distribution

STSMIN3014: Basics of Statistical Inference and Finite Difference

STSMIN4014: Sample Surveys and Design of Experiments

STSMIN5014: Time series and demand Analysis

STSMIN6014: Vital Statistics and Index Numbers

STSMIN7014: Statistical Quality Control and Econometrics

STSMIN8014: Introduction to operation Research

STSMIN1014: Descriptive Statistics

Marks: 100 [In-Sem: 30 + End-Sem: 70 (Theory: 50 & Practical: 20)]

Objective:

- To give the basic concept of importance and limitation of statistics.
- To have an idea about the tabular and graphical presentation of data.
- To give an idea about the different measures of central tendency and dispersion.
- To give an idea about the relationship between the variables.

Learning Outcomes:

After completing this course, the students should have an idea about:

- Concepts of statistical population and sample.
- Diagrammatic and graphical representation of data.
- Measures of central tendency, Dispersion, Skewness, Kurtosis and moments.
- Correlation and regression.

Unit I: Statistical Data:

(Weightage: 10%) (Lectures: 10)

Concepts of statistical population and sample from a population, quantitative and qualitative data, nominal, ordinal and time-series data, discrete and continuous data. Methods of collecting primary data, designing a questionnaire and a schedule, different sources of collecting secondary data. Presentation of data by tables and by diagrams, Graphical representation of a frequency distribution by histogram and frequency polygon, cumulative frequency distributions (inclusive and exclusive methods).

Unit II: Measures of Central Tendency and Dispersion:

(Weightage: 20%) (Lectures: 15)

Mathematical and positional measures of central tendency.

Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation (absolute and relative measure) coefficient of variation, moments, measures of skewness and kurtosis.

Unit III: Bivariate data:

(Weightage: 15%) (Lectures: 15)

Definition, scatter diagram, Karl Pearson coefficient of correlation with properties, Lines of regression, Spearman's rank correlation coefficient, principle of least-square.

Unit IV: Theory of Attributes:

(Weightage: 5%) (Lectures: 5)

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

PRACTICAL/LABWORK:

(15 Lectures: 30 class)

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. Karl Pearson correlation coefficient.
7. Spearman rank correlation with and without ties.

8. Lines of regression, angle between lines and estimated values of variables.
9. Checking consistency of data and finding association among attributes.

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.
4. Gupta, S.C., Kapoor, V.K. (2006): Fundamentals of Mathematical Statistics, 11th Edn., (Reprint), Sultan Chand & Sons, Daryaganj, New Delhi.

STSMIN2014: Probability and Probability Distribution

Marks: 100 [In-Sem: 30 + End-Sem: 70 (Theory: 50 & Practical: 20)]

Objectives:

- To understand and use the terminology of probability.
- To know more about the addition and multiplicative rule of probability.
- To have the concept of inverse probability.
- To have an idea about the mathematical expectation of single random variable.
- To familiarize the students about different standard probability distribution for both discrete and continuous random variables.

Learning Outcomes:

After completing this course students would have :

- Able to determine whether the events are mutually exclusive and independent.
- Able to differentiate between discrete and continuous random variable.
- Knowledge of important discrete distributions such as Binomial, Poisson, Geometric, Negative Binomial and Hypergeometric.
- Knowledge of important continuous distributions such as Uniform, Normal, Exponential, Beta and Gamma and relations with some other distributions.

Unit-I: Probability:

(Weightage: 15%) (Lectures: 15)

Random experiment, sample point and sample space, event, algebra of events, Definition of Probability - classical, relative frequency and axiomatic approaches to probability. Addition theorem of probability. Theorem on conditional probability, independent events. Baye's theorem and its applications.

Unit-II: Random Variables:

(Weightage: 10%) (Lectures: 8)

Random variables: Discrete and continuous random variables, p.m.f., p.d.f. and c.d.f., illustrations of random variables and its properties, expectation and variance of random variable with their properties. Moments and moment generating function.

Unit-III: Convergence in Probability:

(Weightage: 10%) (Lectures: 7)

Statement and application of Chebychev's inequality, Weak Law of Large Numbers , Central limit theorem (CLT), Statement of De-Moivre Laplace and Lindeberg-Levy Central Limit Theorem.

