St Aloysius College (Autonomous)

Mangaluru

Re-accredited by NAAC "A" Grade

Course structure and syllabus of

B. Sc.

STATISTICS

CHOICE BASED CREDIT SYSTEM

(2019 – 20 ONWARDS)

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(ಸ್ವಾಯತ್ತ)

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Re-accredited by NAAC with 'A' Grade - CGPA 3.62
Recognised by UGC as "College with Potential for Excellence"
College with 'STAR STATUS' conferred by DBT, Government of India
3rd Rank in "Swacch Campus" Scheme, by MHRD, Govt of India

No: SAC 40/Syllabus 2019-20 Date: 18-07-2019

NOTIFICATION

Sub: Syllabus of **B.Sc. Statistics** under Choice Based Credit System.

Ref: 1. Decision of the Academic Council meeting held on 02-05-2019 vide Agenda No: 22(2019-20)
2. Office Notification dated 18-07-2019

Pursuant to the above, the Syllabus of **B.Sc. Statistics** under Choice Based Credit System which was approved by the Academic Council at its meeting held on 02-05-2019 is hereby notified for implementation with effect from the academic year **2019-20**.

PRINCIPAL **REGISTRAR**

To:

1. The Chairman/Dean/HOD.
2. The Registrar Office
3. Library

Scheme of Instruction & Examination: B.Sc. Statistics-(Theory and Practical)

Semester	Title of the Paper	Hrs. of instruction	Duration of Exam	Maximum Marks Theory + IA	No. of Credits
I	G 506.1: Descriptive Statistics & Probability Theory	04	03	70+30=100	2
	G 506.1a: Descriptive Statistics & Probability Theory Practical.	03	03	40+10=50	1
	G 506.1E: Applied Statistics	02	02	40+10=50	1
II	G506.2:Probability Distributions	04	03	70+30=100	2
	G506.2a: Probability Distributions Practical.	03	03	40+10=50	1
	G 506.2E: Data Analysis using Ms Excel	02	02	40+10=50	1
III	G506.3: Statistical Inference I	04	03	70+30=100	2
	G506.3a: Statistical Inference I Practical.	03	03	40+10=50	1
	G 506.3E: Probability Distributions	02	02	40+10=50	1
IV	G506.4: Statistical Inference II	04	03	70+30=100	2
	G506.4a: Statistical Inference II Practical.	03	03	40+10=50	1
	G 506.4E: Statistical Data Analysis using SPSS	02	02	40+10=50	1
V	G506.5a.: Designs of Experiments	03	03	70+30=100	2
	G506.5 b:				
	Elective (1) – **Total Quality Management**	03	03	70+30=100	2
	OR	04	04	80+20=100	2
	Elective (2) – Regression Analysis				
	G506.5a: Practical based on G506.5 and G506.5a				
VI	G506.6a: Sampling Theory	03	03	70+30=100	2
	G506.6:				
	Elective (1) – **Operations Research**	03	03	70+30=100	2
	OR	04	04	80+20=100	2
	Elective (2) - Simulation				
	G506.6a.: Practical based on G506.6 and G506.6a				

Programme Outcomes	
PO-1.	Develop and demonstrate an ability to understand major concepts in various disciplines of Statistics.
PO-2.	Solve analytical problems independently and draw logical conclusions.
PO-3.	Analyse, interpret the data and hence help policy makers to take a proper decision.
PO-4.	Have a knowledge regarding use of data analytics tools like Excel, SPSS, R programming and Python.
PO-5.	Use modern statistical techniques and statistical Software to understand the concepts of Statistics.
PO-6.	Think, acquire knowledge and skills through logical reasoning and inculcate the culture of self-learning.
PO-7.	Create an awareness about the impact of Statistics in real life and development outside the scientific community.
Programme Specific Outcomes	
PSO 1:	Understand and apply the principles of least squares to fit a model to the given data, study the association between the variables, applications of Probability Theory and Probability Distributions.
PSO 2:	Understand the concept of Sampling Distributions; study the applications of various probability inequalities and Central limit theorem. Apply the statistical inference to real life situations.
PSO 3:	Understand the principles and applications of Total Quality Management, Designs of Experiment, Sampling theory, Regression Model, Simulation and Operation Research.
PSO 4:	Understand the applications of various Statistical Techniques, use of Statistical tools through Excel and SPSS under Choice Based Credit System (CBCS) requirements.

B.Sc. DEGREE- FIRST SEMESTER

G 506.1: DESCRIPTIVE STATISTICS AND PROBABILITY THEORY

Course Outcomes	
CO-1.	Understand the principle of least squares, fitting of various types of curves and the concept of correlation and its applications.
CO-2.	Explain the theory behind Regression analysis and its applications.
CO-3.	Have complete knowledge of demand analysis with the law of demand and supply, Engel's curves and Pareto;s law of income distribution.
CO-4:	Understand probability density function, mean and variance of a random variable and the theorems of probabilities with their applications.

UNIT-I

Curve Fitting: Principle of least squares- Fitting of linear, quadratic, exponential and geometric curves.

