Choice Based Credit System (CBCS)

NOWGONG COLLEGE

(AUTONOMOUS)

SYLLABUS

DEPARTMENT OF STATISTICS

Learning Outcomes-based Curriculum Framework (LOCF)

of

Undergraduate Programme

BACHELOR OF SCIENCE (HONOURS)/ARTS (REGULAR) IN STATISTICS

(Effective from Academic Year 2020-21)

Syllabus as approved by Academic Council, NC(A)

1. Introduction to Programme

B.Sc. (Honours) Statistics is a three-year undergraduate program with specialization in Statistics. The programme fosters interdisciplinary approach to the study of Statistics, Mathematics and Computers aiming to promote holistic education useful in handling social, economics, engineering, physical and bio-sciences problems. The curriculum is dispensed using a combination of classroom teaching, project-based learning, practical's, group discussions, presentations, home assignments, industry interactions and exposure, internships and fieldwork.

2. Programme Structure

The B.Sc. (Honours) Statistics is a three year programme divided into six semesters. A student is required to complete 148 credits for the completion of programme and the award of degree.

Alignment with CBCS, the B.Sc. (Honours) Statistics programme is aligned with CBCS structure as given in following Table

Course		Credits					
		Theory with Practical			Theory without Practical		
		Theory	Practical	Total	Theory	Tutorial	Total
Core Course (14 Papers)		14x4=56	14x2=28	84	14x5=70	14x1=14	84
Discipline Specific Elective Course (4 Papers)		4x4=16	4x2=8	24	4x5=20	4x1=4	24
Generic Elective Course (4 Papers)		4x4=16	4x2=8	24	4x5=20	4x1=4	24
Ability Enhancement Course	English/MIL Communication	1x4=4	0	4	1x4=4	0	4
	Environmental Science	1x4=4	0	4	1x4=4	0	4
Skill Enhancement Course (2 Papers)		2x2=4	2x2=4	8	2x4=8	0	8
Total		100	48	148	126	22	148

3. Details of the Programme

Core Papers (Credits: 6 each) (14 papers)

STAT-HCC-1016 Descriptive Statistics & Index Number (Theory+ Practical)
STAT-HCC-1026 Calculus (Theory+ Tutorial)
STAT-HCC-2016 Probability and Probability Distributions (Theory+ Practical)
STAT-HCC-2026 Mathematical Methods in Statistics (Theory+ Practical)
STAT-HCC-3016 Sampling Distributions (Theory+ Practical)
STAT-HCC-3026 Survey Sampling and Indian Official Statistics (Theory+ Practical)
STAT-HCC-3036 Mathematical Analysis (Theory+ Practical)
STAT-HCC-4016 Statistical Inference (Theory+ Practical)
STAT-HCC-4026 Linear Models (Theory+ Practical)
STAT-HCC-4036 Statistical Quality Control (Theory+ Practical)
STAT-HCC-5016 Stochastic Processes and Queuing Theory (Theory+ Practical)
STAT-HCC-5026 Statistical Computing Using C/C++ Programming (Theory+ Practical)
STAT-HCC-6016 Design of Experiments (Theory+ Practical)
STAT-HCC-6026 Multivariate Analysis and Nonparametric Methods (Theory+ Practical)

Discipline Specific Elective Papers (Credits: 6 each)

STAT-HDS-5016 Operations Research (Theory+ Practical)
STAT-HDS-5026 Demography and Vital Statistics (Theory+ Practical)

STAT-HDS-6016 Time Series Analysis (Theory+ Practical)
STAT-HDS-6026 Dissertation/Project Work

Skill Enhancement Courses (Credits: 4 each) (2 papers to be selected)
XXXX-SEC-3014
XXXX-SEC-4014
Generic Elective Papers (HGE) (Credits: 6 each) (to be offered to other Departments/Disciplines)
STAT-HGE-1016 Statistical Methods
STAT-HGE-2016 Introductory Probability
STAT-HGE-3016 Basics of Statistical Inference
STAT-HGE-4016 Applied Statistics

Note:

1. Each practical will carry 20 marks including 15 marks for continuous evaluation and 3 marks for practical note book and 2 marks for the oral test.
2. In each semester conduct at least 50% of the practicals using (MS Excel / SPSS / R / PYTHON).
3. At least three questions of 5 marks each have to be compulsorily attempted in the final practical examination.
4. Hardcopy of practical file has to be maintained by the students for each practical paper.

5. Semester-wise Distribution of Courses

SEM	Credit					
	Core Course	AEC	SEC	HDS	HGE	Total
I	STAT-HCC-1016(L+P) STAT-HCC-1026(L+T)	ENGL-AEC-1014(L)			STAT-HGE-1016(L+P)	22
	4+2=6 5+1=6	4			4+2=6	
II	STAT-HCC-2016(L+P) STAT-HCC-2026(L+P)	ENST-AEC-2014(L)			STAT-HGE-2016(L+P)	22
	4+2=6 4+2=6	4			4+2=6	
III	STAT-HCC-3016(L+P) STAT-HCC-3026(L+P) STAT-HCC-3036(L+P)		STAT-SEC-3014		STAT-HGE-3016(L+P)	28
	4+2=6		4		4+2=6	

	4+2=6 4+2=6					
IV	STAT-HCC-4016(L+P) STAT-HCC-4026(L+P) STAT-HCC-4036(L+P)		STAT-SEC-4014		STAT-HGE-4016(L+P)	28
	4+2=6 4+2=6 4+2=6		4		4+2=6	
V	STAT-HCC-5016(L+P) STAT-HCC-5026(L+P)			STAT-HDS 5016(L+P) STAT-HDS-5026(L+P)		24
	4+2=6 4+2=6			4+2=6 4+2=6		
VI	STAT-HCC-6016(L+P) STAT-HCC-6026(L+P)			STAT-HDS-6016(L+P) STAT-HDS-6026(L+P)		24
	4+2=6 4+2=6			4+2=6 4+2=6		
Total						148

6. Learning Outcome Based Approach

B.Sc. (Honours) Statistics programme is designed in such a way that students will be exposed to the real world data related to industries and society, identifying the problems and working towards their solutions through various analytical and statistical techniques. The course is designed in such a way that students can absorb strong foundation of statistics.

7. Graduate Attributes

On completion of the programme students are expected to have acquired the skills of effective communication, critical thinking, social research methods and social outreach. The attributes expected from the graduates of B.Sc. (Honours) Statistics are:

i. A holistic knowledge and understanding of basic concepts in statistics and its application with art, science, commerce and technology.
ii. The capacity to identify, understand and solve the problems of society.
iii. Team building and leadership skills, communication, creative and critical thinking skills, and innovative problem solving skills.
iv. To enable the students to understand basic concepts and aspects related to research, various techniques to collect the data to analyse the data and interpret the results thereafter.
vi. Learning the basic programming languages and statistical software will help students to easily switch over to any other statistical software in future.

8. Programme Objectives

i. To imbibe strong foundation of statistics in students.
ii. To make acquainted students with basic to high-level statistical concepts.
iii. To update students with mathematical tools that aid in statistical theory.
iv. To teach/strengthen students' knowledge of spreadsheets, programming languages and statistical packages.
v. To promote application-oriented pedagogy by exposing students to real world data.
vi. To make students do projects, which prepares them for jobs/markets?

9. Programme Learning Outcomes

This program exposes students to the beautiful world of statistics and how it affects all aspects of our daily lives. This course aims to provide students with all major statistics concepts and the tools necessary to implement them. The introduction of computer software helps them analyze data optimizing the use of time and resources. These softwares provide the necessary support and advantages for their careers. Exposure to a large amount of real-life data helps improve your analytical skills. Each job is practical, which will stimulate your exploration and hone your acting skills. To a large extent, this teaching method provides them with the motivation and confidence to start working as a consultant in the near future. The course structure also motivates / assists students to pursue careers in related disciplines, especially data science, financial statistics, and actuarial science.

