Proposed Syllabus and Scheme of Examination

for

B. Sc. (Honours) Statistics

Submitted

to

University Grants Commission
New Delhi

under

Choice Based Credit System

May 2015
PREAMBLE

Statistics is the language of the uncertainties riddled modern information age. Statistics facilitates the decision making process by quantifying the element of chance or uncertainties. It’s descriptive and inferential roles not only formulate the basis of the growth of almost all the disciplines of the contemporary world, but also provide an array of non-traditional employment avenues ranging from that of sport-analysts to business analysts. The thrust of the course is to prepare students to enter into a promising professional life even after graduation, as also provide to them a platform for pursuing higher studies leading to post-graduate or doctorate degrees.
## PROPOSED SCHEME FOR CHOICE BASED CREDIT SYSTEM IN B. Sc. Honours (Statistics)

<table>
<thead>
<tr>
<th>CORE COURSE (14)</th>
<th>Ability Enhancement Compulsory Course (AECC) (2)</th>
<th>Skill Enhancement Elective Course (SEEC) (2)</th>
<th>Elective: Discipline Specific DSE (4)</th>
<th>Elective: Generic (GE) (4)</th>
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<tbody>
<tr>
<td>I</td>
<td>Descriptive Statistics (Theory+ Practical)</td>
<td>(English/MIL Communication) /Environmental Science</td>
<td></td>
<td>STAT-GE-1</td>
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<tr>
<td></td>
<td>Calculus</td>
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<tr>
<td>II</td>
<td>Probability and Prob. Distributions (Theory+ Practical)</td>
<td>Environmental Science/ (English/MIL Communication)</td>
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<td>STAT-GE-2</td>
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<tr>
<td></td>
<td>Algebra</td>
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<tr>
<td>III</td>
<td>Sampling Distributions (Theory+ Practical)</td>
<td></td>
<td>STAT-SEE-1</td>
<td>STAT-GE-3</td>
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<tr>
<td></td>
<td>Survey Sampling &amp; Indian Official Statistics (Theory+Practical)</td>
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<td></td>
<td>Mathematical Analysis</td>
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<tr>
<td>IV</td>
<td>Statistical Inference (Theory+ Practical)</td>
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<td>STAT-SEE-2</td>
<td>STAT-GE-4</td>
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<td></td>
<td>Linear Models (Theory+ Practical)</td>
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<td>Statistical Quality Control (Theory+ Practical)</td>
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<td>V</td>
<td>Stochastic Processes and Queuing Theory (Theory+ Prac Practical)</td>
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<td>STAT-DSE-2</td>
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<td>VI</td>
<td>Design of Experiments (Theory+ Practical)</td>
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<td>STAT-DSE-3</td>
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<td>SEMESTER I</td>
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<td>STAT-AEC-2</td>
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<tr>
<td>STAT-C-201</td>
<td>Probability and Probability Distributions</td>
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<td>STAT-C-301</td>
<td>Sampling Distributions</td>
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<td>STAT-C-301</td>
<td>Practical/Lab. Work</td>
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<td>STAT-C-302</td>
<td>Survey Sampling &amp; Indian Official Statistics</td>
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<td>STAT-C-302</td>
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<tr>
<td>STAT-C-401</td>
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<td>STAT-C-402</td>
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### SEMESTER V

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<th>Course Code</th>
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<tbody>
<tr>
<td>STAT-C-501</td>
<td>Stochastic Processes and Queuing Theory</td>
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<td>Practical/Lab. Work</td>
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<tr>
<td>STAT-C-502</td>
<td>Statistical Computing Using C/C++ Programming</td>
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### SEMESTER VI

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<thead>
<tr>
<th>Course Code</th>
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<tr>
<td>STAT-C-601</td>
<td>Design of Experiments</td>
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<td>STAT-C-602</td>
<td>Multivariate Analysis and Nonparametric Methods</td>
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<td>STAT-DSE-4*</td>
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* Project Work will be offered in the Sixth Semester.
Core Papers (Credit: 6 each) (14 papers)

