Bachelor of Science (B. Sc.) Semester – I

Core Course – STATISTICS

Core Course Statistics Paper STAT -103 (Statistics Theory)
&
Core Course Statistics Paper STAT -104 (Statistics Theory)

The course content has been designed on **Semester pattern**.
There shall be **02 Theory** papers having **05 Units**. (4 lectures in a week set up by departments.)
There shall be **02 Theory papers** of **70 marks** and 2.30 hours duration in University External Examination. **There shall be Continuous Internal Evaluation of 30 Marks each in ST -103 and ST- 104.**

Course Type	Paper No.	Title of Paper	Total Marks EXT.+ INT* = TOTAL	Passing Standards EXT.+ INT= TOTAL	Total Teaching Hours (in 15weeks)	Exam. Hrs	Credits
Core Course STATISTICS THEORY	Paper STAT – 103	Descriptive Statistics	70+ 30* = 100	28+12* = 40 marks	60 hrs	02 hrs 30 min.	04
Core Course STATISTICS THEORY	Paper STAT – 104	Computational Statistics & Fundamentals of Probability	70+ 30*= 100	28+12* = 40 marks	60 hrs	02hrs 30 min.	04
	TOTAL						08

Modern syllabus for B.Sc. Sem. I & II (Statistics), a newly introduced subject at the first year B.Sc. level confirming to New semester Pattern will be effective from **June 2019**.

Introduction:-Commencing from the academic year 2019-20, the entrant-students to the B.Sc. degree course with a total three years span would study in six semesters earmarked for the course. They would be examined externally at the end of each semester. The proposed syllabus is for B. Sc. Sem. I & II "A" group students who **select Statistics as one of the subjects as Core Course I or Core Course II or Core Course III as per the under mentioned groups**. Along with the weekly distribution of periods each of one hour's duration and the distribution of external marks are presented below .The proposed syllabus and pattern are designed to be implemented from June 2019.

Eligibility:

I. For Admission : A pass in the Higher Secondary Examination (with Science Subjects) conducted by the Government of Gujarat; or an examination accepted as equivalent thereto by the Executive Council/MHRD, India, subject to such conditions as may be prescribed thereof.

II. The candidates who have passed the qualifying examination with A stream (Mathematics) are eligible to choose any one of the following Proposed groups of subjects at the time of admission in 1st Semester.

Choice of Groups – (For 'A' Group Students)

1	2	3
Physics	**Physics**	**Physics**
Mathematics	**Mathematics**	**Statistics**
Chemistry	**Statistics**	**Chemistry**

B.Sc. Semester –I: CORE COURSE–STATISTICS

STAT -CC –103 (Statistics Theory)

Title of Paper: Descriptive Statistics

Teaching Hours: 04 hours per week **Credits:04**

Marks: 100 Marks (External Exam :70 Marks + Internal: 30 Marks)

Unit	Contents	Teach. Hours	Marks/ Wts.
Unit-1	**Introduction of Statistics :** 1.1 Meaning of Statistics as a Science. 1.2 Importance of Statistics. 1.3 Scope of Statistics : In the field of Industry, Biological Sciences, Medical Sciences, Economics, Social Sciences, Management Sciences, Agriculture, Insurance, Information Technology, Education and Psychology. **Collection and Types and Data:** 1.4 Primary data & Secondary data, Method of collection of Primary data & Secondary data. 1.5 Nominal scale, ordinal scale. Interval scale, ratio scale. 1.6 Types of characteristics: Variables and Attributes. Discrete and Continuous variables. Cross-sectional data, time series data, industrial data. 1.7 Construction of tables with one, two or three factors of classification, Requirements of good statistical table 1.8 Designing a Questionnaire, Pre-testing of a Questionnaire and Specimen of a Questionnaire 1.9 Examples and Problems based on above topics.	16 hrs	18
Unit-2	**Presentation of Data:** 2.1 Classification: Raw data and its classification, 2.2 Discrete frequency distribution, continuous frequency distribution, 2.3 Inclusive, exclusive and open end classes methods of classification, 2.4 Relative frequency distribution and Cumulative frequency distribution. **Graphical Presentation of Data**: **2**.5 Histogram, Frequency curve, Frequency polygon, Ogive curves, Stem and Leaf chart. 2.6 Diagrammatic representation using bar diagrams –Single, Multiple, Compound bar diagrams and Pie diagram. 2.7 Examples and Problems based on topics.	16 hrs	18
Unit-3	**Population and Sampling:** 3.1 Notion of a statistical population: Finite population, infinite population, homogeneous population and heterogeneous population. 3.2 Concepts of a Finite Population and a Sample. 3.3 Notion of sample, random sample and non-random sample. 3.4 Complete enumeration vs Sampling.	14 hrs	17

