Choice Based Credit System (CBCS) Syllabus for M.A./M.Sc. Statistics
1st Semester for Batch 2018 w.e.f 2018 and onwards BOSPG held on 19/11/2018

General Instructions for the Candidates

1. The two years (4 semesters) PG Programmes is of 96 credit weightage i.e. 24 credits/semester ($24 \times 4 = 96$).
2. Out of 24 credits in a semester a candidate has to obtain 14 credits compulsorily from the Core Courses, while the remaining 10 credits can be obtained from the Electives(DCE, GE & OE) in the following manner:
   - A candidate can obtain a maximum of 8 credits within his /her own Department out of specialization offered by the Department as Discipline Centric Electives.
   - 2 credits shall be obtained by the candidate from the Electives(GE, OE) offered by the Department other than his/her own. The candidate shall be free to obtain these 2 credits from the General or Open Elective or a Combination of both.

### SEMESTER – I

<table>
<thead>
<tr>
<th>Course Type</th>
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<th>Title of the Course</th>
<th>No. of Credits</th>
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<tr>
<td>Core (CR)</td>
<td>ST18101CR</td>
<td>Probability and Distribution Theory - I</td>
<td>04</td>
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<td>ST18102CR</td>
<td>Sampling Techniques</td>
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<td>Time Series Analysis</td>
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<td>ST18105DCE</td>
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<td>Linear Algebra</td>
<td>02</td>
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<td>ST18107DCE</td>
<td>Real Analysis</td>
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PROBABILITY AND DISTRIBUTION THEORY-I

COURSE NO: ST18101CR       No. of Credits-4

UNIT-I
Class of sets, fields, sigma fields, minimal sigma field, and Borel sigma field. Definition of probability: classical and relative frequency approach, discrete probability space, properties of probability based on axiomatic approach, Independence of events, conditional probability, total and compound probability rules. Bayes theorem and its applications. Random variable. Cumulative distribution function of random variables and its properties, probability function of a random variable.

UNIT-II

UNIT-III
Standard Univariate discrete distributions: Discrete Uniform, Bernoulli, Binomial, Poisson, Negative Binomial, Geometric, Hyper geometric, logarithmic distributions and their structural properties, relations and applications, Marginal and conditional distributions. Some idea of truncations.

UNIT-IV
Univariate Continuous distributions: Uniform, Beta, Gamma, Exponential, Pareto, Weibull, Laplace, Normal, Cauchy and their structural properties, relations and applications, Marginal and conditional distributions. Some idea of truncations.

TEXT BOOKS:

REFERENCES:
SAMPLING TECHNIQUES
COURSE NO: ST18102CR

UNIT I
Simple Random Sampling: Concept of sampling design, expected value and sampling variance of the sample mean, expected value of the sample mean square and estimation of the variance. Determination of sample size. Simple random sampling as applied to qualitative characteristics.

UNIT II
Stratified random Sampling: Estimation of the population mean/total and its variance, choice of sample sizes in different strata, variance under different allocations. Comparison with unstratified sampling. Estimation of the gain in precision due to stratification, construction of strata.

UNIT III

UNIT-IV

TEXT BOOKS:
STATISTICAL COMPUTING

COURSE NO: ST18103CR  No. of Credits-4

UNIT-I

Introduction to computers, Classification of computers, advantages, disadvantages and applications of computers, Basic set up of electronic computers, input and output devices. Basic idea about computer packages (Statistical Packages).

UNIT-II


UNIT-III

Using MINITAB: Correlation & Regression analysis: simple and multiple. Tests of significance, Errors in sampling, Critical region and level of significance, Test of significance of large samples, Test of single proportion, Test of significance of difference of proportions.

UNIT-IV

Using MINITAB: Chi-Square test for independence of attributes and Contingency table, t-test, Paired t-test, Test for correlation in sampling from normal population, F-test, testing of two variance of two univariate normal population.

TEXT BOOKS:

TIME SERIES ANALYSIS

COURSE NO: ST18104CR                                      No. of Credits-2

UNIT –I


UNIT –II

Measurement of Trend, Method of Semi-fitting by principle of least squares, fitting by straight line by Least Squares, Merits and Limitations of given methods, Modified exponential curves and fittings.

References & Text book:


@#
STOCHASTIC PROCESSES

COURSE NO: ST18105DCE

UNIT I
Introduction to Stochastic Processes (SP’s); Classification of Stochastic Processes according to state space and time domain. Definition of Markov Chain and examples. Countable state Markov chains (MC’s), Chapman-Kolmogrov equations; Calculation of n-step transition probability and its limit.