- STAT-C-101 Descriptive Statistics (Theory+ Practical)
- STAT C-102 Calculus
- STAT-C-201 Probability and Probability Distributions (Theory+ Practical)
- STAT C-202 Algebra
- STAT-C-301 Sampling Distributions (Theory+ Practical)
- STAT-C-302 Survey Sampling and Indian Official Statistics (Theory+ Practical)
- STAT C-303 Mathematical Analysis
- STAT-C-401 Statistical Inference (Theory+ Practical)
- STAT-C-402 Linear Models (Theory+ Practical)
- STAT-C-403 Statistical Quality Control (Theory+ Practical)
- STAT-C-501 Stochastic Processes and Queuing Theory (Theory+ Practical)
- STAT-C-502 Statistical Computing Using C/C++ Programming (Theory+ Practical)
- STAT-C-601 Design of Experiments (Theory+ Practical)
- STAT-C-602 Multivariate Analysis and Nonparametric Methods (Theory+ Practical)

Discipline Specific Elective Papers (Credit: 6 each) (4 papers to be selected)

1. Operations Research (Theory+ Practical)
2. Time Series Analysis (Theory+ Practical)
3. Econometrics (Theory+ Practical)
4. Demography and Vital Statistics (Theory+ Practical)
5. Financial Statistics (Theory+ Practical)
6. Actuarial Statistics (Theory+ Practical)
7. Survival Analysis and Biostatistics (Theory+ Practical)
8. Project Work (Sixth Semester)

Generic Elective Papers (GE) (Credit: 6 each) (4 papers of any discipline to be selected from other Departments/Disciplines)

Skill Enhancement Electives (Credit: 2 each) (2 papers to be selected)

1. Statistical-Data Analysis Using Software Packages
2. Statistical Data Analysis Using R
3. Statistical Techniques for Research Methods
4. Data Base Management Systems

Generic Elective Papers (GE) (Credit: 6 each) (Any four to be offered to other Departments/Disciplines)

1. Statistical Methods
2. Introductory Probability
3. Basics of Statistical Inference
4. Introduction to Operations Research
5. Applied Statistics
6. Research Methodology
Core Papers in Statistics

STAT-C-101 Descriptive Statistics

Credit 6

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

UNIT II

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:

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

STAT C-102 - Calculus

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

UNIT II

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, Linear differential equations with non-constant coefficients, Reduction of order method, The Cauchy-Euler’s equation of order n, Legendre’s linear equation.

UNIT IV:

SUGGESTED READINGS:

Core Papers in Statistics

STAT-C-201 Probability and Probability Distributions

Credit 6

UNIT I

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, moment generating function, cumulant generating function and characteristic function. Uniqueness and inversion theorems (without proof) along with applications. Conditional expectations.

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

SUGGESTED READING:

PRACTICAL/LAB. WORK:

List of Practical

1. Fitting of binomial distributions for n and p = q = ½.
2. Fitting of binomial distributions for given n and p.
3. Fitting of binomial distributions after computing mean and variance.
4. Fitting of Poisson distributions for given value of lambda.
5. Fitting of Poisson distributions after computing mean.
6. Fitting of negative binomial.
7. Fitting of suitable distribution.
8. Application problems based on binomial distribution.
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.
14. Fitting of normal distribution when parameters are given.
15. Fitting of normal distribution when parameters are not given.
Core Papers in Statistics

STAT C- 202- Algebra

Credit 6

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

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

SUGGESTED READINGS:
Core Papers in Statistics

STAT-C-301 Sampling Distributions

Credit 6

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 rth order statistic, smallest and largest order statistics. Joint distribution of rth and sth 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 \(\chi^2\) 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.
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(\(n_1,n_2\)). Relationship between t, F and \(\chi^2\) distributions. Test of significance and confidence Intervals based on t and F distributions.

SUGGESTED READING:


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.
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
Core Papers in Statistics
STAT-C-302 Survey Sampling and Indian Official Statistics

Credit 6

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.

UNIT II
Stratified random sampling: Technique, estimates of population mean and total, variances of these estimates, proportional and optimum allocations and their comparison with SRS. Practical difficulties in allocation, estimation of gain in precision, post stratification and its performance. Systematic Sampling: Technique, estimates of population mean and total, variances of these estimates \((N=nxk)\). Comparison of systematic sampling with SRS and stratified sampling in the presence of linear trend and corrections.