	3.5 Requirements of a good sample. 3.6 Idea of Non -Random samplings - Quota and Judgment Samplings. 3.7 Examples and Problems based on above topics		
Unit-4	**Methods of sampling (Description only)** : 4.1 Simple random sampling with replacement (SRSWR), 4.2 Simple random sampling without replacement (SRSWOR), 4.3 Stratified random sampling, 4.4 Systematic sampling, 4.5 Cluster sampling. 4.6 Simple examples based on SRSWR, SRSWOR and Systematic Sample.	**14 hrs**	**17**
		60 hrs	**70**

INTERNAL COMPONENTS **MARKS**

1) TEST :15 Marks

2) ASSIGNMENT/ PRESENTATION : 10 Marks

3) SEMINAR / ATTENDENCE : 05 Marks

INTERNAL MARKS TOTAL : 30 Marks

Books Recommended:

1. **Bhat B. R., Srivenkatramana T and Madhava Rao K. S**. (1997): Statistics: a Beginner's Text, Vol. II, New Age International (P) Ltd.
2. **Dr. Ketan A. Gajjar & Dr. Parag Shah. Scientific and Statistical Computing, Nirav Prakashan, Ahemdabad.**
3. ગાણિતિક આંકડાશાસ્ત્ર– એચ. ડી. શાહ, ગુજરાત ગ્રંથ નિર્માણ બોર્ડ, ગાંધીનગર.
4. આંકડાશાસ્ત્ર ભાગ–1 અને ભાગ– 2 – બી. એસ. શાહ પ્રકાશન, અમદાવાદ
5. **Gupta V.K. & Kapoor S.C.**: Fundamentals of Mathematical Statistics.- Sultan Chand and sons, New Delhi.
6. **Goon A. M., Gupta M. K., Das Gupta B.** (1999): Fundamentals of Statistics, Vol.II, World Press, Calcutta.
7. **Agarwal B.L**. : Basic Statistics, New Age International Ltd.1995.
8. **Shinoy, Shrivastava & Sharma**: Quantitative Techniques for Managerial Decisions.
9. **Mood A. m., Graybill F. A. and Boes D. C**. (1974): Introduction to the Theory of Statistics, McGraw Hill.
10. **Burton, G. Carrol, G. And Wall, S.:** Quantitative methods for Business and Economics. Lengman, New York, 1999 Ch. 1,2.

B.Sc. Semester –I: CORE COURSE–STATISTICS
STAT -CC –104 (Statistics Theory)
Title of Paper: Computational Statistics & Fundamentals of Probability

Teaching Hours: 04 hours per week **Credits:04**
Marks: 100 Marks (External Exam 70 Marks + Internal: 30 Marks)