UNIT II
Stationary distribution, Classification of states: persistent state, transient state and ergodic state, examples, limiting theorems concerning states; Simple Random Walk Model and gambler’s ruin problem; expected duration of the game, Probability of ruin at the nth trail. And Probability of a draw at the rth trial.

UNIT III

UNIT IV

TEXT BOOKS:
LINEAR ALGEBRA

COURSE NO: ST18106DCE  No. of Credits-2

UNIT-I

Algebra of Matrices, trace of a matrix, \( \text{tr}(AB) = \text{tr}(BA) \), idempotent and nilpotent matrices, Inverse of square matrix, Inverse of partitioned matrices, Vector space, basis and dimensions, Rank of matrix, linear independence and linear dependence of row (column) vectors, characteristic and minimal equation, Cayley-Hamilton Theorem and its Applications.

UNIT-II

Linear equations, solution of homogenous and non-homogenous equations, Inner product spaces, orthogonal and orthonormal basis. Eigen values and Eigen vectors of a matrix and their determination, orthogonal and Unitary matrices. Quadratic forms, reduction and classification of quadratic forms,

TEXT BOOKS:

REAL ANALYSIS

COURSE NO: ST18107DCE     No. of Credits-2

UNIT-I

Real Analysis: Finite, countable and uncountable sets, bounded and unbounded sets, Archimedean property, ordered field, completeness of R, sequence and series, limit sup. and limit inf. of a bounded sequence. Convergence and divergence of positive term series (simple problems only).

UNIT-II

Continuity, uniform continuity, the algebra of continuous functions, monotonic functions, types of discontinuities, infinite limits and limits at infinity. Differentiability, Rolle’s Theorem, Mean Value Theorems, Riemann sum and integral and Uniform Convergence (simple problems). Functions of several variables.

TEXT BOOKS:
Apostol, T.M (1985), Mathematical Analysis, Narosa, India Ed.
Courant, R.and John, F.(1965), Introduction to Calculus and Analysis, Wiley.
S.C.Malik, Mathematical Analysis, New Age International Limited.
COURSE NO: ST18108DCE No. of Credits-2

PRACTICAL BASED

ON

COURSES

ST18101CR
&
ST18102CR

Using Statistical Software
COURSE NO: ST18109DCE  No. of Credits-2

PRACTICAL BASED

ON

COURSE

ST18103CR
&
ST18104CR

Using Statistical Software
STATISTICAL METHODS

COURSE NO: ST18110GE

No. of Credits-2

UNIT-I

Descriptive Statistics: Measures of central tendency, Characteristic for an ideal measure of dispersion, Measure of dispersion range, quartile deviation, variance, standard deviation, coefficient of variation, Skewness and Kurtosis.

UNIT-II

Measures of Co-relation: Scatter diagram, Karl Pearson Coefficient of correlation, Rank correlation, Regression, Lines of regression, Regression co-efficient, Fitting of regression lines.

TEXT BOOKS:

- S.C. Gupta & V.K Kapoor (2012), Fundamentals of Mathematical Statistics, Sultan Chand & Sons,
TESTING OF HYPOTHESIS-I (PARAMETRIC)

Course No: ST18111GE  No. of Credits-2

UNIT I

The basic idea of significance test, Null and alternative hypothesis, two tailed and one tailed test of hypothesis, Type I & Type II errors, level of significance, critical region, degree of freedom, concept of p-value.

UNIT II

Test for large samples: test of mean, test for difference between mean of two samples, test for difference between the standard deviations of two samples. Tests of proportions: single and difference of proportion, Chi-square test: for independence of attributes and goodness-of-fit.

References:

BASIC TIME SERIES ANALYSIS

COURSE NO: ST18112OE

UNIT –I


UNIT –II


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<td>Probability and Distribution Theory – II</td>
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<td>ST18202CR</td>
<td>Linear Models and Regression Analysis</td>
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<td>ST18203CR</td>
<td>Advanced Statistical Computing</td>
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<td>ST18204CR</td>
<td>Advanced Sampling Techniques</td>
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<td>Discipline Centric Elective (DCE)</td>
<td>ST18205DCE</td>
<td>Operations Research - I</td>
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<td>ST18206DCE</td>
<td>Actuarial Sciences</td>
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<td>ST18207DCE</td>
<td>Inventory and Queuing Theory</td>
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<td>ST18209DCE</td>
<td>Practical based on ST18203CR &amp; ST18204CR</td>
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<td>Generic Elective (GE)</td>
<td>ST18210GE</td>
<td>Sampling Theory</td>
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<td>ST18211GE</td>
<td>Testing of Hypothesis- II (Non-Parametric)</td>
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<td>Open Elective(OE)</td>
<td>ST18212OE</td>
<td>Basic Design of Experiments</td>
<td>02</td>
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PROBABILITY AND DISTRIBUTION THEORY - II

COURSE NO: ST18201CR  No. of Credits-4

UNIT-I
Sampling distributions: Chi-square and F distributions and their properties and applications, Non-central F and Chi-square distribution. Test of significance of F and Chi-square.