10. Teaching Learning Process

The Department of Statistics at Nowgong College (Autonomous) is primarily responsible for organizing the Bachelor of Science course (Honours) Statistics. Tutorial and practice related instructions are provided by the respective registering units under the general guidance of Department of Statistics of Nowgong College (Autonomous).

There shall be 90 instructional days excluding examination in a semester.

11. Teaching Pedagogy

Teaching Pedagogy involves classroom interaction, discussion, lectures, course-based practical work, classroom tests, and assignments. Section 13 "Promoting the achievement of course learning outcomes" describes each course in the course in detail.

12. Assessment Methods/Evaluation Scheme

The students registered for B.Sc. (Honours) Statistics programme will study semester I to VI at the Nowgong College (Autonomous).

During these semesters Core, AEC, HDS and SEC courses are offered.

(i) English shall be the medium of instruction and examination.

(ii) Examinations shall be conducted at the end of each Semester as per the Academic calendar notified by the Nowgong College (Autonomous).

(iii) The assessment broadly comprises of internal assessment and end semester examination. Each paper will be of 100 marks with 20% marks for internal assessment and 60% marks for theory end semester examination and 20% marks for practical paper end semester examination. Skill enhancement paper will be examined out of 100 marks (Theory + Practical/Presentation as applicable).

Core Papers in Statistics

B.Sc. (Honours) in Statistics

SEMESTER-I

PAPER CODE: STAT-HCC-1016

(Descriptive Statistics & Index Number)

Credits: 6 (Lecture-60, Practical-30) **Marks: 100 (T60+IA20+P20)**

Course Objectives:

The learning objectives include:

To summarize the data and to obtain its salient features from the vast mass of original data.

To understand the concept of attributes.

To understand the concept of index number.

Course Learning Outcomes:

After completing this course, the students should have developed a clear understanding of:Concepts of statistical population and sample, variables and attributes. Tabular and graphical representation of data based on variables.'Conditions for the consistency' and criteria for the independence of data based on attributes.Measures of central tendency, Dispersion, Skewness and Kurtosis. Moments and their use in studying various characteristics of data. Index number and its construction. Different methods of index number.

Contents:

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

SUGGESTED READING:

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

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

3. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co. Ltd.

PRACTICAL/LAB. WORK:

List of Practical

1. Graphical representation of data.

2. Problems based on measures of central tendency.

3. Problems based on measures of dispersion.

4. Problems based on combined mean and variance and coefficient of variation.

5. Problems based on moments, skewness and kurtosis.

6. Fitting of polynomials, exponential curves.

7. Karl Pearson correlation co-efficient.

8. Correlation coefficient for a bi-variate frequency distribution.

9. Lines of regression, angle between lines and estimated values of variables.

10. Spearman rank correlation with and without ties.

11. Partial and multiple correlations.

12. Planes of regression and variances of residuals for given simple correlations.

13. Planes of regression and variances of residuals for raw data.

14. Calculate price and quantity index numbers using simple and weighted average of price relatives

15. To calculate the Chain Base index numbers.

16. To calculate consumer price index number.

PAPER CODE: STAT-HCC-1026

(Calculus)

Credits: 6(Lecture-75, Tutorial-15) **Marks: 100 (T60+IA20+P20)**

Course Objectives:

The learning objectives include:

Fundamentals of differential calculus/Integral calculus/Differential Equation/Partial differential equation.

To analyse the problem and its solution.

Course Learning Outcomes:

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

The fundamental concepts of Differential calculus. Solving complicated integrals.

Finding complete Solution of differential equations and partial differential equation.

Contents:

UNIT I

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

UNIT II

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

UNIT III

Differential Equations: 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.

UNIT IV

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

SUGGESTED READINGS:

1. Gorakh Prasad: Differential Calculus, PothishalaPvt. Ltd., Allahabad (14th Edition - 1997).

2. Gorakh Prasad: Integral Calculus, PothishalaPvt. Ltd., Allahabad (14th Edition -2000).

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

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

PRACTICAL/LAB. WORK:

List of Practical

1. Practical based on double integral.
2. Practical based on change of order of integration.
3. Practical based on Exact differential equations.
4. Practical based on Clairaut's equations.
5. Practical based on Linear differential equations of order n.
6. Practical based on Homogeneous linear differential equations of order n with constant coefficients.
7. Practical based on Non-homogeneous linear differential equations of order n with constant coefficients.
8. Practical based on Linear partial differential equations of first order.

SEMESTER-II

PAPER CODE: STAT-HCC-2016

(Probability and Probability Distributions)

Credits: 6(Lecture-60, Practical-30) **Marks: 100 (T60+IA20+P20)**

Course Objectives:

The learning objectives include:

To understand the concepts of probability and its applications.

To understand the concept of random variables, probability distributions and expectation.

Different approaches to the theory of probability.

Important theorems on probability and their use in solving problems. Concept of random variables and its probability distributions.

Concept of joint, marginal and conditional probability distribution for two dimensional random variables and their independence.

Univariate transformation and expectation of random variables.

Course Learning Outcomes:

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

The fundamental concept of expectation for univariate and bivariate random variables with their distributions and properties.Moment generating function, cumulant generating function and characteristic function. Discrete probability distributions with their properties.Continuous probability distributions with their properties.

Contents:

UNIT I

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

UNIT II

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

UNIT III

Mathematical Expectation and Generating Functions: Expectation of single and bivariate random variables and its properties. Moments and Cumulants, probability generating function, moment generating function, cumulant generating function and characteristic function. Uniqueness and inversion theorems (without proof) along with applications. Conditional expectations.

UNIT IV

Discrete probability distributions: Uniform, Binomial, Poisson, geometric, Negative Binomial, Hyper-geometric distributions along with their characteristics, properties and limiting/approximation cases.

Continuous probability distributions: Normal, Exponential, Uniform, Cauchy, Beta, Gamma, Lognormal and Laplace distributions along with their characteristics, properties and limiting/approximation cases.

SUGGESTED READING:

1. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009): Probability and Statistical Inference, Seventh Ed, Pearson Education, New Delhi.

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

3. Myer, P.L. (1970): Introductory Probability and Statistical Applications, Oxford & IBH Publishing, New Delhi

PRACTICAL/LAB. WORK:

List of Practical

1. Problem based on Bayes' theorem

2**.** Fitting of binomial distributions for n and p = q = ½.

3. Fitting of binomial distributions for given n and p.

4. Fitting of binomial distributions after computing mean and variance**.**

5. Fitting of Poisson distributions for given value of lambda.

6. Fitting of Poisson distributions after computing mean.

7. Fitting of negative binomial.

8. Application problems based on binomial distribution.

9. Application problems based on Poisson distribution.

10. Application problems based on negative binomial distribution.

11. Problems based on area property of normal distribution.

12. To find the ordinate for a given area for normal distribution.

13. Application based problems using normal distribution.

14. Fitting of normal distribution when parameters are given.

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

PAPER CODE: STAT -HCC- 2026

(Mathematical Methods in Statistics)

Credits: 6(Lecture-60, Practical-30) **Marks: 100 (T60+IA20+P20)**

Course Objectives:

The learning objectives include:

Algebra serves as a building block that will enable students to learn more advanced

techniques that will help them to solve problems more quickly and easily.

Course Learning Outcomes:

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

Theory of Equations, The fundamental concepts of matrices and determinants Echelon form,

Linear equations, Rank of a Matrix, Characteristic roots and vectors Quadratic forms,

Partitioning of matrices, Generalized inverse

Contents:

UNIT I

Theory of equations, 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.

UNIT II

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

UNIT III

Determinants of Matrices: 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. 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.

UNIT IV

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.