UNIT III
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. Concept of sub sampling

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. Government of India’s Principal publications containing data on the topics such as population, industry and finance.

SUGGESTED READING:

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. 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.
Core Papers in Statistics

STAT C- 303- Mathematical Analysis

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, neighborhoods and limit points, Superimum and infimum, derived sets, open and closed sets, sequences and their convergence, limits of some special sequences such as \( r^n \left(1 + \frac{1}{n}\right)^n \) and \( \frac{2}{n} \) 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 and Lagrange’s Mean Value theorems. Taylor’s theorem with lagrange’s and Cauchy’s form of remainder(without proof). Taylor’s and Maclaurin’s series expansions of \( \sin x, \cos x \), \( e^x \), \( (1+x)^n \), \( \log (1+x) \).

UNIT-IV

SUGGESTED READINGS
Core Papers in Statistics

STAT-C-401 Statistical Inference

Credit 6

UNIT I

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
Sequential Analysis: Sequential probability ratio test (SPRT) for simple vs simple hypotheses. Fundamental relations among \( \alpha \), \( \beta \), 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 READINGS:

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. SPRT procedure
18. OC function and OC curve
19. ASN function and ASN curve
Core Papers in Statistics

STAT-C-402 Linear Models

Credit 6

UNIT I

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.

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.

SUGGESTED READINGS:


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. Orthogonal Polynomials
9. Analysis of Variance of a one way classified data
10. Analysis of Variance of a two way classified data with one observation per cell
11. Analysis of Covariance of a one way classified data
12. Analysis of Covariance of a two way classified data
Core Papers in Statistics

STAT-C-403 Statistical Quality Control

Credit 6

UNIT I

UNIT II

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

SUGGESTED READING:

PRACTICAL/LAB. WORK:

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.
Core Papers in Statistics

STAT-C-501 Stochastic Processes and Queuing Theory

Credit 6

UNIT I

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, graph theoretic approach.

UNIT III
Poisson Process: postulates of Poisson process, properties of Poisson process, inter-arrival time, pure birth process, Yule Furry process, birth and death process, pure death process.

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 READING:


PRACTICAL/LAB. WORK

List of Practical

1. Calculation of transition probability matrix
2. Identification of characteristics of reducible and irreducible chains.
3. Identification of types of classes
4. Identification of ergodic transition probability matrix
5. Stationarity of Markov chain and graphical representation of Markov chain
6. Computation of probabilities in case of generalizations of independent Bernoulli trials
7. Calculation of probabilities for given birth and death rates and vice versa
8. Calculation of probabilities for Birth and Death Process
9. Calculation of probabilities for Yule Furry Process
10. Computation of inter-arrival time for a Poisson process.
11. Calculation of Probability and parameters for (M/M/1) model and change in behaviour of queue as $N$ tends to infinity.
12. Calculation of generating function and expected duration for different amounts of stake.
13. Computation of probabilities and expected duration between players.
Core Papers in Statistics

STAT-C-502 Statistical Computing Using C/C++ Programming

Credit 6

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 READING:


PRACTICAL/LAB WORK (Using C/C++ Programming Language)

List of Practical

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

STAT-C-601 Design of Experiments

Credit 6

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

UNIT IV
Fractional factorial experiments: Construction of one-half and one-quarter fractions of $2^n$ ($n \leq 5$) factorial experiments, Alias structure, Resolution of a design.

SUGGESTED READINGS:


PRACTICAL/LAB. WORK:

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
12. Analysis of a single replicate of a $2^n$ design
13. Analysis of a fraction of $2^n$ factorial design
Core Papers in Statistics

STAT-C-602 Multivariate Analysis and Nonparametric Methods

Credit 6

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

UNIT II
Multivariate Normal distribution and its properties. Sampling distribution for mean vector and variance-covariance matrix. Multiple and partial correlation coefficient and their properties.

UNIT III
Applications of Multivariate Analysis: Discriminant Analysis, Principal Components Analysis and Factor Analysis.