UNIT-II
Sampling distributions: t distribution and its properties and applications, Non-central t-distribution. Test of significance of t.
Bivariate distributions: Bivariate normal distribution, exponential and multinomial distributions and their properties, marginal and conditional distributions. Expectations and conditional expectations, covariance.

UNIT-III
Bivariate discrete distributions: Power series distributions and generalized power series distribution and its properties, relations and applications.

UNIT-IV
Convergence: Convergence of a sequence of random variables, convergence in probability, almost sure, Convergence of a sequence of pair of random variables. Convergence of moments.
Chebyshev’s and Kintchine’s weak law of large numbers (WLLNs): Condition for the WLLNs. Strong law of large number and Kalmogrov’s theorems and examples.
CLT: Introduction of CLT. Lindberg Levy, Liapunov forms and De-Movier’s central limit theorems (CLT) and examples.

TEXT BOOKS:

REFERENCES:
- Johnson, Kotz and Kemp (1992): Univariate discrete distribution, John Willy
LINEAR MODELS AND REGRESSION ANALYSIS

COURSE NO: ST18202CR       No. of Credits-4

UNIT-I
Linear models; Gauss Markov set up, Model classification, Normal equations and least squares estimates, Error and estimation space, Variance and covariance of least square estimates, Estimation of error variance, estimation with correlated observations, least square estimates with restriction on parameters.

UNIT-II
Test of hypotheses for one and more than one linear parametric functions, Tests of linear hypotheses, estimable linear hypotheses, confidence intervals and prediction intervals, Generalized F test, generalized t test.

UNIT-III
Experimental Design models; Introduction, Point estimation, Re-parameterization, Variance and Covariance of estimable function, testing of hypotheses, Regression models.

UNIT-IV
Simple linear regression fit of polynomials, Residual and their plot as tests for departure from assumption such as fitness of model, normality, and homogeneity of variances and detection of outliers, Analysis of covariance, estimation and testing ,one way model with one covariance, two way model with two covariance

TEXT BOOKS:

• Rencher,A.C And Schaalje,G.B(2007),Linear Model in Statistics, John Wiely and Sons.
ADVANCED STATISTICAL COMPUTING

COURSE NO.: ST18203CR No. of Credits-4

UNIT-I

UNIT-II
Using R Software’s: Correlation & Regression analysis: simple and multiple. Tests of significance, Test of significance of large samples, Test of single proportion, Test of significance of difference of proportions.

UNIT-III
Using R Software’s: Difference of mean & proportion, Chi-Square test for independence of attributes and Contingency table, t-test, Paired t-test, Test for correlation in sampling from normal population, F-test, testing of two variance of two univariate normal population.

UNIT-IV
Using R Software’s: Simulation Studies, random number generation of various probability distributions. Codes for different programmes in R-Software. Estimation of parameters of different probability functions by using R.

TEXT BOOKS:
ADVANCED SAMPLING TECHNIQUES

Course No: STM18204CR  No. of Credits-2

UNIT- I


UNIT- II

Two-stage sampling: (a) Equal first stage unit; estimation of population mean and its variance and estimates of variance. Comparison with one stage sampling
(b) Unequal first stage unit; estimation of population mean. Expected values and variance of different estimates including the case of probability proportional to size

TEXT BOOKS:

OPERATIONS RESEARCH - I
Course No: ST18205DCE No. of Credits-4

UNIT I
Definition and scope of Operational research, Necessity of Operations Research in Industry; phases in Operations Research. LP problems: Simplex method and Extreme point theorems; Revised Simplex Method, Transportation and Assignment Problems with their methods of solution.

UNIT II
Duality in LPP, Symmetric and asymmetric dual problems, duality theorems, Primal-Dual Relations, Complementary Slackness Theorem and Complementary Slackness conditions, Dual Simplex Method.