Unit	Contents	Teach. Hours	Marks/ Wts.
Unit-1	**Measures of Central Tendency:** 1.1: Concept of central tendency of statistical data, Statistical average, characteristics of a good statistical average. 1.2: Arithmetic Mean (A.M.) Definition, effect of change of origin and scale, combined mean of a number of groups, merits and demerits. 1.3: Mode : Definition, formula for computation graphical method of determination of mode, merits and demerits. 1.4: Median : Definition, formula for computation, graphical method of determination of median, merits and demerits. 1.5: Empirical relation between mean, median and mode. **Measures of Positional Values :** 1.6 For raw data, discrete frequency distribution and continuous frequency distribution –Understanding and Computation of Quartiles, merits and demerits. 1.7 For discrete frequency distribution and continuous frequency distribution – Geometric Mean (G.M.) and Harmonic Mean (H.M.) Definition, merits and demerits. 1.8 Weighted Mean : Weighted A.M. and Weighted G.M. its applications in different areas. 1.9 Examples and Problems based on above topics	16 hrs	18
Unit-2	**Measures of Dispersion:** 2.1: Concept of dispersion, characteristics of good measure of dispersion. 2.2 : Range: Definition, merits and demerits. 2.3: Semi-interquartile range (Quartile deviation). 2.4: Mean deviation: Definition, merits and demerits, minimality property (without proof). 2.5: Variance and standard deviation: Definition, merits and demerits, effect of change of origin and scale, Combined variance (derivation for 2 groups). 2.6 Combined standard deviation[upto n =2 groups] 2.7: Measures of dispersion for comparison: coefficient of range, coefficient of quartile deviation and coefficient of mean	14 hrs	17

	deviation, coefficient of variation (C.V.) 2.8: Examples and Problems based on topics.		
Unit-3	**Categorical data analysis:** 3.1 **Attributes** : classification, notion of manifold classification, dichotomy, class-frequency. 3.2 Order of class, positive class-frequency, negative class frequency, contrary class frequencies, ultimate class frequency. 3.3 Relationship among different class frequencies (up to two attributes). 3.4 Fundamental set of class frequencies. 3.5 Consistency of data upto 2 attributes. 3.6 Concepts of independence and association of two attributes. 3.7 Yule's coefficient of association(Q), $-1 \leq Q \leq 1$, interpretation. 3.8 Examples and Problems based on topics	**14 hrs**	**17**
Unit-4	**Sample space, Events and Probability:** 4.1: Concepts of experiments and random experiments. 4.2: Definitions: Sample space, Discrete sample space (finite and countably infinite), Event, Elementary events, Compound event, favourable outcomes to an event. 4.3:Definitions of Mutually exclusive events, Exhaustive events, Impossible event, Certain event. 4.4: Equally likely outcomes (events), A priori (classical) definition of probability of an event. Equi-probable sample space, simple examples of computation of probability of the events based on Permutations and Combinations. 4.5: Algebra of events (Union, Intersection, Complementation). 4.6: Axiomatic definition of probability with reference to a finite and countably infinite sample space. 4.7: Proof of the results: i) $P(\Phi)=0$, ii) $P(Ac)=1-P(A)$, iii) $P(A \cup B) = P(A) + P(B) - P(A \cap B)$ (with proof) and its generalization (Statement only). 4.8: If $A \subset B$, $P(A) \leq P(B)$, 4.9: Results: $0 \leq P(A \cap B) \leq P(A) \leq P(A \cup B) \leq P(A) + P(B)$. 4.10: Examples and Problems based on topics	**16 hrs**	**18**
		60 hrs	**70 Marks**

INTERNAL COMPONENTS **MARKS**

1) TEST :15 Marks

2) ASSIGNMENT/ PRESENTATION : 10 Marks

3) SEMINAR / ATTENDENCE : 05 Marks

INTERNAL MARKS TOTAL : 30 Marks

Books Recommended:

1. **Bhat B. R., Srivenkatramana T and Madhava Rao K. S**. (1997): Statistics: a Beginner's Text, Vol. II, New Age International (P) Ltd.
2. **Dr. Ketan A. Gajjar & Dr. Parag Shah**. Scientific and Statistical Computing, Nirav Prakashan, Ahemdabad.
3. ગાણિતિક આંકડાશાસ્ત્ર – એચ. ડી. શાહ, ગુજરાત ગ્રંથ નિર્માણ બોર્ડ, ગાંધીનગર.
4. આંકડાશાસ્ત્ર ભાગ–1 અને ભાગ–2 – બી. એસ. શાહ પ્રકાશન, અમદાવાદ
5. **Gupta V.K. & Kapoor S.C.:** Fundamentals of Mathematical Statistics.- Sultan Chand and sons, New Delhi.
6. **Shinoy, Shrivastava & Sharma:** Quantitative Techniques for Managerial Decisions.
7. **Mood A. m., Graybill F. A. and Boes D. C**. (1974): Introduction to the Theory of Statistics, McGraw Hill.
8. **Hoel P. G. (1971):** Introduction to Mathematical Statistics, Asia Publishing House.
9. **Rohatgi V. K. and Saleh A. K. Md. E**. (2002): An Introduction to probability and statistics. John wiley & Sons-Asia (JVS-Asia).
10. **Edward P. J., Ford J. S. and Lin** (1974): Probability for Statistical Decision-Making, Prentice Hall.
11. **Mukhopadhyay P.** (2006) : Probability. Books and Allied (P) Ltd.