Unit-IV: Standard Distributions:

(Weightage: 15%) (Lectures: 15)

Binomial, Poisson, Geometric, Negative binomial, Hypergeometric, Normal, Uniform, Exponential, Beta and Gama distributions.

PRACTICAL/LAB. WORK:

(15Lectures: 30 class)

List of Practical:

1. Fitting of binomial distributions for n and $p = q = \frac{1}{2}$ 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 λ
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

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
4. Gupta, S. C., Kapoor, V. K. (2006): Fundamentals of Mathematical Statistics, 11th Edn., (Reprint), Sultan Chand & Sons, Daryaganj, New Delhi.

STSMIN3014. Basics of Statistical Inference and Finite Difference

Marks: 100 [In-Sem: 30 + End-Sem: 70 (Theory: 50 & Practical: 20)]

Objective:

- To understand the process of hypothesis testing.
- To know more about categorical data.
- To have an idea about different non parametric tests.
- To have an idea about different methods of interpolation and numerical integration.

Learning Outcomes:

After completing this course, there should be a clear understanding of:

- Application of large and small sample tests.
- Basic concepts of hypothesis testing, including framing of null and alternative hypothesis.
- Knowledge of non parametric tests
- Clear concept of categorical data and its analysis.
- Application of different methods in interpolation technique.

Unit I: Tests of Hypothesis:

(Weightage: 15%) (Lectures: 15)

Testing of Hypothesis :Statistical Hypothesis, null and alternative hypotheses, simple and composite hypotheses, Level of significance.

,Testofstatisticalhypothesis,Criticalregion.Twotypesoferrors,powerofatest.Large sample test for testing single mean, difference between two means (application only). Small sample test for testing single mean, difference between two means (application only). F-test for testing equality of variance (only definition).

Unit II: Categorical Data Analysis:

(Weightage: 10%) (Lectures: 7)

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

Unit III: Non parametric Tests:

(Weightage: 10%) (Lectures: 8)

Tests for the significance of correlation coefficient, One sample and two sample sign test,Wald-Wolfowitzruntest,runtestforrandomness,MediantestandWilcoxon-Mann-Whitneytest(derivationnotrequired,givestresson examples).

Unit IV: Finite Difference:

(Weightage: 15%) (Lectures: 15)

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.

PRACTICAL/LABWORK:

(15Lectures: 30 class)

List of Practical

1. Large sample test for testing single mean.
2. Large sample test for testing difference between two means.
3. Small sample test for testing single mean.
4. Small sample test for testing difference between two means.
5. Chi-square test of proportions.

6. Chi-square tests of association.
7. Chi-square test of goodness-of-fit.
8. Test for correlation coefficient.
9. Sign test for median.
10. WilcoxonMann-Whitneytest.
11. Problem based on missing values.
12. Newton's Forward and Backward interpolation formula.
13. Divided Difference formula.
14. Lagrange's interpolation formula.
15. Problems based on Trapezoidal, Simpson's $1/3^{\text{rd}}$, $3/8^{\text{th}}$ rules.
16. Newton-Raphson method.

SUGGESTED READING:

1. Goon, A.M., Gupta M.K. & Das Gupta, Fundamentals of statistics, Vol.-I & II (2005).
2. Choudhury, L, Introduction to Statistics, Vol.-I & II
3. Agarwal, B.L., Basic Statistics, New Age International (P) Limited, Daryaganj, New Delhi (2009) (Re print).
4. Das, K.K. & Bhattacharjee, D., A Treatise on Statistical Inference and Distributions, Asian Books Pvt Ltd.
5. Gupta, S.C., Kapoor, V.K. (2006): Fundamentals of Mathematical Statistics, 11th Edn., (Reprint), Sultan Chand & Sons, Daryaganj, New Delhi.
6. Saxena, H.C., Finite Differences and Numerical Analysis, S. Chand & Company Ltd, Ram Nagar, New delhi.

STSMIN4014: Sample Surveys and Design of Experiments

Marks: 100 [In-Sem: 30 + End-Sem: 70 (Theory: 50 & Practical: 20)]

Objective:

- To obtain the maximum information about the population through sampling techniques.
- To design and conduct experiments.
- To analyze and interpret data.

Learning Outcomes:

After completing this course, there should be a clear understanding of:

- The basic concepts of complete enumeration, sample survey and related terminologies.
- Clear understanding of the fundamental concepts and principles used in design of experiments.
- The appropriate experimental designs to analyze the experimental data viz. Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD).