SUGGESTED READINGS:

1. Lay David C.: Linear Algebra and its Applications, Addison Wesley, 2000.

2. Schaum's Outlines : Linear Algebra, Tata McGraw-Hill Edition, 3rdEdition, 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 Algrbra. Narosa Publishing House (Reprint), 2002.

10. Searle S.R.: Matrix Algebra Useful for Statistics. John Wiley &Sons., 1982.

PRACTICAL/LAB. WORK:

List of Practical

1. Finding inverse using Cayley Hamilton theorem.
2. For a real Skew Symmetric matrix S, show that matrix A defined by (I-S) (I+S)-1 is an orthogonal matrix.
3. Reducing a Quadratic Form to its canonical form and finding its rank and index.
4. Proving that a quadratic form is positive or negative definite.
5. Finding the product of two matrices by considering partitioned matrices.
6. Finding inverse of a matrix by partitioning.
7. Finding Generalized Inverse of a matrix and symmetric generalized inverse of a matrix\
8. To show that matrix A defined as $A= (In - X (X'X)^{-1}X')$ is idempotent. Also, determine its rank and characteristic root. Repeat the process by finding a generalized inverse of X'X if inverse does not exist.
9. Find XGX' for any X of order nxk, where G is generalized inverse and show that XGX' is invariant with respect to G.
10. To find whether a given set of vectors is linearly dependent or linearly independent.
11. Constructing an Orthonormal Basis using Gram Schmidt Orthogonalization Process.

SEMESTER-III

PAPER CODE: STAT-HCC-3016

(Sampling Distributions)

Credits: 6(Lecture-60, Practical-30) **Marks: 100 (T60+IA20+P20)**

Course Objectives:

The learning objectives include:

To understand the concept of sampling distributions and their applications in statistical inference.

To understand the process of hypothesis testing.

To have a clear understanding of when to apply various tests of hypothesis about population parameters using sample statistics and draw appropriate conclusions from the analysis.

Course Learning Outcomes:

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

Laws of convergence, their inter relations and applications. Central Limit Theorem and its applications. Order statistics and distribution of sample median and range. Basic concepts of hypothesis testing, including framing of null and alternative hypothesis. Hypothesis testing based on a single sample and two samples using both classical and p value approach. Chi square distribution. Analyze categorical data by using Chi square techniques. t and F distributions and their applications.

Contents:

UNIT I

Limit laws: convergence in probability, almost sure convergence, convergence in mean square and convergence in distribution and their inter relations, Chebyshev's inequality, W.L.L.N., S.L.L.N. and their applications, De-Moivre Laplace theorem, Central Limit Theorem (C.L.T.) for i.i.d. variates, applications of C.L.T. and Liapunov Theorem (without proof).

Order Statistics: 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 II

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

UNIT III

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

UNIT IV

Exact sampling distributions: Student's and Fishers t-distribution, Derivation of its p.d.f., nature of probability curve with different degrees of freedom, mean, variance, moments and limiting form of t distribution. Derivation of distribution of sample correlation coefficient when population correlation coefficient is zero (Sawkin's Methods).Snedecore's F-distribution: Derivation of p.d.f., nature of p.d.f. curve with different degrees of freedom, mean, variance and mode. Distribution of 1/F(n1,n2). Relationship between t, F and χ^2 distributions. Test of significance and confidence Intervals based on t and F distributions.

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. 2ndEdn. (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.

PRACTICAL/LAB. WORK:

List of Practical

1. Testing of significance and confidence intervals for single proportion and difference of two proportions

2. Testing of significance and confidence intervals for single mean and difference of two means and paired tests.

3. Testing of significance and confidence intervals for difference of two standard deviations.

4. Exact Sample Tests based on Chi-Square Distribution.

5. Testing if the population variance has a specific value and its confidence intervals.

6. Testing of goodness of fit.

7. Testing of independence of attributes.

8. Testing based on 2 X 2 contingency table without and with Yates' corrections.

9. Testing of significance and confidence intervals of an observed sample correlation coefficient.

10. Testing and confidence intervals of equality of two population variances

PAPER CODE: STAT-HCC-3026

(Survey Sampling and Indian Official Statistics)

Credits: 6 (Lecture-60, Practical-30) **Marks: 100 (T60+IA20+P20)**

Course Objectives:

The learning objectives include:

To provide tools and techniques for selecting a sample of elements from a target population keeping in mind the objectives to be fulfilled and nature of population.

To obtain estimator of the population parameter on the basis of selected sample and study its properties.

Course Learning Outcomes:

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

The fundamental concepts of population and sample. (or the basic concepts of survey)
The principles of sample survey and the steps involved in selecting a sample.

Simple Random Sampling. Stratified Sampling. Systematic Sampling. Ratio and Regression Methods of Estimation. Cluster Sampling (equal size clusters).Sub Sampling. Indian Official Statistics.

Contents:

UNIT I

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. 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.

UNIT II

Systematic Sampling: Technique, estimates of population mean and total, variances of these estimates (N=nxk) and its efficiency. Comparison of systematic sampling with SRS and stratified sampling in the presence of linear trend and corrections. Cluster sampling (equal clusters only) estimation of population mean and its variance. Two stage sampling and calculation of its mean and variance. Idea of sub sampling.

UNIT III

Introduction to Ratio and regression methods of estimation involving one or more auxiliary variables, first approximation to the population mean and total (for SRS of large size). Probability proportional to size sampling with and without replacement, the Hansen-Hurwitz and the Horvitz Thompson estimators, non-negative variance estimation with reference to the Horvitz-Thompson estimator.

UNIT IV

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.

SUGGESTED READING:

1. Cochran W.G. (1984): Sampling Techniques(3rd Ed.), Wiley Eastern.

2. Sukhatme,P.V., Sukhatme, B.V. Sukhatme,S. Asok,C.(1984). Sampling Theories of Survey With Application, IOWA State University Press and Indian Society of Agricultural Statistics

3. Murthy M.N. (1977): Sampling Theory & Statistical Methods, Statistical Pub. Society, Calcutta.

4. Des Raj and Chandhok, P. (1998): Sample Survey Theory, Narosa Publishing House.

5. Goon A.M., Gupta M.K. and Dasgupta, B. (2001): Fundamentals of Statistics (Vol.2), World Press.

6. Guide to current Indian Official Statistics, Central Statistical Office, GOI, New Delhi.

7. http://mospi.nic.in/

PRACTICAL/LAB. WORK:

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. Cluster sampling: estimation of mean or total, variance of the estimate, estimate of intra-class correlation coefficient, efficiency as compared to SRS.

8. 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.

9. Calculate the mean, variance of PPS sampling.

PAPER CODE: STAT-HCC-3036

(Mathematical Analysis)

Credits: 6 (Lecture-60, Practical-30) **Marks: 100 (T60+IA20+P20)**

Course Objectives:

The learning objectives include:

To study the Real Analysis, this deals with the analytical properties of real functions and sequences.

To study the Numerical Analysis, this is the study of algorithms that use numerical approximation for the problems of mathematical analysis.

Course Learning Outcomes:

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

Fundamental properties of real number and real-valued functions. Analytical properties of sequences.

Infinite series, their properties and different tests.

Limits, continuity, differentiability and mean value theorems.

Fundamentals of numerical analysis, interpolation, numerical integration and difference equation.

Contents:

UNIT-I

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

UNIT-II

Infinite series, positive termed series and their convergence, Comparison test, D'Alembert's ratio test, Cauchy's n^{th} 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. Indeterminate form, L' Hospital's rule.

UNIT-III

Review of limit, continuity and differentiability, uniform Continuity and boundedness of a function. Rolle's theorem, 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 sinx, cosx, log (1+x).