UNIT III
Decision Making in the face of competition, two–person, Zero sum games, Games with mixed strategies, existence of solution and uniqueness of value in zero-sum games, finding solutions in 2x2, 2xm and mxn games, Equivalence between game theory and linear programming problem.

UNIT IV
Sequencing and scheduling problems: 2 machine n-job; 3 machine n-job problems with identical machine sequence for all jobs; 2-job n-machine problem with different routings. Project management; PERT and CPM; Probability of project completion.

TEXT BOOKS:

REFERENCES:
ACTUARIAL SCIENCE

Course No.: ST18206DCE                      No. of Credit-2

Unit I:
Survival models, sickness and marriage models in terms of Markov processes, force of mortality, hazard rate. Actuarial symbols $t_p_x$ and $t_q_x$ and integral formulas, Gompertz-Makeham laws of mortality, life tables

Unit II:
Lifetime distributions and estimation, Failure rate, mean residual life and their elementary properties, types of censoring, Estimation of survival function, Kaplan-Meier estimate, Nelson-Aalen estimate and their applications, Semi-parametric regression for failure rate, Cox proportional hazard model

Recommended Textbooks:

- Elandt - Johnson, R.E. Johnson N.L., Survival models and Data Analysis, John Wiley and Sons
- Miller, R.G., Survival Analysis (Wiley)
- Zacks, S., Reliability
INVENTORY AND QUEING THEORY

Course No.: ST18207DCE No. ofCredit-2

UNIT- I

Analytical structure of inventory problems; ABC Analysis: EOQ problem with and without shortages with (a) production is instantaneous (b) Finite Constant rate (c) shortages permitted random models where the demand follows uniform distributing, multistage inventory subject to constraints,

UNIT - II

Queuing models-specifications and effectiveness measures. Littles formula, Steady-state solutions M/M/1 and M/M/C models with associated distributions of queue-length and waiting time. M/G/1 queue. Steady-state solutions of M/Ek/1. Transient solution of M/M/1 queue.

TEXT BOOKS:


REFERENCE BOOKS:

COURSE NO: ST18208DCE    No. of credits -2

PRACTICAL BASED

ON

COURSES

ST18201CR
&
ST18202CR

Using Statistical Software
COURSE NO: ST18209DCE     No. of credits-2

PRACTICAL BASED

ON

COURSE

ST18203CR
&
ST18204CR

Using Statistical Software
SAMPLING THEORY

COURSE NO: ST18210GE

No. of Credits: 2

UNIT-I

Basic concepts of sampling from a finite population; sampling versus complete enumeration; simple random sampling with replacement and without replacement, Concept of sampling design, expected value and sampling variance of the sample mean, expected value of the sample mean square and estimation of the variance.

UNIT-II

Stratified random Sampling: Estimation of the population mean/total and its variance, choice of sample sizes in different strata, variance under different allocations. Comparison with un-stratified sampling. Estimation of the gain in precision due to stratification, construction of strata.

Text Books:

- S.C. Gupta & V.K Kapoor (2010), Fundamentals of Applied Statistics, Sultan Chand & Sons,
TESTING OF HYPOTHESIS - II (NON - PARAMETRIC)

Course No: ST18211GE                  No. of Credits-2

UNIT-I

Non- Parametric Inference: Introduction, Advantages and disadvantages of non-parametric tests. Sign Test-one sample and two samples, Wilcoxon-Signed rank test- one sample and two samples, Wilcoxon –Mann Whitney test, test of randomness based on total number of runs, Wald –Wilfritz run test, ARE.

UNIT-II

Empirical distribution functions, Kolmogrov-Smirnov- one sample and two samples test (for samples of equal size), Median test. Mood Test, Ansari – Bradlay Test, ARE, Linear rank statistics, distribution properties of the linear rank statistics.

REFERENCES:

- Mukhopadhayay, P.; Mathematical Statistics.
BASIC DESIGN OF EXPERIMENTS

Course No: ST18212OE               No. of Credits-2

UNIT-I

Design of experiments, Principles of Design of experiments (randomization, replication, local control) Assumptions, layout and Analysis of Completely Randomized Design (CRD), Randomized Block Design (RBD), One missing observation in RBD.

UNIT-II

Factorial experiments: General factorial experiments, factorial effects; Main effects and Interactions. Best estimates and testing the significance of factorial effects; study of 2 and 3 factorial experiments in randomized blocks; Yates method for computing different factorial effects.