Bachelor of Science (B. Sc.) Semester – II

Core Course – STATISTICS
Core Course Statistics Paper STAT - 203 (Statistics Theory)
&
Core Course Statistics Paper STAT - 204 (Statistics Theory)

The course content has been designed on **Semester pattern**.
There shall be **02 Theory** papers having **05 Units**. (4 lectures in a week set up by departments.)
There shall be **02 Theory papers** of **70 marks** and 2.30 hours duration in University External Examination.
There shall be Continuous Internal Evaluation of 30 Marks each in STA -201 and STA- 202.

Course Type	Paper No.	Title of Paper	Total Marks EXT.+ INT* = TOTAL	Passing Standards EXT.+ INT= TOTAL	Total Teaching Hours (in 15weeks)	Exam. Hrs	Credits
Core Course STATISTICS THEORY	Paper STAT – 203	Mathematical Statistics - I	70+ 30* = 100	28+12* = 40 marks	60 hrs	02 hrs 30 min.	04
Core Course STATISTICS THEORY	Paper STAT – 204	Applied Statistics - I	70+ 30*= 100	28+12* = 40 marks	60 hrs	02 hrs 30 min.	04
	TOTAL						08

B.Sc. Semester – II : CORE COURSE- STATISTICS

STAT – CC -203 (Statistics Theory)
Title of Paper: Mathematical Statistics - I

Teaching Hours : 04 hours Per Week
Credits:4
Marks: 100 Marks (External Exam: 70 Marks + Internal: 30 Marks **)**

Unit	CONTENTS	Teach. Hours	Marks / Wts.
Unit-1	**Conditional Probability:** 1.1: Definition of conditional probability of an event. 1.2 Multiplication theorem for two events and its extension for three events . Examples on conditional probability. 1.3 Concept of Independence of two events. Multiplication theorem for two Independent events. 1.4 Proof of the result that if A and B are independent then, i) A and B^c, ii) A^c and B, iii) A^c and B^c are independent. Pairwise and Mutual Independence for three events. **Univariate Probability Distributions :** 1.5. Concept of Discrete And Continuous random variable and properties of its probability Distribution. 1.6 Concept and definition Probability density function and cumulative distribution function of Discrete And Continuous random variable and its properties. Their graphical presentation. Difference between a discrete prob. Function and continuous prob. density function. 1.7 Expectation of a function of a random variable and its properties. Proofs of results[for discrete and continuous case] E (X + Y) = E(X) + E (Y); E (X Y) = E(X) . E(Y), if X and Y are independent. 1.8 Variance and standard deviation. Properties of variance. 1.9 Examples and Problems based on above topics.	**16 hrs**	**18**
Unit-2	**Moments and Generating Functions:** 2.1 Raw moments, its definition, r^{th} order raw moment, Expression and definition of first four moments. 2.2 Central moments, expression of r^{th} order central moment in terms of raw moments. 2.3 Moment generating function 2.4 Properties (with proof) of m. g. f. i. $M_x(t) = \sum_{r=0}^{\infty} \mu'_r \frac{t^r}{r!}$ ii. Given C is a constant, $M_{cx}(t) = M_x(ct)$ iii. Given X and Y are independent random variables,	**16 hrs**	**18**