Unit I: Survey Sampling:

(Weightage: 8%) (Lectures: 8)

Concepts of population and sample. Complete enumeration vs. sampling. Need for sampling. Principal steps in a sample survey. Properties of a good estimator, Sampling and non-sampling errors, principles of sample survey, limitation of sampling, types of sampling.

Unit II: Simple Random Sampling (S.R.S):

(Weightage: 7%) (Lectures: 7)

Simple random sampling with and without replacement, merits and demerits of S.R.S., procedure of selecting a sample, estimates of population mean, population total. Determination of sample size, Simple Random Sampling of Attributes.

Unit III: Stratified Random Sampling and Systematic Sampling:(Weightage: 15%) (Lectures:15)

Advantages of stratified random sampling over simple random sampling. proportional and optimum allocations and their comparison with SRS. Systematic Sampling: Technique, estimates of population mean and total, variances of these estimates ($N=n \times k$). Comparison of systematic sampling with SRS.

Unit IV: Design of Experiments:

(Weightage: 20%) (Lectures: 15)

Analysis of variance in one-way and two-way classified data. Basic principles of Design of experiment, Completely Randomized Design (CRD): Layout and analysis, Randomized Block Design (RBD): Layout and analysis, RBD with one missing observation.

PRACTICAL/LAB. WORK:

(15 Lectures: 30 class)

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 a above two methods relative to SRS

5. Analysis of a CRD
6. Analysis of an RBD
7. Analysis of an RBD with one missing observation

SUGGESTED READING:

1. W.G.Cochran,*Sampling Techniques*, John Wiley and Sons, New York, 1997.
2. A.M.Goon, M.K.Gupta, and B.Dasgupta, *Fundamentals of Statistics* (Vol.II), 8th Ed., World Press, Kolkata, 2005.
3. A.M.Goon, M.K.Gupta and B.Dasgupta, *An Outline of Statistical Theory* (Vol.II), 3rd Ed., World Press, Kolkata, 2005.
4. S.C.Gupta and V.K.Kapoor, *Fundamentals of Applied Statistics*, 4th Ed., Sultan Chand and Sons, 2008.
5. A.M.Kshirsagar, *A Course in Linear Models*, Marcel Dekker, Inc., N.Y., 1983.
6. D.C.Montgomery, *Designs and Analysis of Experiments*, John Wiley and Sons, New York, 2001.
7. D.C.Montgomery, E.A.Peak and G.G.Vinning, *Introduction to Linear Regression Analysis*, 3rd Ed., John Wiley and Sons, 2006.
8. P.Mukhopadhyay, *Theory and Methods of Surveys Sampling*, Prentice Hall of India, 1998.
9. D.Singh and F.S.Chaudhary, *Theory and Analysis of Sample Survey Designs*, New Age International (P) Ltd., 1995.
10. P.V.Sukhatme, B.V.Sukhatme, S.Sukhatme and C.Ashok, *Sampling Theory of Surveys with Applications*, Iowa State University Press, Iowa, USA, 1984.
11. Das, M. N. & Giri, N. C.: Design and analysis of experiments. John Wiley.

STSMIN 5014: Time series and demand Analysis

Marks: 100 (In Sem: 30+ End 70 (Theory: 50 and practical: 20)

Objective:

1. To understand the different components and various methods of time series analysis.
- 2 To have a clear idea about demand analysis and income distribution.

Learning Outcomes:

After completion of this course, the students will know about

1. Computing and fitting trend by different methods.
2. Measurement of Seasonal Indices by various methods.
3. Calculation of price elasticity of demand and different income distributions.

Unit I: Introduction to Times Series

(Weightage: 15%) (Lecture: 15)

Introduction, Component of time series, Decomposition of time series- Additive and multiplicative model with their merits and demerits, Methods of measuring trend by graphical method, fitting of mathematical curve (least square method) , method of moving averages; uses of time series.

Unit: 2 Moving Averages

(Weightage: 8%) (Lecture : 8)

Measurement of Seasonal Fluctuations: Method of simple average, Ratio to trend method, Ratio to moving average Method, Link relative Method .

Unit: 3 Demand Analysis

(Weightage : 7%) (Lecture : 7)

Introduction, price elasticity of demand, types of data required for estimating Elasticities. Family Budget Data, Market Statistics or Time Series Data.