Text Books:

- S.C. Gupta & V.K Kapoor (2010), Fundamentals of Applied Statistics, Sultan Chand & Sons,
- Alokdey (1986): Theory of Block Designs, Willey Eastern
- Giri, N (1986): Analysis of Variance, South Asia Publishers
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<td>Elective (OE)</td>
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STATISTICAL INFRINGEMENT – I

COURSE NO: ST18301CR

No. of Credits-4

UNIT-I
Statistical Inference: Problems of estimation and Point Estimation, the general statistical
decision problem, Example (Point estimation, Interval estimation etc.). Criteria of
unbiasedness, consistency and efficiency. Chapman Robin’s Inequality, Cramer-Rao
Inequality. Minimum variance unbiased (MVU) estimation, UMVU Estimation, Asymptotic
relative efficiency, Invariance of consistent estimator under continuous transformation.

UNIT-II
Sufficient and Complete Statistics: Sufficiency, Minimal sufficient statistic, Factorization
Statistics. Exponential families and Pitman families, Invariance property of sufficiency under
one to one transformation of sample space. Fisher information for one and several parameter

UNIT-III
Methods of estimation: Moments Method, Method of maximum likelihood (MLE). Optimum
properties of MLE. Maximum Consistent Asymptotic Normal estimators (CAN) obtained by
MLE method in one parameter exponential family. Other methods of estimation: Minimum
Chi–square, modified minimum Chi–square and least square estimate.

UNIT-IV
Interval Estimation: Determination of confidence interval based on small sample.
Determination of confidence interval based on large samples. Relation between confidence
estimation and hypothesis testing. Bayesian Interval estimation.

TEXT BOOKS:
  Wiley Eastern Ltd. New Delhi (Student Edition)

REFERENCES:
  Edition)
MULTIVARIATE ANALYSIS

COURSE NO: ST18302CR      No. of Credits -4

UNIT-I
Multivariate Normal Distribution Theory: Marginal and conditional distribution, Joint
distribution, Linear function of correlated normal variate. Characteristics function of
multivariate normal distribution, Maximum likelihood estimation of the mean vector and
covariance matrix and their independence. Distribution of sample mean vector. Large
sample behavior of mean vector and covariance matrix. Distribution of non-central chi-
square.

UNIT-II
Quadratic form and its distribution. Multiple and partial correlation co-efficient and their
sampling distribution. Simple regression model, regression co-efficient and distribution of
sample regression co-efficient. Test of linear hypothesis about regression co-efficients
and interval estimation.
Canonical Correlation and Canonical variables: Definition, uses, estimation and
statistical inference. Distribution of characteristic roots and vectors: The distribution of
canonical Correlation.

UNIT-III
Distribution of sample covariance matrix and the sample generalized variance; Wishart
matrix and its distribution. Some important properties of the Wishart distribution.
Characteristic function of Wishart distribution.
Generalized $T^2$ statistics: The general $T^2$ statistics, Derivation of the generalized $T^2$
statistics and its distribution. Some important properties of $T^2$ statistics and its uses.
Two-sample problem with unequal covariance matrices. Likelihood criterion for testing
independence of set of variate and its moments. Walk’s lambda criterion and its
distribution. Mahalanobis $D^2$ statistics and its distribution.

UNIT-IV
Classification and discrimination: Classification and discrimination procedure for
discrimination between two multivariate normal populations. Sample discriminant function,
tests associated with discriminate function, standards of good classification, probability of
misclassification and their estimation, classification into two and more than two multivariate
normal population
Principal Component: Definition of principal components, uses, estimation and computation,
Statistical inference on principal components.
Factor Analysis: Definition of factor analysis and uses, linear factor models, estimation of
factor loading, Factor rotation, estimation of factor scores.

TEXT BOOKS:
  John Wiley Johnson,


Muirhead, R. J. (1982): Aspects of multivariate statistical theory,


COURSE NO.: ST18303CR  No. of Credits-4

SURVEY PROJECT

Based on Data

Using Statistical Software
DATA ANALYSIS USING SPSS

COURSE NO.: ST18304CR  No. of credits -2

UNIT-I
Measurement Scales- Nature of Variables: Types of Data. Introduction to SPSS, entering variables, labelling variables, labelling values, entering string variables, Transformation of variables, Exporting and Importing data files from other packages, selecting cases, Recoding data, computing functions (creating new variables). Measures of Central Tendency and their interpretation, OLAP Cubes, Summary Statistics (overall and for groups of cases), Dispersion, Skewness, Quartiles, Percentiles and Kurtosis. Saving data and output files. Split files, Weight cases, Graphical Representation of Data- Bar Charts, Stacked Bar, Histogram, Line diagram, Pie diagram, Box Plot, Multiple Box Plot, Error bar, Stem–and–Leaf diagram, Exporting Graphs. Three dimensional Graphs. Missing values analysis. Generating Random variables, Embedded Tables. Basic distributions (Binomial, Poisson, Normal, Exponential etc.) Generating random samples from these distributions. Cross Tabs, odds ratio and risk ratio.