	$M_{x+y}(t) = M_x(t)\, M_y(t)$. 2.5 Cumulant generating function , 2.6 Expression of first four cumulant in terms of moments, concept of skewness and kurtosis in terms of moments. 2.7 Examples based on above topics.		
Unit-3	**Bernaulli and Binomial Probability Distribution:** 3.1. Bernoulli Probability Distribution, 3.2 Mean, variance and Standard Deviation of Bernoulli Probability Distribution, 3.3 MGF and Applications of Bernoulli Probability Distribution, 3.4. Definition of binomial Probability distribution, 3.5 Suitable conditions for its Application, 3.6 Derivation of Probability function, 3.7 Mean, Variance, S.D., 3.8 MGF, CGF,$\sqrt{\beta_1}$, β_2, MGF Recurrence Relation of Central Moments. 3.9 Additive property of binomial Probability distribution 3.10 Examples &applications based on above topics.	**14 hrs**	**17**
Unit-4	**Poisson Probability Distributions:** 4.1 Definition of Poisson Probability distribution, 4.2 Real life applications, 4.3 Poisson Approximation to binomial Probability Distribution, 4.4 Mean, variance S.D., 4.5 MGF, CGF, equality of all cumulants, 4.6 $\sqrt{\beta_1}$, β_2, Recurrence Relation of Central Moments, 4.7 Additive property of Poisson Distribution. Examples &applications based on above topics.	**14 hrs**	**17**
		60 hours	**70 Marks**

INTERNAL COMPONENTS **MARKS**

1) TEST :15 Marks

2) ASSIGNMENT/ PRESENTATION : 10 Marks

3) SEMINAR / ATTENDENCE : 05 Marks

INTERNAL MARKS TOTAL : 30 Marks

Books Recommended:

1. **Bhat B. R., Srivenkatramana T and Madhava Rao K. S**. (1997): Statistics: a Beginner's Text, Vol. II, New Age International (P) Ltd.
૨. **ગાણિતિક આંકડાશાસ્ત્ર– એચ. ડી. શાહ, ગુજરાત ગ્રંથ નિર્માણ બોર્ડ, ગાંધીનગર.**
૩. **આંકડાશાસ્ત્ર ભાગ–1 અને ભાગ– 2 – બી. એસ. શાહ પ્રકાશન, અમદાવાદ**
4. **Gupta V.K. & Kapoor S.C.**: Fundamentals of Mathematical Statistics.- Sultan Chand.Sons, New Delhi.
5. **Mood A. m., Graybill F. A. and Boes D. C**. (1974): Introduction to the Theory of Statistics, McGraw Hill.
6. **Hogg R. V. and Crag R. G**.: Introduction to Mathematical Statistics Ed.4.
7. **Hoel P. G**. (1971): Introduction to Mathematical Statistics, Asia Publishing House.
8. **Edward P. J., Ford J. S. and Lin** (1974): Probability for Statistical Decision-Making, Prentice Hall.

B.Sc. Semester – II : CORE COURSE- STATISTICS

Paper STAT-204 (Statistics Theory)
Title of Paper: Applied Statistics - I

Teaching Hours : 04 hours **Credits:4**

Marks: 100 Marks (External Exam: 70 Marks + Internal: 30 Marks **)**

Unit	CONTENTS	Teach. Hours	Marks / Wts.
Unit-1	**Correlation:** 1.1: Bivariate Data –Classification as Frequency distribution. 1.2: Concept of correlation between two variables, Types of correlation. Scatter diagram, its type, utility and Interpretations. 1.3:**Karl Pearson's coefficient of correlation (r)**:Definition, Computation for ungrouped and grouped data. Properties: i) $-1 \leq r \leq 1$, ii) Effect of change of origin and scale. iii) Interpretation when r = – 1, 0, 1. 1.4: Covariance: Definition, Effect of change of origin and scale. **Rank correlation:** 1.5: Concept of Paired or related data, Assigning Ranks for Qualitative data, Definition of Spearman's rank correlation coefficient, Computation of Spearman's rank correlation coefficient (for with and without ties). 1.6: Derivation of the Spearman's rank correlation coefficient formula for without ties. 1.7 : Examples and Problems based on above topics.	**16 hrs**	**18**
Unit-2	**Regression Analysis** 2.1 Meaning of linear Regression. 2.2 Method of least squares to estimate the regression coefficient. 2.3 Estimation of the intercept term. 2.4 Properties of Regression coefficients. 2.5 Standard error of estimator $S_{y.x}$. 2.6 Interpretation and application of Standard error of estimator. 2.7 Examples &Problems based on above topics.	**16 hrs**	**18**
Unit-3	**Introductory Demography :** 3.1 Vital Events, Vital Statistics. 3.2 Methods of Obtaining Vital statistics - Census and Vital Statistics Registers. 3.3 **Rates of Vital Events.** 3.4 **Mortality Rate:** CDR, Specific (age, sex etc.) death Rates, Standardized death Rate (Direct Method 3.4 Infant Mortality Rate. 3.5 **Fertility Rates:** Crude Birth Rate, General Fertility Rate. 3.6 **Specific Fertility Rates:** Age group wise and sex wise.	**14 hrs**	**17**