Correlation Analysis: Concept of correlation, Scatter diagram, Karl Pearson's coefficient and its properties. Rank correlation coefficient- Properties and derivation of the expression for the case where there are no ties. **-10 hrs.-**

UNIT-II

Regression Analysis: Bivariate regression- derivation of regression lines- properties- derivation of expression for standard error of estimate and its interpretation- correlation between observed and theoretical value obtained from the linear regression- Regression coefficient and its properties. Multiple linear regression for three variates. **-13 hrs.-**

UNIT-III

Demand Analysis: Introduction, Price elasticity of supply and demand, Partial and crossed elasticity's of demand, Methods of determining demand and supply curves, Engel curves, Pareto's law of income distribution. **-12hrs.-**

UNIT-IV

Probability and Random Variables: Addition theorem of probability- proof based on axiomatic approach, Multiplication theorem of probability. Baye's theorem and its applications. Random variables (discrete and continuous), its properties. p.m.f., p.d.f., with properties. Distribution function with properties. Bivariate p.m.f.'s, p.d.f.'s, marginal and conditional probability distributions for two random variable, independence of random variables. Pairwise and mutually independent events. **15hrs.-**

B.Sc. DEGREE- FIRST SEMESTER

G 506.1: DESCRIPTIVE STATISTICS AND PROBABILITY THEORY- PRACTICAL

Course Outcomes	
CO-1.	Analyse the data through correlation and regression analysis. Understand the applications of mathematical expectation.
CO-2.	Understand the concept of demand analysis with practical examples.
CO-3.	Find the mean and variance of the given random variable.

1. Curve fitting-1 Fitting linear and quadratic curves.
2. Curve fitting-2 Fitting curves of the form $y=ab^x$, $y=ae^{bx}$, $y=ax^b$.
3. Correlation- Spearman's rank Correlation Coefficient and Karl Pearson's Product Moment.
4. Analysis of Correlation Coefficient.
5. Bivariate Regression.
6. Trivariate Regression.
7. Demand Analysis I.
8. Demand Analysis II.
9. Application of Addition and Multiplication and Baye's theorems of probabilities.
10. Exercises on Random variables.

References:

1. S.C. Gupta and V.K. Kapoor (2018), Fundamentals of Mathematical Statistics. Sultan Chand and Sons.
2. Parimal Mukhopadhyay P. (2014), Mathematical Statistics- Books and Allied (P) Ltd. Kolkata.
3. R. V. Hogg and E. A. Tanis (2001), Probability and Statistics, Pearson Education Asia.

CBCS -I SEMESTER

G 506.1E: APPLIED STATISTICS (CBCS)

Course Outcomes	
CO-1.	Understand the applications of Vital events, Life table in government policies and planning.
CO-2.	Apply the Statistical tools like Index Numbers and Time Series for real life situations.

Objectives:

1. To understand the applications of Statistics through these measures.
2. To give a broad idea about applications of Statistics in governance.

UNIT I

Vital Statistics: Uses and Methods of obtaining vital statistics. Rates & Ratios. Measurement of Mortality: Crude, Specific & Standardized death rates. Life Table: Stationary & Stable population, Construction of life tables. Fertility: Crude, General, Specific & Total fertility rates. **10 hrs.**

UNIT II

Index Numbers: Definition, construction of index numbers and problems related to weighted and unweighted index numbers including Laspeyre's, Paasche's, Edgeworth-Marshall and Fisher's. Consumer price index numbers. Index of industrial and agriculture production, usage and limitations of index numbers.

10 hrs.

UNIT III

Time Series: 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 various mathematical curves and growth curves. **10 hrs.**

References:

1. S. C. Gupta & V. K. Kapoor (2018), Fundamentals of Applied Statistics, Sultan Chand and Co. New Delhi.
2. Parimal Mukhopadhyay P. (2014), Applied Statistics, Books & Allied Ltd. ISBN: 8187134380.

B.Sc. DEGREE- SECOND SEMESTER

G 506.2: PROBABILITY DISTRIBUTIONS

Course Outcomes	
CO-1.	Understand the concept of mathematical expectation and its properties.
CO-2.	Have complete knowledge about standard discrete distributions and its applications.
CO-3.	Explain the various continuous probability distributions with mean, variance median, MGF and its applications.
CO-4:	Understand the theory of distribution functions of random variables using mgf and Jacobian transformation.

UNIT I

Mathematical Expectation: Rules of expectation, Addition and Multiplication Theorems of expectation. Variance, Covariance, Coefficient of Correlation. Mean and Variance of linear combination of random variables.

UNIT II

Standard Discrete Distribution: Bernoulli, Binomial, Poisson, Negative Binomial, Geometric, Hyper geometric and Discrete Uniform Distribution- Definition, examples of variates following these distributions. Mean and Variance of these distributions. Mode of a Binomial, Poisson and Negative Binomial Distribution, Moment Generating Function (wherever they exist). Lack of memory property of Geometric Distribution and its physical interpretation. Recurrence Relation for Central Moments of Binomial, Poisson and Negative Binomial Distribution. **– 20 hrs -**

UNIT III

Continuous Univariate Distribution: Uniform, Exponential, Gamma, Beta, Normal and Cauchy distributions.-Definition through p.d.f. Distribution function of Uniform, Exponential and Cauchy distribution. Computation of moments (wherever they exist). Moment generating function for Exponential, Gamma and Normal distributions. Application of these distributions. Finding mode and points of inflexions of Normal distribution. Finding median for Uniform, Normal and Cauchy distribution. **- 20 hrs-**

UNIT IV

Functions of Random Variables: Distribution functions of random variables using mgf, Distribution function technique, Jacobian of transformation. **-4hrs.-**

B.Sc. DEGREE- SECOND SEMESTER

G 506.2: PROBABILITY DISTRIBUTIONS – PRACTICAL

Course Outcomes	
CO-1.	Understand the applications of mathematical expectation.
CO-2.	Identify, relate and differentiate probability distributions and apply them in day to day life.
CO-3.	Have the ability to fit a probability distribution to the given data.