UNIT-II
Correlation Analysis: Scatter plot, Karl Pearson’s, Spearman’s and Partial correlation, Concept of p-value. Regression Analysis: Introduction to linear models. Simple linear regression involving two variables. Multiple Linear regression including stepwise Regression. Significance of $R^2$ and Adjusted $R^2$, significance of Regression Coefficients. Concept of Multicollinearity and Tolerance, and their remedies. Model diagnostics. Parametric Tests: Normal Probability curve, checking normality assumption using histogram, box plot, quantile (Q-Q), and probability (P-P) plots. Kolmogorov-Semirnov’s and Spiro-Wilk’s tests for normality. Basic concepts of Testing (hypothesis, types of errors, power, critical value, level of significance), one-sample t-test, independent t-test, paired t-test, one-way & two-way ANOVA. Repeated ANOVA.

TEXT BOOKS:
AjaiGaur,S. Statistical methods for practice & research: a guide to data analysis using SPSS
Choice Based Credit System (CBCS) Syllabus for M.A./M.Sc. Statistics
3rd - Semester for Batch 2018 w.e.f 2018 and onwards BOSPG held on
19/11/2018

DEMOGRAPHY

COURSE NO: ST18305DCE  No. of Credits–4

UNIT I

Introduction and definition of vital Statistics, coverage and content errors in demographic
data, use of balancing equations, Chandera sekharan-Deming formula to check
completeness of registration data. Accuracy of age data on sex and age: Whipple’s and
Myer’s indices. Dependency ratio.

UNIT II

Measure of fertility; relationship between CBR, GFR and TFR. Mathematical models on
fertility and human reproduction process, Dandekar’s modified binomial and Poisson
models. Distributions of time to first birth, William Brass Model, Singh’s model and
Singh’s modified model, inter-live birth intervals and of number of births, estimation of
parity progression ratios from open birth interval data.

Unit III

Mortality: concepts and rates; measures of infant mortality rate. Force of mortality. Life
table and its construction: Complete and abridged. Greville’s and Reed-Merrels methods.
Relationship between life table functions and their estimation. Relationship between
abridged life table functions.

Unit IV

Population projection: Methods for population projection. Use of Leslie matrix. Frejka’s
component method. Logistic Model for population growth and their fitting to population
data. Migration: concepts and rates. Uses of place of birth and duration of residence data.

TEXT BOOKS:

  Press.
OPERATIONS RESEARCH - II

COURSE NO.: ST18306DCE

UNIT I

Integer Programming: Gomory’s Cutting Plane algorithm & branch and bounded method for all integer and mixed integer, Dynamic programming: Single additive constraint; additive separable return, single multiple constraints; additive separable returns, Single additive constraints; multiple separable returns.

UNIT II

Nonlinear programming, Formulation, Lagrange multiplier Technique, Kuhn Tucker necessary and sufficient conditions for optimality of an NLPP, constraint multivariable optimization with inequality constraints. Quadratic Programming problems: Wolfe’s and Beale’s algorithms for solving quadratic programming problems.

TEXT BOOKS:
- Kabmboj ,Puri,N,C;Mathematical Programming

REFERENCES:
- Bazara and Shetty (1979) Nonlinear Programming Theory And Algorithms; John Wiley
BIO - STATISTICS

COURSE NO.: ST18307OE       No. of credits-2

UNIT-I

Epidemiological method: Evolution of Epidemiology, Causal relationship, establishing a causal relationship, Prevalence, Incidence, Prevalence versus incidence. Types of study design:- Cross-sectional study; Case-Control study measures of association in case control studies, cohort studies; measures of association.

UNIT- II

Importance of sample size in research design: Diagnostic tests:- Accuracy of a diagnostic test, sensitivity and specificity; predictive values, limitation of predictive values. Bayes theorem, Likelihood ratio. LR of positive tests (LR+) & LR of a negative test(LR-). Post test odds when the test outcome is positive (negative). Tree method for obtaining post test probabilities, Receiver operating characteristics curve.