	3.7 Total Fertility Rate and their interpretation. 3.8 Examples based on above topics.		
Unit-4	**Operations Research & Linear Programming Problems:** 4.1 Meaning and Definition of Operations research. 4.2 Advantages of O.R. 4.3 Applications and Scope of O.R. 4.4 General structure of L.P.P.. 4.5 Assumption of L.P.P. 4.6 Concept of slack variable, feasible solution, basic solution, basic feasible solution, optimal solution and degenerate solution. 4.7 Formulation of L. P. P.[upto only three decision variable case]. 4.8 Graphical method of solving L.P.P. for two decision variables. 4.9 Examples based on above topics.	**14 hrs**	**17**
		60 hours	**70 Marks**

INTERNAL COMPONENTS **MARKS**

1) TEST :15 Marks
2) ASSIGNMENT/ PRESENTATION : 10 Marks
3) SEMINAR / ATTENDENCE : 05 Marks
INTERNAL MARKS TOTAL : 30 Marks

Books Recommended:

1. **Dr. Ketan A. Gajjar & Dr. Parag Shah.** Scientific and Statistical Computing**,** Nirav Prakashan, Ahemdabad.
૨. ગાણિતિક આંકડાશાસ્ત્ર– એચ. ડી. શાહ, ગુજરાત ગ્રંથ નિર્માણ બોર્ડ, ગાંધીનગર.
૩. આંકડાશાસ્ત્ર ભાગ–1 અને ભાગ– 2 – બી. એસ. શાહ પ્રકાશન, અમદાવાદ
4. **Gupta V.K. & Kapoor S.C.**: Fundamentals of Mathematical Statistics.- Sultan Chand and sons, New Delhi.
5. **Goon A. M., Gupta M. K., Das Gupta B.** (1999): Fundamentals of Statistics, Vol.II, World Press, Calcutta.
6. **Agarwal B.L**. : Basic Statistics, New Age International Ltd.1995.
7. **Shinoy, Shrivastava & Sharma**: Quantitative Techniques for Managerial Decisions.
8. **Hogg R. V. and Crag R. G.**: Introduction to Mathematical Statistics Ed.4.
9. **Hoel P. G**. (1971): Introduction to Mathematical Statistics, Asia Publishing House.
10. **Mukhopadhyay P.** (2006) : Probability. Books and Allied (P) Ltd.
11. **Dunn** :Basic Statistics, A premier for the biomedical Sciences,2 Edn.- **JVS-Asia.**
12. **Sharma J. K.** : Operations Research – Theory and Applications.

CHOICE BASED CREDIT SYSTEM (CBCS)

B.Sc. Semester III – STATISTICS
STRUCTURE OF CORE COURSE

Modern syllabus for second year B.Sc. Semester III (Statistics) confirming to New Credit and Continuous Internal Evaluation Based Semester Pattern.

Introduction:- The proposed syllabus for B.Sc. semester III students who offer Statistics as either principal or as a subsidiary subject upon their admission in semester III along with the weekly distribution of periods each of one hour's duration and the distribution of marks at Internal and External Evaluation are presented below.