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

SUGGESTED READING:

PRACTICALS/ LAB WORK:

List of Practical

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

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 READING:

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

List of Practical

1. Mathematical formulation of L.P.P and solving the problem using graphical method, Simplex technique and Charne’s Big M method involving artificial variables.
2. Identifying Special cases by Graphical and Simplex method and interpretation
   a. Degenerate solution
   b. Unbounded solution
   c. Alternate solution
   d. Infeasible solution
3. 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
DSE Papers in Statistics

STAT-DSE-2 Time Series Analysis

UNIT I
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
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

UNIT IV

SUGGESTED READING:


PRACTICAL / LAB WORK

List of Practical
1. Fitting and plotting of modified exponential curve
2. Fitting and plotting of Gompertz curve
3. Fitting and plotting of logistic curve
4. Fitting of trend by Moving Average Method
5. Measurement of Seasonal indices Ratio-to-Trend method
6. Measurement of Seasonal indices Ratio-to-Moving Average method
7. Measurement of seasonal indices Link Relative method
8. Calculation of variance of random component by variate difference method
9. Forecasting by exponential smoothing
10. Forecasting by short term forecasting methods.
UNIT I
Introduction: Objective behind building econometric models, nature of econometrics, model building, role of econometrics, structural and reduced forms. General linear model (GLM). Estimation under linear restrictions.

UNIT II
Multicollinearity: Introduction and concepts, detection of multicollinearity, consequences, tests and solutions of multicollinearity, specification error.

UNIT III

UNIT IV

SUGGESTED READING:


PRACTICAL /LAB WORK

List of Practical

1. Problems based on estimation of General linear model
2. Testing of parameters of General linear model
3. Forecasting of General linear model
4. Problems concerning specification errors
5. Problems related to consequences of Multicollinearity
6. Diagnostics of Multicollinearity
7. Problems related to consequences of Autocorrelation (AR(I))
8. Diagnostics of Autocorrelation
9. Estimation of problems of General linear model under Autocorrelation
10. Problems related to consequences Heteroscedasticity
11. Diagnostics of Heteroscedasticity
12. Estimation of problems of General linear model under Heteroscedastic distance terms
13. Problems related to General linear model under (Aitken Estimation )
DSE Papers in Statistics

STAT-DSE-4 Demography and Vital Statistics

Credit 6

UNIT I

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 READING:

PRACTICAL/LAB. WORK:

List of Practical

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

UNIT I

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

UNIT III

UNIT IV

SUGGESTED READING:


PRACTICAL / LAB WORK (Using spreadsheet/ R)

List of Practical

1. To verify “no arbitrage” principle
2. To verify relationship between spot price, forward price, future price
3. To price future contracts
4. To verify put-call parity for European options
5. To construct binomial trees and to evaluate options using these trees
6. To price options using black – Scholes formula
7. To hedge portfolios using delta and gamma hedging
8. To hedge portfolios theta hedging
9. Pricing of call options using binomial model
10. Computation of dividends on call options as a percentage of stock price.
11. Computation of dividends on call options as a fixed amount of money.
12. Pricing of put options using binomial model
13. Call-put parity for options following binomial models.
14. Effect of dividends on put options.
UNIT I
Introductory Statistics and Insurance Applications: Discrete, continuous and mixed probability distributions. Insurance applications, sum of random variables. Utility theory: Utility functions, expected utility criterion, types of utility function, insurance and utility theory.

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

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

UNIT IV

SUGGESTED READING:

PRACTICAL / LAB WORK (Using Spreadsheet/R)

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

Credit 6

UNIT I
Survival Analysis: Functions of survival times, survival distributions and their applications-exponential, gamma, Weibull, Rayleigh, lognormal, death density function for a distribution having bath-tub shaped hazard function.
Censoring Schemes: Type I, Type II and progressive or random censoring with biological examples. Estimation of mean survival time and variance of the estimator for Type I and Type II censored data with numerical examples. Non-parametric methods: Actuarial and Kaplan-Meier methods for estimating survival function and variance of the Estimator.

UNIT II

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

UNIT IV

SUGGESTED READING:
PRACTICAL / LAB WORK

List of Practical

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

Credit 6

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

STAT-GE-1 Statistical Methods

Credit 6

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, interval and ratio. Presentation: tabular and graphic, including histogram and ogives.