1. Exercises on Mathematical expectation of Probability distributions.
2. Exercises on Binomial and Poisson distributions.
3. Fitting of Binomial distribution.
4. Fitting of Poisson distribution.
5. Generating Random Observations from Binomial and Poisson distribution.
6. Generating Random Observations from Negative Binomial and Geometric distributions.
7. Exercises on Normal distribution.
8. Fitting of Normal distribution.
9. Generating random observations from Normal and Exponential distribution.
10. Generating random observations from Cauchy distribution.
11. Fitting of Exponential distribution.

References:

1. Goon A.M., Gupta M.K. and Das Gupta (2014), Fundamentals of Statistics. Vol.1, 6th Edn. World Press, Kolkata.
2. S.C. Gupta and V.K. Kapoor (2019), Fundamentals of Mathematical Statistics. Sultan Chand and Sons.
3. Hogg R.V and Graig A.T. (2015), Introduction to Mathematical Statistics. Macmilan N.Y.
4. Parimal Mukhopadhyay P. (2014), Mathematical Statistics, Books and Allied (P) Ltd. Kolkata.

CBCS-II SEMESTER

Course Outcomes	
G 506.2E: Data Analysis using Ms Excel (CBCS)	
CO-1.	Analyse the data through MS Excel.
CO-2.	Acquire Data Visualization skills.
CO-3.	Have knowledge of statistical measures.

Objective:

1. To develop the Data Processing skill in MS Excel.
2. To develop the Data Analysis and Data Visualization skill.

UNIT I

Introduction to MS Excel, MS Excel Options-Ribbon-Sheets- Saving Excel File as PDF, CSV and Older versions - Using Excel Shortcuts - Copy, Cut, Paste, Hide, Unhide, and Link the Data in Rows, Columns and Sheet - Using Paste Special Options - Formatting Cells, Rows, Columns and Sheets - Protecting & Un protecting Cells, Rows, Columns and Sheets with or without Password - Page Layout and Printer Properties. **10 hrs.**

UNIT II

Charts:- Simple Bar Chart, Multiple Bar Chart, Subdivided Bar Chart, Pie Chart, Donut Chart, Line Chart and Histogram. Scatter Plot, Radar Chart, Bubble Chart, Plotting Density Function and Distribution Function. **10 hrs.**

UNIT III

Statistical measures – Mean, Variance, Percentiles, Quartiles - Pearson correlation, Spearman's, Rank correlation and Regression equations and Multiple Linear regression.

10 hrs.

References:

1. Curtis Frye (2016), Microsoft Excel, Step by Step.
2. Bernd Held and Brain Morairty (2016), Microsoft Excel Functions & Formulas.
3. William Fischer (2016), Excel: QuickStart Guide- From Beginners to Expert (Excel, Microsoft Office).

B.Sc. DEGREE-THIRD SEMESTER

G 506.3: STATISTICAL INFERENCE I

Course Outcomes	
CO-1.	Understand the sampling distributions like Chi-square, Student's t Snedecor's F distributions and the distribution of Order statistic.
CO-2.	Impart knowledge about probability inequalities and convergence concepts.
CO-3.	Understand the theory of point estimation, method of maximum likelihood estimation, method of moment and its applications.
CO-4:	Explain the theory of interval estimation and its applications.

UNIT I

Sampling Distribution: Concept of Statistic, sampling distribution of statistic and its standard error. Definition and derivation of Student t, Chi-Square and F-distributions-their properties, mean and variance. Distribution of sample mean, sample variance under normality assumption. Distribution of sampling variance from normal population under the assumption of independence of sample mean and variance. Inter-relationship between the sampling distributions.

Order statistic: Definition of order statistic, derivation of the distribution of 1^{st} and n^{th} order statistic.

-15hrs.-

UNIT II

Probability inequality and Convergence concepts: Markov's inequality (Statement only), Chebysheve's inequality (with proof). Sequence of r.v's, Convergence in probability. Basic results (without proof), WLLN for i.i.d. r.v's, applications. Convergence in distribution, C.L.T and its applications. **- 8hrs -**

UNIT III

Point Estimation: Estimator and estimate. Unbiasedness, asymptotic unbiasedness and consistency of estimators. Sufficient condition for consistency, Relative efficiency, Sufficiency. Statement of Fisher Neyman criterion and its applications. Maximum likelihood and moment methods of estimation. Properties of these methods (without proof). Discussion of examples to be restricted to the standard distributions studied during 2^{nd} and 3^{rd} semesters. **-15 hrs.-**

UNIT IV

Interval Estimation: Confidence coefficient, confidence interval using Pivotal Quantity method. Confidence interval for mean, difference between means variance and ratio of variances under normality. Large sample confidence interval for mean and proportion, difference of means and proportions.