UNIT-IV

Numerical Analysis: Factorial, finite differences and interpolation. Operators, E and divided difference. Newton's forward, backward and divided differences interpolation formulae. Lagrange's interpolation formulae. Central differences, Gauss and Stirling interpolation formulae. Numerical integration. Trapezoidal rule, Simpson's one-third rule, three-eighth rule, Weddle's

rule with error terms. Stirling's approximation to factorial n. Solution of difference equations of first order.

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. B. Sc. Honours (Statistics) 19

4. Appostol T.M.: Mathematical Analysis, Second Edition, Narosa Publishing House, NewDelhi, 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.

9. Jain,M. K., Iyengar, S. R. K. and Jain, R. K. (2003): Numerical methods for scientific and engineering computation, New age International Publisher, India.

10. Mukherjee, Kr. Kalyan (1990): Numerical Analysis. New Central Book Agency.

11. Sastry, S.S. (2000): Introductory Methods of Numerical Analysis, 3rd edition, Prentice Hall of India Pvt. Ltd., New Del

PRACTICAL/LABWORK:

List of Practical

1. Formation of difference table, fitting of polynomial and missing terms for equal interval of differencing.
2. Based on Newton's Gregory forward difference interpolation formula.
3. Based on Newton's backward difference interpolation formula.
4. Based on Newton's divided difference and Lagrange's interpolation formula.
5. Based on Gauss forward, Gauss backward central difference interpolation formula.
6. Based on Stirling's central difference interpolation formula.
7. Based on Lagrange's Inverse interpolation formula.
8. Based on method of successive approximation or iteration.
9. Based on method of reversion of series.
10. Based on Trapezoidal Rule, Simpson's one-third rule, Simpson's three-eighth rule, Weddle's rule.
11. To find sum by Euler-Maclaurin summation formula.

SEMESTER-IV

PAPER CODE: STAT-HCC-4016

(Statistical Inference)

Credits: 6(Lecture-60, Practical-30) **Marks: 100 (T60+IA20+P20)**

Course Objectives:

The learning objectives include:

Drawing inference about the unknown population parameters based on random samples.

Validating our estimation/ inference about the population using hypothesis testing.

Course 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.

Methods to develop/find best point estimators based on the desirable properties (Using Cramer- Rao inequality, Rao-Blackwell theorem, and Lehmann-Scheffe Theorem).

General methods of constructing interval estimators (Confidence Intervals) for unknown population parameters.

Basic principle of Bayesian estimation (Finding posterior distributions of unknown population parameters).

Practical applications of estimation theory and hypothesis testing pertaining to all discussed methods.

Contents

UNIT I

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

UNIT II

Methods of Estimation: Method of moments, method of maximum likelihood estimation, method of minimum Chi-square, Basic idea of Bayes estimators.

UNIT III

Principles of test of significance: Null and alternative hypotheses (simple and composite), Type-I and Type-II errors, critical region, level of significance, size and power, best critical region, most powerful test, uniformly most powerful test, Neyman Pearson Lemma (statement and applications

to construct most powerful test). Likelihood ratio test, properties of likelihood ratio tests (without proof).

UNIT IV

Interval estimation: Confidence interval for the parameters of various distributions, Confidence interval for Binomial proportion, Confidence interval for population correlation coefficient for Bivariate Normal distribution, Pivotal quantity method of constructing confidence interval, Large sample confidence intervals.

SUGGESTED READINGS:

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

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

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

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

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

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

7. Snedecor G.W and Cochran W.G.(1967) Statistical Methods. lowa State University Press. B. Sc. Honours (Statistics) 21

PRACTICAL/LABWORK:

List of Practical

1. Unbiased estimators (including unbiased but absurd estimators)

2. Consistent estimators, efficient estimators and relative efficiency of estimators.

3. Cramer-Rao inequality and MVB estimators

4. Sufficient Estimators – Factorization Theorem, Rao-Blackwell theorem, Complete Sufficient estimators

5. Lehman-Scheffe theorem and UMVUE

6. Maximum Likelihood Estimation

7. Asymptotic distribution of maximum likelihood estimators

8. Estimation by the method of moments, minimum Chi-square

9. Type I and Type II errors 10. Most powerful critical region (NP Lemma)

11. Uniformly most powerful critical region

12. Unbiased critical region

13. Power curves

14. Likelihood ratio tests for simple null hypothesis against simple alternative hypothesis

15. Likelihood ratio tests for simple null hypothesis against composite alternative hypothesis

16. Asymptotic properties of LR tests

17. Confidence interval for Binomial proportion.

18. Confidence interval for population correlation coefficient for Bivariate Normal distribution.

PAPER CODE: STAT-HCC-4026

(Linear Models)

Credits: 6(Lecture-60, Practical-30) **Marks: 100 (T60+IA20+P20)**

Course Objectives:

The learning objectives include developing a clear understanding of the fundamental concepts of linear models and a range of associated skills allowing the students to work effectively with them.

Course Learning Outcomes:

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

Theory and estimation of Linear Models. Gauss Markov Theorem and its use. Distribution of quadratic forms. Simple and Multiple linear regression models and their applications. Fitting of these models to real or synthetic data, derivation of confidence and prediction intervals, and a sound scientific interpretation of the results. Techniques of Analysis of Variance and Covariance under fixed effects model.

Contents:

UNIT I

Gauss-Markov set-up: Theory of linear estimation, Estimability of linear parametric functions, Method of least squares, Gauss-Markov theorem, Estimation of error variance. Distribution of Quadratic Forms.

UNIT II

Regression analysis: Simple regression analysis, Estimation and hypothesis testing in case of simple and multiple regression models, Concept of model matrix and its use in estimation. . Effect of orthogonal columns in the X matrix, Partial F-test and Sequential F-test, Bias in regression estimates.

UNIT III

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 IV

Model checking: Prediction from a fitted model, Violation of usual assumptions concerning normality, Homoscedasticity and collinearity, Diagnostics using quantile-quantile plots. Model Building: Techniques for Variable selection. Polynomial Regression models: Orthogonal Polynomials.

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.

PRACTICAL/LAB. WORK:

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. Stepwise Regression procedure.

9. Analysis of Variance of a one way classified data

10. Analysis of Variance of a two way classified data with one observation per cell

11. Analysis of Variance of a two way classified data with m(>1) observation per cell

12. Analysis of Covariance of a one way classified data

13. Residual Analysis.

14. Orthogonal polynomial.

PAPER CODE: STAT-HCC-4036

(Statistical Quality Control)

Credits: 6(Lecture-60, Practical-30) **Marks: 100 (T60+IA20+P20)**

Course Objectives:

The learning objectives include:

This course will help students to learn techniques and approach of SQC being used in industry to manufacture goods and services of high quality at low cost. This course will also give exposure to Six sigma and Index Numbers.

Course Learning Outcomes:

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

Statistical process control tools- Control charts for variables, attributes. Statistical product control tools, Sampling inspection plans. Overview of Six sigma, Lean manufacturing, TQM. Overview of Six sigma training plans, VOC, CTQ.

Contents:

UNIT I

Quality: Definition, dimensions of quality, its concept, application and importance. Introduction to Process and Product Controls. Statistical Process Control - Seven tools of SPC, chance and assignable Causes of quality variation. Introduction to Six-Sigma: Overview of Six Sigma, Lean Manufacturing and Total Quality Management (TQM). Voice of customers (VOC): Importance and VOC data collection. Critical to Quality (CTQ), Introduction to DMAIC.

UNIT II

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: 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

Sequential Analysis: Sequential probability ratio test (SPRT) for simple vs simple hypotheses. Fundamental relations among α, β, A and B, determination of A and B in practice. Wald's fundamental identity and the derivation of operating characteristics (OC) and average sample number (ASN) functions, examples based on normal, Poisson, binomial and exponential distributions.