UNIT II

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:


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.
Generic Elective

STAT-GE-2 Introductory Probability

Credit 6

UNIT I

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:

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
Generic Elective

STAT-GE-3 Basics of Statistical Inference

Credit 6

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 Chi-
square 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:

   (2005).
   John Wiley.

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.
7. Test for correlation coefficient.
8. Sign test for median.
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.
Generic Elective

STAT-GE-4 Introduction to Operations Research

Credit 6

UNIT I

UNIT II
Optimum solution to a L.P.P: Simplex method, concept of artificial variables and Charne’s big M-technique. Graphically identifying special cases of L.P.P. Concept of duality in L.P.P.

UNIT III
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. Assignment problem: Hungarian method to find optimal assignment.

UNIT IV
Game theory: 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. Networking: Shortest route problem

SUGGESTED READING:


PRACTICAL/LAB WORK: Using TORA/WINQSB/LINGO

List of Practical

1. Mathematical formulation of L.P.P and solving the problem using graphical method
2. Simplex technique to solve L.P.P 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, Alternate 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. Problems based on game matrix: mx2 / 2xn rectangular and Mixed strategy
Generic Elective

STAT-GE-5 Applied Statistics

Credit 6

UNIT I

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

UNIT III

UNIT IV

SUGGESTED READING:

PRACTICAL/LAB WORK

List of Practical

1. Measurement of trend: Fitting of linear, quadratic trend, exponential curve and plotting of trend values and comparing with given data graphically.
2. Measurement of seasonal indices by Ratio-to-trend method and plotting of trend values and comparing with given data graphically.
4. Construction of wholesale price index number, fixed base index number and consumer price index number with interpretation
5. Construction and interpretation of X bar & R-chart
6. Construction and interpretation p-chart (fixed sample size) and c-chart
7. Computation of measures of mortality
8. Completion of life table
9. Computation of measures of fertility and population growth
GE Papers in Statistics

STAT-GE-6 Research Methodology

Credit 6

UNIT I
Introduction to research, meaning of research, role of research in important areas, process of research, types of research, Unit of analysis, characteristics of interest. Research problem as a hypothesis testing
Sampling Techniques: Introduction to sampling, advantage of sampling over census, simple random sampling, sampling frame, probabilistic aspects of sampling, stratified random sampling, other methods of sampling, sampling design, non probability sampling methods

UNIT II
Data: Introduction, primary and secondary data, methods of collecting primary data, merits and demerits of different methods of collecting primary data, designing a questionnaire, pretesting a questionnaire, editing of primary data, technique of interview, collection of secondary data, scrutiny of secondary data,
Data Processing: Introduction, editing of data, coding of data, classification of data, tables as data presentation devices, graphical presentation of data

UNIT III
Data Analysis: An overview on techniques in univariate, bivariate and multivariate data
Models and Model Building: role of models, types of models, objectives of modeling, model building/ model development, model validation, simulation models

UNIT IV
Formats of Reports: introduction, parts of a report, cover and title page, introductory pages, text, reference section, typing instructions, copy reading, proof reading,
Presentation of a report: introduction, communication dimensions, presentation package, audio-visual aids, presenter's poise.

SUGGESTED READING:

PRACTICAL/LAB WORK
Submit a Research Report based on empirical study on some real life situation. The student will personally collect, analyse, interpret the data and prepare a report under the supervision of a faculty.
Skill Enhancement Elective

STAT-SEE-1 Statistical-Data Analysis Using Software Packages

Credit 2

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

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

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

UNIT III
Random number generation and sampling procedures. Fitting of polynomials and 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:
Skill Enhancement Elective

STAT-SEE-2 Statistical Data Analysis Using R

Credit 2

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

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

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

UNIT III
Random number generation and sampling procedures. Fitting of polynomials and 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:

Skill Enhancement Elective

STAT-SEE-3 Statistical Techniques for Research Methods

Credit 2

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

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

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

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

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

SUGGESTED READING:

Skill Enhancement Elective

STAT-SEE-4 Data Base Management Systems

Credit 2

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

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

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

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

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

SUGGESTED READING:

1. Gruber, M(1990): Understanding SQL, BPB publication