-10 hrs.-

B. Sc .DEGREE-THIRD SEMESTER

G 506.3: STATISTICAL INFERENCE-I PRACTICAL

Course Outcomes	
CO-1.	Understand the applications of probability inequalities, central theorem and WLLN.
CO-2.	Understand the applications of methods of point estimation.
CO-3.	Apply the theory of interval estimation to real life.

1. Applications of Chebysheve's inequality.
2. Applications of C.L.T.
3. Estimating parameters of Binomial, (p unknown), Poisson, and Uniform (Continuous), Exponential, Normal and Beta distribution by the method of MLE.
4. Estimating parameters of Binomial, Negative Binomial, Poisson, Uniform, Exponential, Normal, Beta, and *G*amma by the method of moments.
5. Large sample confidence intervals for proportions and difference of proportions.
6. Interval estimation of mean of normal population (variance known and unknown cases).
7. Interval estimation of variance of normal population (variance known and unknown cases) (mean known and unknown cases).
8. Interval estimation of difference in means of two independent normal populations (with known and unknown means).
9. Interval estimation of ratio of variances of independent normal populations (with known and unknown means) .

References:

1. S.C.Gupta and V.K.Kapoor (2019), Fundamentals of Mathematical Statistics, Sultan Chand and Co. New Delhi.
2. Goon A.M., Gupta M.K. and Das Gupta B. (2016), Fundamentals of statistics Vol I and Vol II World press Kolkatta.
3. Hogg R.V and Craig A.T. (2015), Introduction to Mathematical Statistics Mac Milan, New York.
4. Mood A.M., Gray bill F and Bose D.C. (2013), Introduction to the theory of Statistics.
5. Parimal Mukhopadhyay P (2014), Mathematical Statistics, Books and Applied (P) Ltd. Kolkata.
6. D.W. Wackerly, L. Mendenhall, R.L. Scheafres (2002), Mathematical Statistics with Applications, Duxbury Advance Series.
7. R.V. Hoggand E.A. Tanis (2001), Probability and Statistics, Pearson Education Asia.

CBCS-III SEMESTER

G 506.3E: Probability Distributions (CBCS)

Course Outcomes	
CO-1.	Understand the applications of mathematical expectation and its properties.
CO-2.	Have the knowledge of standard discrete probability distribution and its applications.
CO-3.	Understand continuous probability distributions its applications in day to day life.

Objective:

1. Providing students with a formal treatment of probability theory.
2. Equipping students with essential tools for statistical analyses at the graduate level.
3. Fostering understanding through real-world statistical applications.

UNIT I

Mathematical Expectation: Definition, Rules of expectation, Addition and Multiplication theorems of expectation. Variance, Covariance and Coefficient of correlation. **3 hrs.**

UNIT II

Standard Discrete Distributions: Bernoulli, Binomial, Poisson, Negative Binomial, Geometric, Hyper geometric and Discrete Uniform Distribution. Definition, examples of variates following these distributions. Mean and Variance of these distributions. Lack of memory property of Geometric distribution. Applications of all these distributions. **15 hrs.**

UNIT III

Continuous Univariate Distribution: Uniform, Exponential, Gamma, Beta of first kind and second kind, Normal and Cauchy distributions. Definition through p.d.f. Application of these distributions. **12 hrs.**

References:

1. S.C.Gupta and V.K.Kapoor (2018), Fundamentals of Mathematical Statistics, Sultan Chand and Co. New Delhi.
2. Goon A.M., Gupta M.K. and Das Gupta B. (2013), Fundamentals of statistics, Vol I and Vol II World press Kolkatta.
3. V.K. Rohutgi (2014), Introduction to the Theory of Probability and Mathematical Statistics.
4. Parimal Mukhopadhyay P. (2014), Mathematical Statistics, Books and Applied (P) Ltd. Kolkata.

B. Sc. DEGREE-FOURTH SEMESTER

G 506.4: STATISTICAL INFERENCE II

Course Outcomes	
CO-1.	Understand the basic knowledge about testing of hypotheses and the Statistical basis behind every test. Also to Develop Most Powerful Test and Likelihood Ratio Test.
CO-2.	Apply various large sample, small sample and Chi-square test to real life situations and interpret the results.
CO-3.	Explain sequential testing and applications of Wald's test for probability distributions.
CO-4:	Understand the concept and derive the test statistic for various non- parametric tests. Also the applications of these tests.

UNIT I

Testing of Hypothesis: Statistical Hypothesis, Null and alternative, Simple and composite hypothesis. Critical region and Critical function. Concepts of type I, type II errors, level of significance, P-Value (descriptive level), power of test and power function-power curve. Relationship between testing of hypothesis and interval estimation. MP-test, Statement of Likelihood ratio tests, Derivation of the test for normal distribution, with two sided alternatives for mean, equality of means with unknown common variance and equality of variance. Application of these tests for one sided alternatives, paired t-test. Test for correlation coefficient. Properties of LRTP (without proof). **-20 hrs.-**

UNIT II

Large Sample Tests: Large sample test for mean, difference between two means, test for proportion, difference between proportions. Fisher's Z transformation and its applications.

Chi-square tests: Test of goodness of fit and independence of attributes in contingency tables, Derivation of Brandt-Snedecor's formula, Chi-square test for 2X2 contingency table. Yates correction for continuity. **-10hrs.-**

UNIT III

Sequential testing: Need for sequential test, Strength of sequential tests. Wald's SPRTP applied to Bernoulli, Poisson and Normal distributions. Expressions for constants to be given without proof.