Books Recommended

- Bio statistics by Daniel. @#
COURSE NO.: ST18308DCE    No. of credits -2

PRACTICAL BASED

ON

COURSES

ST18301CR
&
ST18304CR

Using Statistical Software
COURSE NO.: ST18309DCE    No. of credits -2

PRACTICAL BASED
ON
COURSES
ST18302CR

Using Statistical Software
DATA ANALYSIS USING MINITAB

COURSE NO: ST18310GE  No. of Credits-2

UNIT-I

Statistical Software’s: MINITAB reading and manipulation of data, descriptive statistics. Commands/ Statements in MINITAB, Working with Software Package MINITAB for graphics (Histogram, Plot, Box plot, Pi-chart, QQ plot, density plot, Stem and Leaf). Matrix processing (Basic operations, Eigen Values and inversion of Matrices etc.).

UNIT-II

Using MINITAB: Correlation and Regression analysis: simple and multiple. Simple hypothesis tests (t, $\chi^2$ and F) and analysis of variance.

TEXT BOOKS:

STANDARD PROBABILITY DISTRIBUTIONS - I

COURSE NO: ST18311GE
No. of Credits-2

UNIT-I

Discrete Random variable, Distribution function, Probability mass function. Mathematical expectation, Moments, moment generating function and their properties.

UNIT-II

Standard Discrete distributions: Uniform, Bernoulli, Binomial, Poisson, geometric and their mean, variances, moments and moment generating function properties and relations.

TEXT BOOKS:

- S.C. Gupta & V.K Kapoor (2012), Fundamentals of Mathematical Statistics, Sultan Chand & Sons,
STATISTICAL QUALITY CONTROL

Course No: ST18312OE No. of Credits-2

UNIT-I:
Meaning and scope of SQC, Applications of SQC, Stewarts control chart, Statistical basis of a control chart, control chart for variables (X bar, R, & S) charts.

UNIT-II:
Control charts for attributes (np, p & C) charts. Operating Characteristic function (OC) and Average Run length (ARL) of X-bar chart. Moving average charts.

TEXT BOOKS:

- Phadke, M.S. (1989) Quality Engineering through Robust Design; Prentice Hall.
General Instructions for the Candidates

1. The two years (4 semesters) PG Programmes is of 96 credit weightage i.e. 24 credits/semester \((24 \times 4 = 96)\).

2. Out of 24 credits in a semester a candidate has to obtain 14 credits compulsorily from the Core Courses, while the remaining 10 credits can be obtained from the Electives(DCE, GE &OE) in the following manner:
   - A candidate can obtain a maximum of 8 credits within his /her own Department out of specialization offered by the Department as Discipline Centric Electives.
   - 2 credits shall be obtained by the candidate from the Electives (GE, OE) offered by the Department other than his/her own. The candidate shall be free to obtain these 2 credits from the General or Open Elective or a Combination of both.

### SEMESTER – IV

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STATISTICAL INFERENCE – II
COURSE NO: ST18401CR No. of Credits-4

UNIT-I
Testing of Hypothesis: Concepts of critical regions, test functions, two kinds of errors, size function, power function, level of significance, Most Powerful (MP) and Uniformly most powerful (UMP) test, in class of size tests. Neyman Pearson Lemma, MP tests for simple null against simple alternative hypothesis.

UNIT-II
UMP tests for simple null hypothesis against one-sided alternatives and for one-sided null against one-sided alternatives in one parameter exponential family. Extension of these results to distributions with Monotone Likelihood ratio property.

UNIT-III
Likelihood ratio tests: Large sample properties, derivation of common likelihood ratio tests, asymptotic distribution of likelihood ratio test, Consistency of tests. Uniformly Most Powerful Unbiased Tests, similar tests with Newman structure locally best unbiased tests, type A and A1 critical regions for the exponential family. Randomized test.

UNIT-IV

TEXT BOOKS:

REFERENCES:
- Berger, J, O.; Statistical Decision Theory and Bayesian Analysis, Springer Verlag.
INDUSTRIAL STATISTICS AND RELIABILITY THEORY

COURSE NO: ST18402CR  No. of Credits-4

UNIT-I:

Meaning and scope of SQC, Stewarts control chart, Statistical basis of a control chart, control chart for variables (X, R, & S) charts. Control charts for attributes (np, p & C) charts. Moving average charts, Operating Characteristic function (OC) and Average Run length (ARL) of X-bar chart.

UNIT-II:

Consumer and producer’s risk, Operating Characteristic curve/function (OC). Corrective Sampling Plan (CSP), Average Sample Number (ASN), Average out-going Quality (AOQ), Graphical method of drawing AOQ, Average out-going Quality Limit (AOQL), Single Sampling Plan, Methods of finding n and c, Double Sampling Inspection Plan and sequential sampling plan.