Unit : 4 Income Distribution

(Weightage: 20%) (Lecture: 15)

Engel's Law and Engel's curve, Pareto's Law of Income Distribution, Curve of Concentration – Lorenz curve and Gini coefficient Utility Function, Leontief's Method.

PRACTICAL/LAB. WORK:

(15 Lectures: 30 class)

List of Practical:

1. Fitting of trend line
2. Fitting of straight line by Least Square Method
3. Fitting of Parabola
4. Elimination of trend values.
5. Computation of 3-yearly, 4 yearly and 5 yearly moving averages.
6. Calculation of seasonal variation by Ratio to trend Method.
7. Calculation of seasonal variation by link relatives.
8. To find equilibrium price.
9. To find equilibrium quantities.
10. Time Path for equilibrium Price.

Suggested Readings:

1. Gupta, S.C. and Kapoor, V. K.: Fundamentals of Applied Statistics, Sultan Chand & Sons
2. Choudhury, L.: Introduction to statistics vol-II
3. Gun, A.M., Gupta, M.K. and Dasa Gupta, B.: Fundamentals of Statistics, volume-Two
4. Kendall, M.G. (1976). Time Series, Charles Griffin.

STSMIN 6014: Vital Statistics and Index Numbers

Marks: 100 (In Sem 30+ End Sem 70, (Theory 50 and practical 20)

Objective:

1. To learn basic measures of Mortality, Fertility and Population Growth.
2. To construct life table.
3. To have an idea about different measures of index numbers.

Learning Outcomes:

After completing this course, students should have developed a clear understanding of:

1. Basic measures of Mortality and fertility.
2. Concept of simple Life Table with its construction and uses.
3. Base shifting, splicing and deflating of Index numbers.

Unit I: Measurement of Mortality:

(Weightage: 10%) (Lecture:8)

Introduction, Uses of vital Statistics, Methods of obtaining Vital Statistics: Registration Method, Census Method, Rates and Ratios of vital events. Measurement of Mortality: crude Death Rate (CDR), Specific Death Rates (SDR), Age Specific Death Rate (A.S.D.R.) Standardized Death Rates, (Direct Method of Standardization, Indirect Standardisation).

Unit II: Measurement of Fertility:

(Weightage 15%) (Lecture:15)

Mortality Table or Life table, Stationary Population, Stable Population, Central Mortality Rate, Force of Mortality, Assumptions, Description and Construction of Life Table, uses of Life Table. Fertility, crude Birth Rate (C.B.R.) General Fertility Rate (G.F.R.) specific Fertility Rate (S.F.R.) Fertility Rate (T.F.R.), Gross Reproduction Rate (GRR). Net Reproduction Rate (NRR).

Unit III: Index Numbers:

(Weightage-15%) (Lecture:15)

Definition, Problems in the construction of Index Number, The Criteria of a Good Index Number, Construction of index numbers of prices and quantities, Chain Indices, Wholesale price Index number, Cost of Living index number.

Unit IV: Base shifting, Splicing and Deflating of index numbers: (Weightage-10%) (Lecture-7)

Base shifting, splicing of Two Index number, Series, Deflating the Index nos. Index of Industrial Production, Uses and limitations of Index numbers.

PRACTICAL/LAB. WORK:

(15 Lectures: 30 class)

List of Practical:

1. Computation of crude and standardized death rates.
2. Estimation of standardized death rates
3. Computation of standardised death rate by Direct and Indirect Methods.
4. Computation of different columns of a life table.
5. To calculate CBR, GFR, TFR, GRR, NRR, SRR
6. To calculate Laspeyer, Paache, Edgeworth Marshall and Fisher's Index no.
7. To construct the chain Indices.
8. To Calculate the CLIN.

Suggested Readings:

1. Gupta, S.C. and Kapoor, V. K.: Fundamentals of Applied Statistics, Sultan Chand & Sons
2. Choudhury, L.: Introduction to statistics vol-II
3. Gun, A.M., Gupta, M.K. and Dasa Gupta, B. (2008): Fundamentals of Statistics, volumeTwo, World Press
4. Mukhopadhyaya, P (1999) Applied Statistics Books and Allied (P) Ltd.
5. Croxton, Fridrick E, Cowden, Dudley J. and Klein, S (1973) : Applied Statistics, 3rd Edition, Prentice Hall of India Pvt. Ltd.
6. Keyfitz, Beekman John A: Demography through problems S Verlag New York.