-8 hrs.-

UNIT IV

Non-parametric tests: Advantages and limitations. Sign test for one sample problem and f or pairs of observations. Two sample median test. Run test for randomness. Two sample run test. Null distribution of test statistic to be derived in each case. Large sample approximation to these tests.

-10 hrs.-

B.Sc DEGREE-FOURTH SEMESTER

G 506.4: Statistical Inference-II PRACTICAL

Course Outcomes	
CO-1.	Measure the probability of two types of errors, power of the Test and the BCR to the given situation and help the policy makers.
CO-2.	Know the applications of various small sample and large sample tests. Also to apply various Chi-square tests and interpret the result.
CO-3.	Apply SPRTP for various probability distributions and take a Decision about sampling.
CO-4:	Know the applications of various non-parametric tests.

1. Evaluation of probability of type I and type II errors and power of tests. Power function and Power curve (this practical is based on distributions studied during 3rd SEM.)
2. Large Sample Tests.
3. t Tests.
4. Tests for single variance and equality of variances under normality.
5. Test for goodness of fit.
6. Test for independence of attributes in contingency tables.
7. SPRTP-(1) Bernoulli and Poisson distribution.
8. SPRTP-(2) Normal distribution (Mean and Variance).
9. Non-parametric test-(1) Sign test and Median test. (Small and Large samples).
10. Non-parametric test-(2) Run test. (Small and Large samples)

Reference Books:

1. S.C. Gupta and V.K. Kapoor (2014), Fundamentals of Mathematical Statistics, Sultan Chand and Co. New Delhi.
2. Hogg R.V and Craig (2014), AT Introduction to Mathematical Statistics Mac Milan, New York.
3. Parimal Mukhopadhyay P (2014), Mathematical Statistics, Books and Applied (P) Ltd. Kolkata.
4. D.W. Wackerly, L. Mendenhall, R.L. Scheafres (2002), Mathematical Statistics with Applications, Duxbury Advance Series.
5. R.V. Hogg and E.A. Tanis (2001), Probability and Statistics, Pearson Education Asia.

CBCS-IV SEMESTER

G 506.4E: Statistical Data Analysis using SPSS (CBCS)

Course Outcomes	
CO-1.	Understand the measures of averages, variation, correlation and regression.
CO-2.	Train the students in data analysis using SPSS software.
CO-3.	Acquire knowledge in data handling and visualization.

Objectives:

1. To train students in SPSS Software.
2. To expose the students to the analysis of statistical data.

UNIT I

Descriptive Statistics: Measures of averages, Measures of variation, Kurtosis. Correlation: Karl Pearson's and Spearman's Rank Correlation, Regression analysis: Simple Regression Analysis. **10 hrs.**

UNIT II

Introduction to SPSS: Description of SPSS menu, import from other data source, data entry, labelling for dummy numbers, recoding of the variables, transpose of data, insert variables and cases merge variables and cases. **10 hrs.**

UNIT III

Data handling: Split, select cases, transform, compute total scores and table looks, changing column, font style and sizes. Diagrammatic representation: Simple bar diagram, Multiple bar diagram, Sub-divided bar diagram, Percentage bar diagram, Pie diagram, Frequency table, Histogram, Scatter diagram, Box plot. **10 hrs.**

References:

1. Darren George & Paul Mallery (2019), IBM SPSS Statistics 25 Step by Step, 15th Ed., ISBN: 978-1-138-49104, Taylor & Francis.
2. Ronald D. Yockey (2018), SPSS Demystified-A Simple Guide and Reference, 3rd Ed., Taylor & Francis.
3. Ajay S. Gaur & Sanjana S. Gaour (2009), Statistical Methods for Practice and Research: A Guide to Data Analysis using SPSS, ISBN**:** 9788132101000.

B. Sc .DEGREE –FIFTH SEMESTER

G 506.5a: DESIGNS OF EXPERIMENTS

Course Outcomes	
CO-1.	Impart knowledge on applying the technique of ANOVA to design studies, perform analyses, interpret the results appropriately, and make generalizations.
CO-2.	Understanding the advantages & disadvantages of various designs and also learning to apply various designs for agricultural data/agricultural fields.
CO-3.	Describe the analysis of the data from the experiment should be carried out for missing data/ missing plots in the agricultural field.
CO-4:	Familiarize with 2^2 & 2^3 factorial experiments and analyze the data for agriculture data and draw meaningful conclusions.

UNIT I

Analysis of variance: Meaning, basic assumptions Gauss Markov model and Gauss Markov and Cochran's Theorem (Statement only), fixed effect model. Analysis of one way, two way and three way classified data with one observation per cell, mathematical model, least square estimates, splitting of total sum of squares, expectation of sums of squares and mean sums of squares(under appropriate hypothesis)and ANOVA table. Critical difference and comparison of treatment means.

-15 hrs.-

UNIT II

Designs of experiments: Meaning and terminology-experiment, treatment, experimental unit, experimental error and precision, uniformity trials. Principles of experimental design, choice of size of plot, shape of blocks and plot.