SUGGESTED READING:

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

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

3. Mukhopadhyay, P (2011):Applied Statistics, 2nd edition revised reprint, Books and Allied(P) Ltd.

4. Montogomery, D. C. and Runger, G.C. (2008): Applied Statistics and Probability for Engineers, 3rd Edition reprint, Wiley India Pvt. Ltd.

5. Ehrlich, B. Harris (2002): Transactional Six Sigma and Lean Servicing, 2nd Edition, St. Lucie Press.

6. Hoyle, David (1995): ISO Quality Systems Handbook, 2nd Edition, Butterworth Heinemann Publication.

PRACTICAL/LAB. WORK:

List of Practical

1. Construction and interpretation of statistical control charts for X-bar & R-chart, for X-bar & s-chart, for np-chart, for p-chart, for c-chart and for 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

5. SPRT procedure

6. OC function and OC curve

7. ASN function and ASN curve

SEMESTER-V

PAPER CODE: STAT-HCC-5016

(Stochastic Processes and Queuing Theory)

Credits: 6 (Lecture-60, Practical-30) **Marks: 100 (T60+IA20+P20)**

Course Objectives:

The learning objectives include:

To define, design and model; To analyze;

To identify the real life applications of stochastic processes.

Course Learning Outcomes:

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

The fundamental concepts of stochastic processes. Tools needed to analyze stochastic processes. Markov processes and Markov chains. Stability of Markov chains. Poisson process and its variations. Queuing systems. Random walk and ruin theory.

Contents:

UNIT I:

Probability Distributions: Generating functions, Bi-variate probability generating functions. Stochastic Process: Introduction, Stationary Process.

UNIT II:

Markov Chains: 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, stability of Markov system.

UNIT III:

Poisson Process: postulates of Poisson process, properties of Poisson process, inter-arrival time.

UNIT IV:

Queuing System: 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: Classical ruin problem, expected duration of the game.

SUGGESTED READINGS:

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

PRACTICAL/LAB WORK

List of Practicals:

Mode of Conducting Practical Examination: The students should be encouraged to perform practical problems on computers using whatsoever software/package as far as possible.

1. Applications of Partial Fraction Theorem.
2. Problems based on (covariance) stationary processes.
3. Markov Chains:

   a) Simulation of Markov chains and Calculation of transition probability matrices.

   b) Stability of Markov chains.
   c) To check whether the given chain is irreducible or not.

   d) Computation of probabilities in case of generalizations of independent Bernoulli trials.
4. Simulation and applications of Poisson processes.
5. Calculation of probabilities for ruin problems.
6. Problems based on (M/M/1) queuing models.

PAPER CODE: STAT-HCC-5026

(Statistical Computing Using C/C++ Programming)

Credits: 6 (Lecture-60, Practical-30) **Marks: 100 (T60+IA20+P20)**

Course Objectives:

The learning objectives include:

To understand computer programming and its roles in problem solving.

To understand basic data structures and develop logics which will help them to create well-structured programs using C language.

Learning the basic programming language will help students to easily switch over to any other language in future.

Course 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, Character and strings. User- defined functions, recursion functions. Storage class of Variables. Pointers and arrays, arrays of pointers, pointers as function arguments, functions returning pointers. Structure, array of structures, structure pointers. Dynamic memory allocation functions. Pre-processors: Macro substitution, macro with argument. File inclusion in C/C++, I/O operations on files.

Contents:

UNIT I:

History and importance of C/C++. Components, basic structure programming, character set, C/C++ tokens, Keywords and Identifiers and execution of a C/C++ program. Data types: Basic data types, Enumerated data types, derived data types. Constants and variables: declaration and assignment of variables, Symbolic Constants, overflow and underflow of data. Operators and Expressions: Arithmetic, relational, logical, assignment, increment/decrement, operators, precedence of operators in arithmetic, relational and logical expression. Implicit and explicit type conversions in expressions, library functions. Managing input and output operations: reading and printing formatted and unformatted data.

UNIT II:

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

UNIT III:

User- defined functions: A multi -function program using user-defined functions, definition of functions, return values and their types, function prototypes and calls. Category of Functions : no arguments and no return values, arguments but no return values , arguments

with return values, no arguments but returns a value, functions that return multiple values. Recursion function. Passing arrays to functions, Storage class of Variables.

UNIT IV:

Pointers: Declaration and initialization of pointer variables, accessing the address of a variable, accessing a variable through its pointer, pointer expressions, pointer increments/decrement and scale factor. Pointers and arrays, arrays of pointers, pointers as function arguments, functions returning pointers Structure: Definition and declaring, initialization, accessing structure members, copying and comparison of structure variables, array of structures, structure pointers. Dynamic memory allocation functions: malloc, calloc and free. Pre-processors: Macro substitution, macro with argument File inclusion in C/C++: Defining and opening a file (only r, w and a modes), closing a file, I/O operations on files-fscanf and fprintf functions.

SUGGESTED READINGS:

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

PRACTICAL/ LAB WORK:

List of Practicals:

1. Plot of a graph y = f(x).
2. Roots of a quadratic equation (with imaginary roots also).
3. Sorting of an array and hence finding median.
4. Mean Median and Mode of a Grouped Frequency Data.
5. Variance and coefficient of variation of a Grouped Frequency Data.
6. Preparing a frequency table.
7. Value of n! using recursion.
8. Random number generation from uniform, exponential, normal (using CLT) and gamma distribution calculate sample mean and variance and compare with population parameters.
9. Matrix addition, subtraction, multiplication Transpose and Trace.
10. Fitting of Binomial, Poisson distribution and apply Chi-square test for goodness of fit.
11. Chi-square contingency table.
12. t-test for difference of means.
13. Paired t-test.
14. F-ratio test.
15. Multiple and Partial correlation.
16. Compute ranks and then calculate rank correlation (without tied ranks).
17. Fitting of lines of regression.

SEMESTER-V

PAPER CODE: STAT-HDS-5016

(Operations Research)

Credits: 6 (Lecture-60, Practical-30) **Marks: 100 (T60+IA20+P20)**

Course Objectives:

The learning objectives include:

To study various Operational Research Techniques and Models.

Course Learning Outcomes:

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

The fundamental concepts of Operational Research Techniques Linear Programming. Transportation and assignment problems Game Theory and Inventory Models.

Contents:

UNIT I:

Introduction to Operations Research (O.R.): Definition and phases of O.R.Model building, various types of O.R. problem. Linear Programming Problem (L.P.P.): Mathematical formulation of the L.P.P, graphical solutions of L.P.P. Simplex method for solving L.P.P. Charne's M-technique for solving L.P.P. involving artificial variables. Special cases of L.P.P. Concept of Duality in L.P.P: Dual simplex method. Economic interpretation of Duality. Post-optimality analysis.

UNIT II:

Transportation Problem: Initial solution by North West corner rule, Least cost method and Vogel's approximation method (VAM), MODI's method to find the optimal solution, special cases of transportation problem.

Assignment problem: Hungarian method to find optimal assignment, special cases of assignment problem.

UNIT III: Game theory: Rectangular game, minimax - maximin principle, solution to rectangular game using graphical method, dominance and modified dominance property to reduce the game matrix and solution to rectangular game with mixed strategy Networking: Shortest route and minimal spanning tree problem.

UNIT IV:

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

SUGGESTED READINGS:

1. Taha, H. A. (2007). Operations Research: An Introduction, 8thEd., Prentice Hall of

India.