STSMIN7014: Statistical Quality Control and Econometrics

Marks: 100 [In sem 30 + End sem 70 (Theory 50 and Practical 20)]

Objective:

1. To study different causes of variation and tools of Statistical Quality Control.
2. To study control chart for variables and attributes.
3. To study different sampling plan.
4. To study two variable linear regression model.

Learning Outcomes:

After completing this course, students should have developed a clear understanding of:

1. The concept and utility of SQC techniques.
2. Various charts for variables and attributes.
3. Understand single and double sampling inspection plans, OC and ASN functions and use and interpretation of Dodge and Romig's sampling inspection plan tables.

Unit I: Statistical Process Control

(Weightage: 10%) (Lecture -10)

Introduction, chance and assignable causes of variation, uses of S.Q.C., process and product control, control charts, 3σ control limits, tools for S.Q.C. Control charts for variations; X-bar and R charts.

Unit II: Control chart for attributes

(Weightage: 15%) (Lecture -10)

Control chart for attributes: np-chart, p-chart, c-chart and u-chart. Natural Tolerance limits and specification limits.

Unit III: Sampling Plan

(Weightage: 15%) (Lecture -15)

Acceptance sampling by Attributes, Acceptance Quality Level (A.Q.I), lot Tolerance proportion or present Defective (LTPD), process Average Fraction Defective (p), consumer risk, producers risk, Rectifying inspection plans, Average outgoing Quality limit (AOQL) O.C. curve, Average Sample Number (ASN) and Average Amount of Total inspection, Dodge and Roming Rectifying Sampling Insepection plans, single Sampling plan, Double sampling plan.

Unit IV: Econometrics

(Weightage: 10%) (Lecture -10)

Definition and scope, relation between variables, Linear model (two variables only), Estimation of regression parameters.

PRACTICAL/LAB. WORK:

(15 Lectures: 30 class)

List of Practical:

1. To construct a control chart for mean and range.
2. To calculate control limit for X and \bar{R} -chart.
3. To draw control chart for fraction defective.
4. To draw control chart for number of defects.
5. Construction and Interpretation of control chart

- x - bar & R chart
- x - bar & S - chart

- np – chart
 - p – chart
 - c – chart
 - u – chart
6. Single Inspection Plan; Construction and Interpretation of OC, AQL, LTPD, ASN, ATI, AOQ, AOQL curves.
 7. Two variable linear regression model

Suggested Readmgs

1. Gupta, S.C. and Kapoor, V. K.: Fundamentals of Applied Statistics, Sultan Chand & Sons
2. Gun, A.M., Gupta, M.K. and Dasa Gupta, B. (2008): Fundamentals of Statistics, volumeTwo, World Press
3. Muktopadhy, p (2011): Applied statistics, 2nd Edition revised reprint, Books Allied (P) Ltd.
4. Montogomery, D.C. (2009):Introduction to statistics Quality control, 6th Edition, Wiley India Pvt. Ltd.
5. Hoyle, Devid (1995):ISO Quality system Handbook, 2nd Edition, Butterworth Heinemann Publication.

STSMIN 8014: Introduction to operation Research

Marks: 100 (In Sem: 30+End Sem: 70) (Theory: 50 and Practical: 20)

Objective:

1. To have an idea about operation research.
2. To know the mathematical and graphical solution of Linear Programming Problem
3. To know different methods to solve transportation problem and game theory.

Learning Outcomes:

After completing this course, students should have developed a clear understanding of:

1. Different methods to solve LPP and transportation problem.
2. Problems based on minimax-maximin principle, using of dominance rule to solve rectangular game.

Unit I: Operation Research

(Weightage: 10%) (Lecture:8)

Introduction to Operation Research, Phases of O.R., Modeling in Operation Research, various types of O.R. Problems, Linear Programming problem, Mathematical formulation of the L.P.P, Graphical solution of L.P.P.

Unit II: Linear Programming Problem (L.P.P)

(Weightage: 15%) (Lecture: 15)

Simplex method, computational; producer of simplex method, Artificial variable and its uses in LPP, Two phase method of solving LPP, Big-M-Method for solving LPP. Outlines of simplex method for solving LPP: basic variable, basic solution, basic feasible solution.