CRD, RBD and LSD: Layout, model, splitting of total sums of squares, least square estimates of effects, ANOVA tables, comparison of treatment means. Advantages and limitations of each design. Efficiency of a design, efficiency of RBD over CRD and LSD over RBD. **-10 hrs.-**

UNIT III

Missing plot technique: Estimation of one and two missing observations in RBD and LSD (least square estimates). ANOVA in case of missing observations. **-5 hrs-**

UNIT IV

Factorial experiments: Meaning and advantages. 2^2 and 2^3 factorial experiments in RBD and LSD, main and interaction effects. Yates's method of computing factorial effect totals, ANOVA table and inferences. Contrasts and orthogonal contrasts. **-10 hrs.-**

B.SC. DEGREE – FIFTH SEMESTER

G 506.5 b: TOTAL QUALITY MANAGEMENT (ELECTIVE-1)

Course Outcomes	
CO-1.	Understand the concept of Total Quality Management in the production process and tools of TQM,
CO-2.	Explain the various tools and techniques of TQM and general theory of control charts.
CO-3.	Derive the control limits of various variable and attribute control charts and interpret the same.
CO-4:	Design acceptance sampling methods for attributes and variables

UNIT I

Essentials of TQM: Customer satisfaction, leadership, quality policy, organizational structure, employee involvement, quality cost, supplier selection and development, recognition and reward.

-5 **hrs.-**

UNIT II

Tools and Techniques of TQM: Statistical Process control and Acceptance Sampling Plan, Quality characteristics – variables and attributes, quality control – offline quality control, process control, product control. Causes of variation in quality, uses of statistical quality control.

General theory of control charts: Criteria of lack of control, control limits, action limits, warning limits and probability limits. Concepts of rational subgroups. Charts with and without standard values.

-10 hrs.-

UNIT III

Control charts for variables: Outline of steps involved in $\overline{X}$ -R charts. Derivation of trial control limits. Derivation of limits, interpretation of a process in control, process capability studies, continuing the use of charts, actions to be taken on the process, actions to be taken on the specifications, modified control limits or reject limits for $\overline{X}$

Control charts for attributes: p and np- charts (subgroup size constant and variable cases), c and u – charts. Derivation of control limits, outline of steps in their construction, analysis and their interpretations. **-13 hrs.-**

UNIT IV

Acceptance sampling plan: Need for sampling plans, single sampling by attributes given PR, CR, AQL and LTPD. Derivation of OC, ASN, ATI and AOQ functions for single sampling plans. AOQL, indifference quality. Construction of SSP by attributes. (Given AQL, LTPD, PR of CR method and minimum ATI method. Double sampling plan- description and its advantage over single sampling plans.

Single sampling plans for variables: Advantages and limitations, derivation of expression for OC – sigma known and unknown cases. (Single specification only) Construction of SSP. **-12 hrs.-**

B.SC. DEGREE – FIFTH SEMESTER

G 506.5 a: DESIGN OF EXPERIMENTS &G 506.5 b: TOTAL QUALITY MANAGEMENT

(ELECTIVE -1) PRACTICAL

Course Outcomes	
G506.5a: Practical based on G506.5 and G506.5a Elective (1)	
CO-1.	Explain the applications of various models of designs of experiment.
CO-2.	Analyse factorial experiments for real life.
CO-3.	Understand the applications of control charts in industry and analyse the given data.
CO-4:	Understand how to design a proper Acceptance Sampling Plan.

1. Analysis of CRD.
2. Analysis of RBD.
3. Analysis of LSD.
4. Missing plot technique-RBD & LSD Single value missing.
5. Missing plot technique-RBD & LSD-two values missing.
6. Analysis of 2^2 factorial experiments.
7. Analysis of 2^3 factorial experiments.
8. $\overline{X} - R$ charts (standards known and unknown).
9. np chart and p-chart.
10. C- Chart and U-chart.

References:

1. S.C. Gupta and V.K. Kapoor (2018), Applied Statistics, Sultan Chand & Co.
2. M.N. Das and N.C. Giri (1997), Design and analysis of experiments, New Age International (P) Ltd. Publishers.
3. B. L. Agarwal, (2010), Theory and Analysis of Experimental Designs, CBS Publishers and Distributors.
4. R. P. Mohanty and R. R. Lakhe (2002), Hand book of Total Quality Management, Jaico Publishing House.
5. Dale H. Besterfield, Carol Besterfield, Glen H. Besterfield and Mary Besterfield- Sacre (2001), Total Quality Management, Pearson Education Asia.
6. P. L. Jain (2001), Quality Control and Total Quality Management, Tata McGraw- Hill Publishing Co. Ltd.
7. Montgomery, D. C. (2010), Introduction to Statistical Quality Control, John Wiley & Sons Inc. International Edition.

B.SC. DEGREE – FIFTH SEMESTER

G 506.5 b: REGRESSION ANALYSIS (ELECTIVE - 2)

Course Outcomes	
G506.5b. Elective (2) – Regression Analysis	
CO-1.	Explain the meaning of Regression models, point and interval estimation using the regression equation, prediction and residual analysis.
CO-2.	Understand Multiple regression model, estimation of paramete testing and confidence intervals and prediction.
CO-3.	Build a regression model and analyse the given data.
CO-4:	Understand how to use various variable selection procedure and multiple regression approach to analysis of variance and experimental design.

UNIT I

Regression Models: Simple linear regression model, least squares method, coefficient of determination, model assumptions, testing for significance of model parameters, point and interval estimation using the estimation regression equation, prediction, residual analysis. **-10 hrs.-**

UNIT II

Multiple Regression Models: Estimation of model parameters, hypothesis testing and confidence intervals, prediction, regression diagnosis. **-10 hrs.-**

UNIT III

Regression Analysis: Model building, general linear model, addition or deletion of variables.