2. Swarup, K., Gupta, P.K. and Man Mohan (2007). Operations Research, 13th Ed., Sultan Chand and Sons.

PRACTICAL/ LAB WORK (Using TORA/WINQSB/LINGO)

List of Practicals:

1. Mathematical formulation of L.P.P and solving the problem using graphical method, Simplex technique and Charne's Big M method involving artificial variables.
2. Identifying Special cases by Graphical and Simplex method and interpretation:
    a) Degenerate solution
    b) Unbounded solution
    c) Alternate solution
    d) Infeasible solution
3. Post-optimality:
    a) Addition of constraint
    b) Change in requirement vector
    c) Addition of new activity
    d) Change in cost vector
4. Allocation problem using Transportation model.
5. Allocation problem using Assignment model.
6. Networking problem:
    a) Minimal spanning tree problem
    b) Shortest route problem
7. Problems based on game matrix:
    a) Graphical solution to mx2 / 2xn rectangular game
    b) Mixed strategy
8. To find optimal inventory policy for EOQ models and its variations.
9. To solve all-units quantity discounts model.

PAPER CODE: STAT-HDS-5026

(Demography and Vital Statistics)

Credits: 6 (Lecture-60, Practical-30) **Marks: 100 (T60+IA20+P20)**

Course Objectives:

The learning objectives include:

To collect valid Demographic data using different methods. To learn basic measures of Mortality, Fertility and Population Growth. To construct life tables.

Course Learning Outcomes:

After completing this course, students should have developed a clear understanding of: Distinction between Vital Statistics and Demography. Errors in Demographic data. To check the completeness of registration data using Chandrasekaran-Deming formula. Use of Myer's and UN indices in evaluating age data. Use of Balancing Equations. Population Composition and Dependency Ratio. Sources of data collection on Vital Statistics and errors therein. Measurement of Population. Distinction between Rate and Ratio. Basic measures of Mortality. Concepts of Stable and Stationary Populations. Concept of Life Tables, their construction and uses. Concept of Abridged life tables and their construction by Reed and Merrell method, Greville's method and King's Method. Basic measures of Fertility. Measures of Population Growth.

Contents:

UNIT I:

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

UNIT II:

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:

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.

UNIT IV:

Abridged Life Tables; Concept and construction of abridged life tables by Reed-Merrell method, Greville's method and King's Method. Measurements of Fertility: Crude Birth Rate (CBR), General Fertility Rate (GFR), Specific Fertility Rate (SFR) and Total Fertility Rate (TFR). Measurement of Population Growth: Crude rates of natural increase, Pearl's Vital Index, Gross Reproduction Rate (GRR) and Net Reproduction Rate (NRR).

SUGGESTED READINGS:

1. Biswas, S. (1988). Stochastic Processes in Demography & Application, Wiley Eastern Ltd.
2. Croxton, Fredrick, E. Cowden, Dudley J. and Klein, S. (1973). Applied General Statistics, 3rd Ed., Prentice Hall of India Pvt. Ltd.
3. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2008). Fundamentals of Statistics, Vol. II, 9thEd., World Press.
4. Keyfitz, N. and Beekman,J.A. (1985). Demography through Problems. S-Verlag, New York.
5. Mukhopadhyay, P. (1999). Applied Statistics, Books and Allied (P) Ltd.

PRACTICAL/LAB WORK

List of Practicals:

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

SEMESTER-VI

PAPER CODE: STAT-HCC-6016

(Design of Experiments)

Credits: 6 (Lecture-60, Practical-30) **Marks: 100 (T60+IA20+P20)**

Course Objectives:

The learning objectives include:

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

Course Learning Outcomes:

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

The fundamental concepts of design of experiments. Introduction to planning valid and economical experiments within given resources. Completely randomized design. Randomized block design. Latin square design. Balanced incomplete block design. Full and confounded factorial designs with two and three levels. Fractional factorial designs with two levels.

Contents:

UNIT I:

Experimental designs: Role, historical perspective, terminology, experimental error, basic principles, uniformity trials, fertility contour maps, choice of size and shape of plots and blocks. Basic designs: Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD) -layout, model and statistical analysis, relative efficiency, analysis with missing observations.

UNIT II:

Incomplete Block Designs: 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.

UNIT III:

Factorial experiments: Concepts, notations and advantages, 2^2, $2^3 \ldots 2^n$ and 3^2 factorial experiments, design and analysis, Total and Partial confounding for 2^n ($n \leq 5$), 3^2 and 3^3. Factorial experiments in a single replicate.

UNIT IV:

Split-plot design and its analysis, Lattice design, transformation of data, Duncan's multiple range test

SUGGESTED READINGS:

1. Cochran, W.G. and Cox, G.M. (1959). Experimental Design. AsiaPublishing House.
2. Das., M.N. and Giri, N.C. (1986). Design and Analysis of Experiments. Wiley Eastern

3. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2005). Fundamentals of Statistics. Vol. II, 8thEd. 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.

PRACTICAL/LAB WORK

List of Practicals:

1. Analysis of a CRD with equal and unequal replicates.
2. Analysis of RBD.
3. Analysis of LSD.
4. Analysis of RBD with one missing observation.
5. Analysis of LSD with one missing observation.
6. Intra block analysis of BIBD.
7. Intra block analysis of a symmetric BIBD.
8. Analysis of 2^2 and 2^3 factorial in CRD, RBD and LSD.
9. Analysis of a 3^2 factorial in CRD and RBD.
10. Analysis of a completely confounded two level factorial design in 2 blocks.
11. Analysis of a completely confounded two level factorial design in 4 blocks.
12. Analysis of a partially confounded two level factorial design.
13. Analysis of a single replicate of a 2^n design.
14. Analysis of one half fraction of 2^n factorial design.
15. Analysis of one quarter fraction of 2^n factorial design.

PAPER CODE: STAT-HCC-6026

(Multivariate Analysis and Non-Parametric Methods)

Credits: 6 (Lecture-60, Practical-30) **Marks: 100 (T60+IA20+P20)**

Course Objectives:

The learning objectives include:

Study of theoretical concepts of Bivariate Normal and Multivariate Normal Distributions along with their properties. Analyze multivariate data. Application of Wald's SPRT and Non-Parametric methods of testing of hypothesis.

Course Learning Outcomes:

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

The understanding of basic concepts associated with Multivariate Normal Distributions and their properties with special emphasis on Bivariate Normal Distribution. Analyzing Multivariate data using data reduction techniques like Principal Component Analysis, Factor Analysis. Classification method namely Discriminant Analysis. Testing of hypothesis using Non-Parametric tests like Median test, Runs test, U test, Kruskal Wallis test etc. and ability to use them judiciously for the testing of given data.

Contents:

UNIT I:

Bivariate Normal Distribution (BVN): pdf of BVN, properties of BVN, marginal and Conditional pdf of BVN. Multivariate Data: Random Vector: Probability mass/density functions, Distribution Function, Mean vector, Dispersion matrix, Marginal distributions, Conditional distributions.

UNIT II:

Multivariate Normal distribution and its properties. Sampling distribution for mean vector and variance-covariance matrix. Mahalanobis D^2 and Hotellings T^2 statistics and their applications. Multiple and partial correlation coefficient and their properties.

UNIT III:

Introduction to discriminant Analysis, Principal Components Analysis and Factor Analysis.

UNIT IV:

Nonparametric Tests: Introduction and Concept, Kolmogorov's test for goodness of fit and its consistency, sign test -one sample and two samples and its optimality, Wilcoxon signed-rank test and its consistency, Kolmogorov Smirnov test for two sample, run test, Wilcoxon-Mann-Whitney test and median test, their consistency and asymptotic normality, Kruskal-Wallis test.