UNIT-III:

Capability indices $C_p$, $C_{pk}$ and $C_{pm}$, estimation, confidence intervals relating to capability indices for normally distributed characteristics. Reliability concepts, hazard rate, distribution of longevity and moments. Some important theorems based on reliability theory.

UNIT-IV:

Common life time distributions: exponential, Weibull, gamma, Gumbel and normal distributions. Type I and Type II censored samples. Reliability and hazard rate of a system with independent units connected in (a) series and (b) Parallel systems.

TEXT BOOKS:
- Montgomery, D.C. (1985) Introduction to Statistical Quality Control; Wiley
- Phadke, M.S. (1989) Quality Engineering through Robust Design; Prentice Hall
DESIGN AND ANALYSIS OF EXPERIMENTS

COURSE NO: ST18403CR       No. of Credits-4

UNIT-I

Planning of experiment: Nomenclature, Introduction to basic designs and their analysis, Principles of experimental design. Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD), missing plot techniques for RBD and LSD.

UNIT-II


UNIT-III

Introduction to Incomplete block design intra block analysis (estimability), estimates of estimable linear parametric function; Balanced Incomplete Block Design. Intra block analysis, recovery of inter block information;

UNIT IV

General factorial experiments, factorial effects; best estimates and testing the significance of factorial effects; study of 2 and 3 factorial experiments in randomized blocks; Confounding, complete and partial confounding. Fractional replication for symmetric factorials.

TEXT BOOKS:

- Alokdey (1986): Theory of Block Designs, Willey Eastern
- Giri, N (1986): Analysis of Variance, South Asia Publishers
INFORMATION THEORY

COURSE NO: ST18405DCE No. of Credits -4

UNIT-I


UNIT-II


UNIT-III


UNIT-IV

Inequalities of Information Theory: Kullback-Leibler measure of information. Mean information for discrimination and divergence and their properties, Some important generalizations of entropy measures and inequalities and their properties.

TEXT BOOKS:

- Reza,F.M(2012).: An Introduction to Information Theory, McGraw Hill
BAYESIAN ANALYSIS

COURSE NO: ST18406DCE  No. of Credits-2

Unit I

Fundamentals of Bayesian Statistics: Conditional probability and its applications in Bayesian analysis, Bayes theorem for events, Bayes factor, Generalized Bayes theorem for events, Bayes theorem for future events, Bayes theorem for random variables, and Sequential nature of Bayes theorem.

Unit II

Prior distribution and types of prior distributions, proper prior, improper prior, conjugate prior, Jeffrey’s prior, informative and non-informative priors. Bayesian method of estimation: Bayes estimation of Binomial, Poisson, exponential, Weibull and normal distributions by using various types of priors.

References:

ECONOMETRICS

COURSE NO: ST18407DCE No. of credits -2

Unit- I


Unit- II


REFERENCES:

COURSE NO.: ST18408DCE   No. of credits - 2

PRACTICAL BASED

ON

ST18401CR
&
ST18402CR

Using Statistical Software
COURSE NO.:ST18409DCE   No. of credits-2

PRACTICAL BASED

ON

ST18403CR

&

ST18404CR

Using Statistical Software
DATA ANALYSIS USING R SOFTWARE

COURSE NO: ST18410GE   No. of Credits-2

UNIT-I

Statistical Software R : Reading & Manipulation of data, Commands/Statements in R, different types of functions in R software, Descriptive Statistics, Working with Software package R for graphics, EDA: Histogram, Plot, Box plot, Pi-chart, QQ plot and density plot.

UNIT-II


TEXT BOOKS:

STANDARD PROBABILITY DISTRIBUTION – II

COURSE NO: ST18411GE No. of Credits-2

UNIT-I

Continuous Random variable, Distribution function, Probability density function, Mathematical expectation, Moments, moment generating function and their properties.

UNIT-II

Standard Continuous distributions: uniform, exponential, gamma and normal distributions, their mean, variances, Moments, moment generating function and their properties and relation.

TEXT BOOKS:

BASIC BIO - STATISTICS

COURSE NO.: ST18412OE

UNIT-I

Epidemiological method: Evolution of Epidemiology, Causal relationship, establishing a causal relationship, Prevalence, Incidence, Prevalence versus incidence. Types of study design:- Cross-sectional study ; Case-Control study measures of association in case control studies, cohort studies; measures of association.

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Books Recommended

- Bio statistics by Daniel.