Unit III: Transportation problem

(Weightage: 10%) (Lecture:7)

Initial solution by North West corner rule, Methods for initial Basic feasible solution, Lowest Cost Entry (Matrix Minima) Method, Vogel's approximation Method.

Unit IV: Game theory

(Weightage: 15%) (Lecture:15)

Rectangular game, minimax-maximin principle, solution to rectangular game using graphical method, dominance property to reduce the game matrix and solution to rectangular game with mixed strategy.

PRACTICAL/LAB. WORK:

(15 Lectures: 30 class)

List of Practical:

1. Mathematical formulation of LPP and solving the problem using graphical method.
2. Simplex method technique to solve LPP and reading dual solution from the optimal table.
3. Charne's Big M – method involving artificial variables.
4. Identifying special cases: Degenerate solution, Unbounded solution, Alternative solution and infeasible solution by graphical method and interpretation.
5. Allocation problem using transportation model.
6. Allocation problem using Assignment model.
7. Networking shortest route problem.
8. Problem based on game matrices: $m \times n$ rectangular and mixed strategy

Suggested Readings:

1. Sharma, S.D.: Operation Research, Kedar Nath, Ram Nath & Co.
2. Kanti, S., Gupta, P.K. and Manmohan (2007): Operation Research, 13th Edition, Sultan Chand and sons.
3. Taha, H.A. (2007): Operation Research : An Introduction, 8th Edition, Prentice Hall of India.
4. Ravindram, A, Philips D.T. Solberg j.j. (2005): Operation Research, principles and practice, John Wiley & Sons.

IDC Papers (Credit: 3each) (Theory 2 + Practical 1) (3papers)

IDC Papers (Credit: 3each)

STS IDC1013: Descriptive Statistics

STS IDC2013: Probability and Probability Distribution

STS IDC3013: Applied Statistics and Test of Significance

STS IDC1013: Descriptive Statistics

Marks: 50 [End-Sem: 50 (Theory: 30 & Practical: 20)]

Objective:

- To give the basic concept of importance and limitation of statistics.
- To give an idea about the preparation of good questionnaire for the collection of data.
- To have an idea about the tabular and graphical presentation of data.
- To give an idea about the different measures of central tendency and dispersion.
- To know the use of weighted and unweighted index number in different time periods.

Learning Outcomes:

After completing this course, the students should have an idea about:

- Concepts of statistical population and sample.
- Diagrammatic and graphical representation of data.
- Measures of central tendency, Dispersion, Skewness, Kurtosis.

Unit I: Statistical Data:

(Weightage: 5%) (Lectures: 5)

Meaning of Statistics, Scope and limitation of Statistics, Idea of statistical population and sample, Different types of data: primary and secondary data and methods of collecting primary data, designing a questionnaire and a schedule, different sources of collecting secondary data.

Unit II: Presentation of data:

(Weightage: 7%) (Lectures: 7)

Frequency distribution for discrete and continuous data, Presentation of data by tables and diagrams, Graphical representation of a frequency distribution by histogram and frequency polygon, cumulative frequency distributions (inclusive and exclusive methods).

Unit III: Measures of Central Tendency and Dispersion:

(Weightage: 10%) (Lectures: 10)

Mathematical Measure: mean, median, mode. Graphical location of median and mode, Relation between mean, median and mode, Range, quartile deviation, mean deviation, standard deviation (only absolute measure) coefficient of variation, idea of skewness and kurtosis.

UNITIV: Index Numbers:

(Weightage: 8%) (Lectures: 8)

Definition, Index number as economic barometer, problems in the construction of index numbers, uses of index number, weighted and unweighted index numbers including Laspeyre's, Paasche's, Edgeworth-Marshall and Fisher's, Various tests of index numbers (Time and Factor Reversal test).

PRACTICAL/LABWORK:

(15 Lectures: 30 class)

List of Practical

10. Graphical representation of data
11. Construction of frequency distribution table
12. Problems based on mean, median and mode
13. Graphical location of median and mode
14. Problems based on the relation between mean, median and mode
15. Problems based on measures of dispersion
16. Problems based on combined mean and variance and coefficient of variation.
17. Problems based on price and quantity index number using Laspeyre's, Paasche's, Edgeworth-Marshall and Fisher's formula.
18. Problems based on time and factor reversal test.