SUGGESTED READINGS:

1. Anderson, T.W. (2003). An Introduction to Multivariate Statistical Analysis, 3rd Ed., John Wiley& Sons.
2. Arora, S.and Bansi, L. (1968). New Mathematical Statistics, 1st Ed., Vanita Printers.
3. Gibbons, J. D. and Chakraborty, S. (2003). Non-Parametric Statistical Inference. 4thEd., Marcel Dekker, CRC.
4. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2005). An Outline of Statistical Theory, Volume II, World Press.
5. Gupta, S.C. and Kapoor, V.K. (2014). Fundamentals of Mathematical Statistics, 11th Ed., Sultan Chand.
6. Johnson, R.A. and Wichern, D.W. (2007). Applied Multivariate Analysis, 6th Ed., Prentice Hall.
7. Kshirsagar, A.M. (1972). Multivariate Analysis, 1st Ed., Marcel Dekker.
8. Muirhead, R.J. (1982). Aspects of Multivariate Statistical Theory, John Wiley.
9. Mukhopadhyay, P. (2015). Mathematical Statistics.
10. Rao, C. R. (2000). Linear Statistical Inference, John Wiley & Sons.
11. Siegel, S. and Castellan, N.J. (1988). Non-Parametric Statistics for the Behavioral Sciences, 2nd Ed., International Edition.
12. Siegel, S. (1956). Non-Parametric Statistics for the Behavioral Sciences, McGraw Hill.

PRACTICAL/LAB WORK

List of Practicals:

1. Bivariate Normal Distribution and it's properties.
2. Multivariate Normal Distribution and it's properties.
3. Partial Correlation Coefficient.
4. Multiple Correlation Coefficient.
5. Plane of Regression.
6. Principal Component Analysis.
7. Discriminant analysis.
8. Factor Analysis.
9. SPRT Procedure and Graphical representation of decision lines, acceptance and rejection regions.
10. ASN function and ASN curve.
11. OC function and OC curve.
12. Test for randomness based on total number of runs.
13. Kolmogorov Smirnov test for one sample.
14. Sign test: one sample, two sample, large samples.
15. Wilcoxon-Mann-Whitney U – test.
16. Kruskal - Wallis test.
17. Wald- Wolfowitz test.
18. Median Test.

SEMESTER-VI

PAPER CODE: STAT-HDS-6016

(Time Series Analysis)

Credits: 6 (Lecture-60, Practical-30) **Marks: 100 (T60+IA20+P20)**

Course Objectives:

The course objectives include:

Understanding of the process generating a time series. Forecasting future values of the observed series.

Course Learning Outcomes:

After completing this course, the students will possess skills to understand the components and forecast values of a time series at future time points.

Contents:

UNIT I:

Introduction to times series data, application of time series from various fields, Components of a times series, Decomposition of time series. Estimation of trend by free hand curve method, method of semi averages, fitting mathematical curve and growth curves. Estimation of trend by method of moving averages. Detrending: effect of elimination of trend on other components of a time series.

UNIT II:

Seasonal Component: Estimation of seasonal component by the methods of - simple averages, Ratio to Trend, Ratio to Moving Averages and Link Relative method. Deseasonalization. Cyclic Component: Harmonic Analysis.

UNIT III:

Random Component: Variate difference method. Stationary Time series: Weak stationarity, autocorrelation function and the correlogram. Some Special Processes: Moving-average (MA) process and Autoregressive (AR) processes. Estimation of the parameters of AR (1) and AR (2). Autocorrelation functions of AR(1) and AR(2) processes.

UNIT IV:

Introduction to methods of Forecasting a time series. Forecasting by the methods of Exponential smoothing. Introduction to ARMA and ARIMA models. Short-term forecasting methods Brown's discounted regression, Box-Jenkins method and Bayesian forecasting.

SUGGESTED READINGS:

1. Kendall, M.G. (1976). Time Series, 2nd Ed., Charles Griffin and Co Ltd., London and High Wycombe.
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

4. Goon, A. M., Gupta, M. K. and Dasgupta, B. (2003). Fundamentals of Statistics, 6th Ed., Vol II Revised,Enlarged.
5. Gupta, S.C. and Kapoor, V.K. (2014). Fundamentals of Mathematical Statistics, 11th Ed., Sultan Chand and Sons.
6. Montgomery, D. C. and Johnson, L. A. (1967). Forecasting and Time Series Analysis, 1st Ed. McGraw-Hill, New York.

PRACTICAL / LAB WORK

List of Practicals: (May be done using EXCEL, SPSS, R, Calculators)

1. Fitting and plotting of modified exponential curve by different methods.
2. Fitting and plotting of Gompertz curve by different methods.
3. Fitting and plotting of logistic curve by different methods.
4. Fitting of trend by Moving Average Method for given extent and for estimated extent.
5. Fitting of trend by Spencer's 15-point and 21-point formulae.
6. Measurement of Seasonal indices:
   a) Simple Averages method
   b) Ratio-to-Trend method
   c) Ratio-to-Moving Average method
   d) Link Relative method
7. Estimation of variance of the random component by variate difference method.
8. Forecasting by exponential smoothing.
9. Plotting of Correlogram of moving average.

PAPER CODE: STAT-HDS-6026

(Dissertation/Project Work)

Credits: 6 (Lecture-60, Practical-30) **Marks:100(W80+P20)**

Course Objectives:

The aim of the course is to initiate students to write and present a statistical report, under the supervision of a faculty of the department on some area of interest of the students. The project work will provide hands on training to the students to deal with data originate from some real life situation and relate it to some theoretical concepts of Statistics.

Course Learning Outcomes:

The project work will provide hands on training to the students to deal with data and relate it to some theoretical concepts.

The project work itself a practical problem and it relates to some theoretical concepts.

Each candidate is required to complete any one project work related to any area of the syllabus to be evaluated by internal examiners through viva voce test. The project work will have to be completed according to the following steps –

- Introduction
- Objectives of the study
- Review of related literature
- Significance of the study
- Methodology
- Results/Findings
- Discussion
- Conclusion
- References/Bibliography

Contents:

UNIT I:

Define the scope and objectives of the research project. Objectives of project, project work approaches, significance of project work, defining the project work, Census and Sample Survey, implications of a sample design, steps in sampling design, criteria of selecting a sampling procedure.

UNIT II:

Project Schedule Methods of data collection, Collection of Primary Data, observation method, interview method, collection of data through questionnaires, collection of data through schedules, difference between questionnaires and schedules, some other methods of data collection, collection of secondary data, selection of appropriate method for data collection.

UNIT III:

Processing operations, some problems in processing, elements/types of analysis, need for sampling, important sampling distributions, estimation, sample size and its determination, determination of sample size through the approach based on precision rate and confidence level, Processing and Analysis of Data.

UNIT IV:

Meaning of Interpretation, Technique of Interpretation, precaution in Interpretation, significance of report project writing, different steps in writing project report, layout of the project report, types of reports, oral presentation, Mechanics of writing a research report, precautions for Writing project reports, conclusions.

SUGGESTED READINGS:

1. Kothari, C.R. (2015): Research Methodology: Methods and Techniques, 3rd Edition reprint, New Age International Publishers.
2. Kumar, R (2011): Research Methodology: A Step - by - Step Guide for Beginners, SAGE publications.
3. Cochran, W.G. (2011): Sampling Techniques (3rd Ed.), Wiley Eastern John Wiley and Sons.
4. Murthy M.N. (1977): Sampling Theory & Statistical Methods, Statistical Pub. Society, Calcutta.
5. Sukhatme, P. V., Sukhatme, B. V., Sukhatme, S. and Asok, C. (1984): Sampling Theories of Survey with Application, IOWA State University Press and Indian Society of Agricultural Statistics.
6. Gujarati, D. and Sangeetha, S. (2007): Basic Econometrics, 4 Edition, McGraw Hill Companies.

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Honours Generic Papers in Statistics

SEMESTER-I

PAPER CODE: STAT-HGE/RCC-1016

(Statistical Methods)

Credits: 6 (Lecture-60, Practical-30) **Marks: 100(T60+IA20+P20)**

Course Objectives:

The learning objectives include:

To introduce students to different measurement scales, qualitative and quantitative and discrete and continuous data.

To help students to organize data into frequency distribution graphs, including bar graphs, histograms, polygons, and Ogives.