-10 hrs.-

UNIT IV

Variable Selection Procedures: Stepwise regression, forward and backward elimination procedures, best- subsets regression, Mallow's ^2C_p, residual analysis. Multiple regression approach to analysis of variance and experimental design. **-15 hrs.-**

B.SC. DEGREE – FIFTH SEMESTER

G 506.6 b: REGRESSION ANALYSIS (ELECTIVE-2) PRACTICAL

Course Outcomes	
G506.5a: Practical based on G506.5 and G506.5a Elective (2)	
CO-1.	Explain the applications of various models of designs of experiment.
CO-2.	Analyse factorial experiments for real life.
CO-3.	Apply the regression analysis to analyse real life data.
CO-4:	Understand how to use multiple regression and variable selection procedure.

1. Exercise on Simple Linear Regression.
2. Regression Diagnostics for Simple Linear Regression.
3. Exercise on Multiple Linear Regression.
4. Regression Diagnostics for Multiple Linear Regressions.
5. Exercise on Residual Analysis.
6. Variable selection procedure.
7. ANOVA using Multiple Regression approach.

References:

1. Douglas G. Montgomery (2001), Design and Analysis of experiments, John Wiley & sons.
2. Fred L. Ramsey and Daniel W. Schafer (1997), The statistical Sleuth: a course in methods of Data Analysis, Duxbury Press.
3. D. C. Montgomery, E. A. Peck, G. G. Vining (2003), Introduction to Linear Regression Analysis, John Wiley & sons.

B.Sc. DEGREE – SIXTH SEMESTER

G 506.6a: SAMPLING THEORY

Course Outcomes	
CO-1.	Understand the importance of sampling in analysing data and the methods of determining size of the sample.
CO-2.	Understand the difference between simple random sampling with replacement and without replacement, estimation of various population parameters and precision of these estimates.
CO-3.	Have complete knowledge of Stratified random sampling and its application. Also to identify the efficiency of various sampling methods with Stratified sampling.
CO-4:	Understand theoretical concept of Systematic and Cluster sampling with applications in real life.

UNIT I

Statistical Investigation: Complete enumeration v/s sample surveys – merits and demerits, framing of the questionnaire. Probability sampling and Judgment sampling, Principles of sample surveys. Principal steps in sample survey, Errors in sampling. Concepts of parameters and estimators. Bias, mean square error, accuracy and precision of estimators. Selection of samples using random numbers. Drawing samples from finite populations with and without replacement. Sampling from frequency distributions and contingency Tables.

-10 hrs.-

UNIT II

Simple random sampling with and without replacement: Unbiased estimators of mean, variance and population total. Sampling variances, standard errors and their estimation, Comparison of SRSWR with SRSWOR.

-10 hrs.-

UNIT III

Stratified random sampling: Need for stratification, Stratified sampling under SRSWOR, Unbiased estimators of mean and total. Variances of these estimators and their estimation. Allocation of sample size – proportional and optimum allocation (w.r.t. SRSWOR stratification only), Neyman's allocation, allocation with cost functions. Comparison of SRSWOR and stratified sampling. Gain in efficiency due to stratification. **-10 hrs.-**

UNIT IV

Linear systematic sampling: Estimation of mean. Variance of the estimator of mean in terms of S^2_{wsy} and intra class correlation. Comparison of SRSWOR and systematic sampling. Sampling of attributes, Estimation of population proportion and its standard error.

Cluster Sampling : Meaning and procedure, cluster sampling with equal number of unit, Estimation of population total and variance of the estimate. **-10 hrs.-**

B.Sc. DEGREE – SIXTH SEMESTER

G 506.6b: OPERATIONS RESEARCH (ELECTIVE - 1)

Course Outcomes	
CO-1.	Understand the concept of OR, Linear programming problem various methods of solving linear programming problem and its applications in industry.
CO-2.	Gain knowledge about transportation problems, applying various methods to real life situations and obtaining optimum solutions.
CO-3.	Understand the concepts of Assignment problem and Game Theory with their applications.
CO-4:	Familiarize the concepts of inventory problems and apply various types of EOQ models to solve the problems of industry.

UNIT I

Operations Research (OR): Origin, definition, phases of OR – types of models.

Linear Programming Problem: General model, formation, graphical solution, Simplex algorithm (without proof), Charne's big M method – indication of unique solution, multiple solution, unbounded solution, no solution and degeneracy – dual LPP and its properties.

-15 hrs.-

UNIT II

Transportation Problem: General description and Statement of T.P., Balanced and unbalanced TP – initial solution by NWCR, matrix minima and Vogel's method, MODI method of optimization (without proof), degeneracy.

-10 hrs.-

UNIT III

Assignment Problem: General description and Statement of A.P., Hungarian method, maximization and minimization problems.

Game Theory: Nature of games, Two person zero sum games – Pay off Matrix – Pure and mixed strategies – Showing A's Problem as the Dual of the B's Problem – Principles of Dominance – Algebraic solution of rectangular games (Zero sum) – Solution of 2xn and mx2 games.