SUGGESTED READING:

5. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.
6. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
7. 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.
8. Gupta, S.C., Kapoor, V.K. (2006): Fundamentals of Mathematical Statistics, 11th Edn., (Reprint), Sultan Chand & Sons, Daryaganj, New Delhi.

STS IDC2013: Probability and Probability Distribution (Credit3)

Marks: 50 [End-Sem: 50 (Theory: 30 & Practical: 20)]

Objective:

- To have an idea about addition and multiplicative theorem of probability.
- To know more about random variables
- To have an idea about the mathematical expectation with single random variable
- To familiarize the students about different standard probability distribution for both discrete and continuous random variables.

Learning Outcomes:

After completing this course students would have :

- Knowledge of important discrete distributions such as Binomial, Poisson and continuous distributions such as Normal.
- Clear idea of probability along with random variable and mathematical expectation.

UNIT I: Probability:

(Weightage: 8%) (Lecture: 8)

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

UNIT II: Random Variable

(Weightage: 7%) (Lecture: 5)

Discrete and Continuous random variable, p.m.f, p.d.f., and c.d.f., illustrations and properties.

UNIT III: Mathematical Expectation

(Weightage: 8%) (Lecture: 7)

Addition and multiplication rule of mathematical expectation (Statement only). Properties of mathematical expectation, mean and variance of mathematical expectation.

UNIT IV: Discrete and Continuous Probability Distribution (Weightage: 7%) (Lecture: 10)

Binomial, Poisson and Normal distribution.

PRACTICAL/LABWORK:

(15 Lectures: 30 class)

List of Practical

1. Fitting of binomial distributions for n and $p = q = 1/2$.
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 λ .
5. Application problems based on binomial distribution.
6. Application problems based on Poisson distribution.
7. Fitting of normal distribution when parameters are given.
8. Fitting of normal distribution when parameters are not given.

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. Gupta, S.C., Kapoor, V.K. (2006): Fundamentals of Mathematical Statistics, 11th Edn., (Reprint), Sultan Chand & Sons, Daryaganj, New Delhi.
3. Myer, P.L. (1970): Introductory Probability and Statistical Applications, Oxford & IBHP Publishing, New Delhi

IDC3013: Applied Statistics & Tests of Significance (Credit 3)

Marks: 50 [End-Sem: 50 (Theory: 30 & Practical: 20)]

Objective:

- To study demand function and consumption, elasticity of demand and income distribution.
- To know more about categorical data.
- To have the idea about large and small sample.
- To have the idea about large and small sample tests.

Learning Outcomes:

After completing this course students would have:

- Clear understanding of different index numbers like chain index number, consumer price index number.
- Clear concept of use of different laws of income distribution.
- Have the idea of association of attributes.
- Knowledge of use of large and small sample tests.
- Knowledge of use of chi-square distribution for the goodness of fit.

UNIT I : Bivariate Data:

(Weightage: 8%) (Lectures: 7)

Definition, scatter diagram, Karl Pearson coefficient of correlation with properties, rank correlation with repeated rank, Simple linear regression with properties, lines of regression, idea of principle of least squares.

UNIT II: Time Series:

(Weightage: 5%) (Lectures: 7)

Definition, Components of time series with their merits and demerits and related examples, Models used in time series, uses of time series, Measurement of trend.

UNIT III: Vital statistics:

(Weightage: 9%) (Lectures: 8)

Different sources of vital statistics data, Death rates (Crude Death Rate, Specific Death Rate, Standardised Death Rate) with their merits and demerits. Birth rates (Crude Birth Rate, general Fertility Rate, Age Specific Fertility Rate, Total fertility Rate), Gross reproduction Rate, Net Reproduction Rate.

UNIT IV: Testing of Hypothesis:

(Weightage: 8%) (Lectures: 8)

Idea of population and sample, Statistical Hypothesis, null and alternative hypotheses, Level of significance, Large sample test for testing single mean, difference between two means (application only), Small sample test for testing single mean, difference between two means, Chi-square test for goodness of fit (application only).

PRACTICAL/LABWORK:

(15 Lectures: 30 class)

List of Practical

1. Karl Pearson correlation coefficient.
2. Spearman rank correlation with and without ties.
3. Lines of regression.
4. Fitting of trend line.
5. Problems based on semi-average method.
6. Problems based on 3 yearly and 4 yearly moving average methods.
7. Fitting of straight line by Least Square Method.
8. Crude Death Rate, Specific Death Rate, Standardised Death Rate.
9. Crude Birth Rate, general Fertility Rate, Age Specific Fertility Rate, Total fertility Rate.