Students should be able to understand the purpose for measuring central tendency, variation, skewness and kurtosis and should be able to compute them as well.

Students should be able to understand and compute various statistical measures of correlation, fitting of curve and regression.

Course Learning Outcomes:

Upon successful completion of this course students will demonstrate knowledge of:

Introduction to Statistics, definitions and data classification, types of studies and types of samples.

Graphical displays of data, frequency distributions, analyzing graphs.

Numerical descriptions of data, measures of central tendency, measures of dispersion, skewness and kurtosis.

Correlation and regression. Theory of attributes.

Contents:

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

SUGGESTED READING:

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

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

3. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co. Ltd.

PRACTICAL/ LAB WORK

List of Practical

1. Graphical representation of data

2. Problems based on measures of central tendency

3. Problems based on measures of dispersion

4. Problems based on combined mean and variance and coefficient of variation

5. Problems based on moments, skewness and kurtosis

6. Fitting of polynomials, exponential curves

7. Karl Pearson correlation coefficient

8. Partial and multiple correlations

9. Spearman rank correlation with and without ties.

10. Correlation coefficient for a bivariate frequency distribution

11. Lines of regression, angle between lines and estimated values of variables.

12. Checking consistency of data and finding association among attributes.

SEMESTER-II

PAPER CODE: STAT-HGE/RCC-2016

(Introductory Probability)

Credits: 6(Lecture-60, Practical-30) **Marks: 100 (T60+IA20+P20)**

Course Objectives:

The learning objectives include:

Understanding probability theory at basic and advance level, random variables and also their convergences at weak and strong levels.

Different probability distribution (discrete and continuous).

Course Learning Outcomes:

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

The fundamental concepts of Probability Theory. Solving probabilistic problems.

Understanding random variables and computing properties of distribution they follow. Different

probability distributions and their implementation at realistic models.

Contents:

UNIT I

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

UNIT II

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

UNIT III

Convergence in probability, almost sure convergence, Chebyshev's inequality, weak law of large numbers, De-Moivre Laplace and Lindeberg-Levy Central Limit Theorem (C.L.T.).

UNIT IV

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

SUGGESTED READING:

1. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009): Probability and Statistical Inference, Seventh Ed, Pearson Education, New Delhi.

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

3. Myer, P.L. (1970): Introductory Probability and Statistical Applications, Oxford & IBH Publishing, New Delhi

PRACTICAL/LAB. WORK:

List of Practical

1. Fitting of binomial distributions for n and p = q = ½ given

2. Fitting of binomial distributions for n and p given

3. Fitting of binomial distributions computing mean and variance

4. Fitting of Poisson distributions for given value of lambda

5. Fitting of Poisson distributions after computing mean

6. Application problems based on binomial distribution

7. Application problems based on Poisson distribution

8. Problems based on area property of normal distribution

9. To find the ordinate for a given area for normal distribution

10. Application based problems using normal distribution

11. Fitting of normal distribution when parameters are given

12. Fitting of normal distribution when parameters are not given

SEMESTER-III

PAPER CODE: STAT-HGE/RCC-3016

(Basics of Statistical Inference)

Credits: 6 (Lecture-60, Practical-30) **Marks: 100 (T60+IA20+P20)**

Course Objectives:

The learning objectives include:

To learn how the mathematical ideas of Statistics carry over into the world of applications.

To analyse and interpret the data.

Course Learning Outcomes:

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

Theory of estimation. Tests of hypothesis.

Application of Chi-square test. Nonparametric tests.

Analysis of variance.

Fundamentals and analysis of basic designs (CRD, RCBD). Bioassay.

Contents:

UNIT I

Estimation of population mean, confidence intervals for the parameters of a normal distribution (one sample and two sample problems). The basic idea of significance test. Null and alternative hypothesis. Type I & Type II errors, level of significance, concept of p-value. Tests of hypotheses for the parameters of a normal distribution (one sample and two sample problems).

UNIT II

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

UNIT III

Tests for the significance of correlation coefficient. Sign test for median, Sign test for symmetry, Wilcoxon two-sample test.

UNIT IV

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

SUGGESTED READING:

1. Daniel, Wayne W., Bio-statistics: A Foundation for Analysis in the Health Sciences. John Wiley (2005).

2. Goon, A.M., Gupta M.K. & Das Gupta, Fundamentals of statistics, Vol.-I & II (2005).

3. Dass, M. N. &Giri, N. C.: Design and analysis of experiments. John Wiley.

4. Dunn, O.J Basic Statistics: A primer for the Biomedical Sciences .(1964, 1977) by John Wiley.

5. Bancroft, Holdon Introduction to Bio-Statistics (1962) P.B. Hoebar New York.

6. Goldstein, A Biostatistics-An introductory text (1971). The Macmillion New York.

PRACTICAL/LAB WORK

List of Practical

1. Estimators of population mean.

2. Confidence interval for the parameters of a normal distribution (one sample and two sample problems).

3. Tests of hypotheses for the parameters of a normal distribution (one sample and two sample problems).

4. Chi-square test of proportions.

5. Chi-square tests of association.

6. Chi-square test of goodness-of-fit.

7. Test for correlation coefficient.

8. Sign test for median.

9. Sign test for symmetry.

10. Wilcoxon two-sample test.

11. Analysis of Variance of a one way classified data

12. Analysis of Variance of a two way classified data.

13. Analysis of a CRD.

14. Analysis of an RBD.

SEMESTER-IV

PAPER CODE: STAT-HGE/RCC-4016

(Applied Statistics)

Credits: 6 (Lecture-60, Practical-30) **Marks: 100 (T60+IA20+P20)**

Course Objectives:

The learning objectives include:

This course will help students to know the applications of Statistics and learn and apply these techniques in the core course of their study.

This course will give exposure to four applied fields of statistics viz. Time Series, Index Numbers, Statistical Quality Control and Demographic methods. They will be having hands on practice of working on the data related to above mentioned fields.

Course Learning Outcomes:

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

Time series data, components of time series data, study the behavior and identifying the variation due to different components in the data. They will study to identify and measure various components of time series data. The fundamental concepts of Index Numbers, Construction of price and quantity Index numbers. Construction of Wholesale and Consumer price Index and its significance. Statistical Quality Control, Use of Statistical methods in industrial research and practice. Chance and Assignable causes of variation in data. Statistical process control tools- Control charts for variables and attributes. To learn about different demographic methods. Measurement of mortality and fertility rates, reproduction and population growth measures. Construction and importance of Life Table.

Contents:

UNIT I:

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

UNIT II:

Index numbers: Introduction, Construction of price and quantity Index Numbers by Simple and Weighted Aggregate Method. Construction of price and quantity index numbers by Laspeyre's, Paasche's, Marshall-Edgeworth's and Fisher's Formula. Criteria for a good index number. Construction of wholesale price index number, fixed base index number and Consumer price indexnumber with interpretation. Uses and limitations of index numbers.

UNIT III:

Statistical Quality Control: Importance of statistical methods in industrial research and practice. Determination of tolerance limits. Causes of variations in quality: Chance and Assignable. General theory of control charts, Process & Product control, Control charts for variables: and R-charts. Control charts for attributes: p and c-charts.

UNIT IV:

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

SUGGESTED READINGS:

1. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2008). Fundamentals of Statistics, Vol. II, 9th Ed., World Press, Kolkata.
2. Gupta, S.C. and Kapoor, V.K. (2014). Fundamentals of Mathematical Statistics, 11th Ed., Sultan Chand.
3. Mukhopadhyay, P. (1999). Applied Statistics, New Central Book Agency, Calcutta.
4. Montogomery, D.C. (2009). Introduction to Statistical Quality Control, 6th ed., Wiley India Pvt. Ltd.

PRACTICAL/LAB WORK

List of Practicals:

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

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