-10 hrs.-

UNIT IV

Inventory Theory: Basic concepts, deterministic models with instantaneous/finite production with/without shortages, Models with one/two price breaks, stochastic model with pre-fixed time (discrete case) and newspaper boy problem.

-5 hrs.-

G 506.6 a: SAMPLING THEORY & G 506.6b : OPERATIONS RESEARCH (ELECTIVE - 1) PRACTICAL

Course Outcomes	
G506.6a.: Practical based on G506.6 and G506.6a Elective (1)	
CO-1.	Understand how to draw a simple random sample with replacement and without replacement and find best estimates for the population.
CO-2.	Find out the efficiency of various methods of sampling and decide the best method for the situations under consideration.
CO-3.	Understand the applications of various optimal tools in industry.
CO-4:	Take a proper decision about the selection of one of the tools of optimization.

1. Drawing random samples from frequency tables and contingency tables. Estimation of mean and variance.
2. Drawing random samples from finite population – SRSWR, Estimation of mean, total and variance of the estimate.
3. SRSWOR.
4. Stratified sampling under SRSWOR.
5. Linear systematic sampling.
6. LPP Formulation and graphical solution.
7. LPP Simplex- slack variables only.
8. Big M method.
9. Solving balanced/unbalanced TP.
10. Exercise on Game Theory.
11. Deterministic inventory models with/without shortages- instantaneous/finite production rate.
12. Inventory models with one/two price breaks.

References:

1. Cochran W. G. (1984), Sampling Techniques – 3rd edition, Wiley Eastern.
2. Singh D. Chaudhary F. S. (1986), Theory and Analysis of Sampling Survey Design – Wiley Eastern.
3. S. C. Gupta & V. K. Kapoor (2014) Fundamentals of Applied Statistics, Sultan Chand & Co.
4. Sampath (2001), Sampling theory and methods, Narosa Publishing House.
5. P. V. Sukhatne and B. R. Sukhatne (1978), Sampling theory and techniques**,** ISBN-10: 021022519X, ISBN-13: 978-0210225196.
6. Kantiswarup, Manmohan and Gupta (2002), Operations Research, Sultan Chand & Co., New Delhi.
7. S.D. Sharma (2014), Operations Research, WordPress.com.
8. P.T. Gupta and D.S. Hira (2000), Operations research, S. Chand & Co., New Delhi.
9. Taha H.A. (2000), Research- An Introduction, Macmillan.

B. SC. DEGREE – SIXTH SEMESTER

G 506.6 b: SIMULATION (ELECTIVE - 2)

Course Outcomes	
G506.6a:Elective (2) Simulation	
CO-1.	Understand the technique of Simulation and its areas of applications.
CO-2.	Explain the method of random number generation and applications of various tests for random numbers.
CO-3.	Understand various random variate generation methods and how to apply these methods for different continuous probability distributions.
CO-4:	Apply Variance Reduction technique.

UNIT I

Introduction to simulation: Meaning and need for simulation, advantages and disadvantages of simulation, areas of applications, systems and system environment, components of a system, discrete and continuous systems, models of a system, types of models, discrete event system simulation, steps in simulation study. **-10 hrs.-**

UNIT II

Random number generation: Properties of random numbers, generation of pseudo random numbers, techniques of generating random numbers – linear congruential method. Tests for random numbers – frequency test, run tests, test for auto correlation, gap test, poker test.

-10 hrs.-

UNIT III

Random variate generation: Inverse transformation technique – exponential, uniform, Weibull, triangular distributions, empirical continuous distributions without closed form inverse . Discrete distributions, Box – Muller method for normal distribution, convolution method, acceptance – rejection method – Poisson and geometric distribution. **-15 hrs.-**

UNIT IV

Variance Reduction Technique. **-5 hrs.-**

B.SC. DEGREE – SIXTH SEMESTER

G 506.6 b : SIMULATION (ELECTIVE - 2) PRACTICAL

Course Outcomes	
G506.6a.: Practical based on G506.6 and G506.6a Elective (2)	
CO-1.	Understand how to draw a simple random sample with replacement and without replacement and find best estimates for the population.
CO-2.	Find out the efficiency of various methods of sampling and decide the best method for the situations under consideration.
CO-3.	Understand the applications of various simulation techniques.

1. Simulation of queuing systems (single and two servers).
2. Simulation of continuous queuing systems.
3. Simulation of Inventory systems.
4. Generation of random numbers and tests of random numbers.
5. Generation of random variates from continuous distributions.
6. Generation of random variates from empirical distributions.
7. Generation of random variates using acceptance – rejection techniques.

Reference Books:

1. Jerry Banks, John S. Carson II, Barry L. Nelson and David M. Nicol (2002), Discrete Event System Simulation, Prentice – Hall of India, Pvt. Ltd., New Delhi.
2. Sheldon Ross (2002), A first course in Probability, Pearson Education Asia.

QUESTION PAPER PATTERN (THEORY)

CHOICE BASED CREDIT SYSTEM (CBCS)

STATISTICS

TIME: 1.5 HOURS	**MAX MARKS: 50**
I .ANSWER ANY FIVE OF THE FOLLOWING	5 / 7 x 2 = 10 MARKS
II. ANSWER ANY FOUR OF THE FOLLOWING	4 / 5 x 5 = 20 MARKS
III. ANSWER ANY TWO OF THE FOLLOWING	2 / 3 x 10 = 20 MARKS

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