10. Gross reproduction Rate, Net Reproduction Rate.
11. Large sample test for testing single mean.
12. Large sample test for testing difference between two means.
13. Small sample test for testing single mean.
14. Small sample test for testing difference between two means.
15. Chi-square test of goodness-of-fit.

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. 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.
3. Gupta, S.C., Kapoor, V.K. (2006): Fundamentals of Mathematical Statistics, 11th Edn., (Reprint), Sultan Chand & Sons, Daryaganj, New Delhi.
4. Gupta, S.C. and Kapoor, V.K. (2011): Fundamentals of Applied Statistics, 4th Edn., (Reprint), Sultan Chand & Sons, New Delhi.

SEC Papers Credit: 3 each (Practical only) (3 papers)

STSSEC1013-Statistical Data Analysis Using Excel (Credit3)

STSSEC2013: Statistical Data Analysis Using R (Credit 3)

STSSEC3013- Statistical Data Analysis Using SPSS (Credit3)

STSSEC1013-Statistical-Data Analysis Using Excel (Credit3)

Marks: 50 [In-Sem: 10 + End-Sem: 40 (Practical)]

Total Lecture: 90

Objectives:

- *To get idea about Microsoft Excel software.*
- *To understand basic statistical calculation using Excel.*
- *To help graphical interpretation of statistical data using Excel.*

Learning Outcomes:

After completion of the course, students will be able to:

- *How to enter data in Excel.*
- *Import and export data files.*
- *Plot graphs and charts of statistical data in Excel.*
- *To generate different statistical applications and tests in Excel.*

UNITI:

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

UNITII:

Measures of central tendency and dispersion, correlation and lines of regression.

UNITIII:

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

UNITIV:

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. Microsoft Excel Manual: University of Mary Washington (Version 1)

STSSEC2013: Statistical Data Analysis Using R (Credit 3)

Marks: 50 [In-Sem: 10 + End-Sem: 40 (Practical)]

Total Lecture: 90

Objectives:

- *To do statistical computing with the help of free software 'R'.*
- *To help graphical interpretation of statistical data using 'R'.*
- *To know how to explore and plot data for performing statistical test.*

Learning Outcome: *Students will able to learn*

- *R syntax*
- *Plot graphs and charts in R*
- *To generate different statistical applications and tests in R*

UNIT I:

Introduction to R and R studio, Reading and getting data in R, how to include excel data in R programming, plot a graph viz. histograms (equal class intervals and unequal class intervals), boxplot, stem-leaf, frequency polygon, pie chart, ogives with graphical summaries of data.

UNIT II:

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

UNIT III:

Random number generation and sampling procedures, fitting of exponential Curves, Application problems Based on fitting Of Suitable distribution, Normal probability plot.

UNIT IV:

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:

Gardener, M (2012) *Beginning R: The Statistical Programming Language*, Wiley Publications.

Braun WJ, Murdoch DJ (2007): *A First Course in Statistical Programming with R*. Cambridge University Press. New York.

STSSEC3013- Statistical Data Analysis Using SPSS(Credit3)

Marks: 50 [In-Sem: 10 + End-Sem: 40 (Practical)]

Total Lecture: 90

Objectives:

- *To give an idea about the windows of 'SPSS' software.*
- *To do statistical computing with the help of free software 'SPSS'.*
- *To know how to import data in SPSS from Excel sheet.*
- *To help graphical interpretation and statistical test of statistical data using 'SPSS'.*

Learning Outcomes:

After completion of the course, students will be able to:

- *How to enter data in SPSS.*
- *Import and export data files in SPSS.*
- *Plot graphs and charts of statistical data in SPSS.*
- *To generate different statistical applications and tests in SPSS.*

UNITI:

Idea of categorical and nominal data, different parts of variable view, learn how to load data, plot a graph viz. histograms (equal class intervals and unequal class intervals), boxplot, stem-leaf, frequency polygon, pie chart, ogives with graphical summaries of data.

UNITII:

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

UNITIII:

Random number generation and sampling procedures, Fitting of polynomial and exponential curves.

UNITIV:

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