Course Type	Paper No.	Title of Paper	Total Marks EXT.+ INT* = TOTAL	Passing Standards EXT.+ INT= TOTAL	Total Teaching Hours (in 15weeks)	Exam. Hrs	Credits
Core Course STATISTICS THEORY	STAT - CC- 303	Mathematical Statistics - II	70+ 30* = 100	28+12* = 40 marks	15 Weeks × 4 lect.= 60 hrs	02 hrs 30 min.	04
Core Course STATISTICS THEORY	STAT – CC - 304	Applied Statistics -II	70+ 30 = 100	28+12 = 40 marks	15 Weeks × 4 lect.= 60 hrs	02hrs 30 min.	04
Core Course STATISTICS PRACTICAL	STAT – CC- 305	Practicals in Statistics [Sec. A & B]	= 100 [Only External]	= 40 marks [Only External]	15 Weeks × 6 lect.= 90 hrs	02 × 03hrs = 6 hrs	06
						TOTAL	14

(1) In a week, there will be two laboratory sessions each of three hours' duration per batch for conduction of course **STAT – PRAC - 305** - Section A & Section B.

(2) Course **STAT – PRAC - 305** consists of two Section A & Section B of practicals in statistics based on STAT – CC – 303 and STAT – CC – 304 designed to make students proficient in real life applications of some statistical methods .

(3) There will be **Two Semester-End Practical Examination papers based on** Section A & Section B, **each of three hours'** duration in the batches of 20 students per batch and **every written practical paper carries 40 marks each**. During the written practical examination, there will be a compulsory VIVA - VOCE Examination and Journal Assessment for every practical batch. The **Viva - voce and Term-work Assessment will carry 10 marks**.

In all Statistics Practical Course **STAT–PRAC-305 carries 100 marks**.

B. Sc. Sem. III [Statistics]
STAT-CC- 303 [Mathematical Statistics –II]

Credits: 04

Internal Marks: 30
External Marks:70 **Max : 60 Lectures**

UNIT	CONTENTS	Lect.	Marks
Unit –1	**PROBABILTY & BAYE'S THEOREM:** 1.1: Overview of probability & conditional probability. 1.2: Proof of conditional probability function related to Axioms of probability. Addition theorem of probability and its extension for three variables, examples based on topics. Multiplication theorem of probability and its extension for three events, examples based on topics. 1.3 Partition of a Sample Space, Total probability rule. Baye's theorem of probability and its applications. **BIVARIATE DISTRIBUTION:** 1.4:Study of discrete and continuous bivariate probability distribution 1.5:.Study of marginal and conditional probability distributions in case of Discrete and continuous bivariate random variables. 1.6: Conditional expectation & conditional variance with examples. Independence of two random variables. 1.7 Idea of covariance between two random variables, Properties of covariance without proof. 1.8 Examples based on above topics.	**16**	**18**
Unit –2	**DISCRETE PROBABILITY DISTRIBUTIONS:** 2.1: Idea of univariate discrete random variable with concept of probability mass function with elementary examples. 2.2: Idea of univariate continuous random variable with concept of probability density function with elementary examples. 2.3: Cumulative distribution function with elementary properties and examples. 2.4: Detailed study of Bernoulli probability distributions with derivations of their properties and examples. 2.5: Detailed study of Binomial probability distributions with derivations of their properties and examples. 2.6: Detailed study of Poisson probability distributions with derivations of their properties and examples. 2.7: Poisson approximation to Binomial (Without proof). 2.8: Examples and applications based on topics.	**16**	**18**
Unit –3	**NORMAL AND STANDARD NORMAL DISTRIBUTIONS:** 3.1 Definition of Normal probability distribution. 3.2 Chief characteristics of Normal distribution(Without proof). 3.3 Definition of standard normal distribution. 3.4 Derivation of Additive property of normal distribution. 3.5 Area property and use of standard normal probability tables. 3.6 Importance of normal probability model.	**14**	**17**

	3.7 Examples based on above topics.		
Unit –4	**UNIFORM & EXPONETIAL PROBABILITY DISTRIBUTIONS:** 4.1: Definition of Uniform distribution (rectangular distribution). 4.2: Derivation for MGF & MGF does not exist at t =0. 4.3: Derivations for mean and standard deviation of distribution. 4.4: Mean deviation about mean of uniform distribution, 4.5: Exponential probability Distribution. 4.6: Nature of Probability Curve. 4.7: Study of properties like- mean S.D., MGF, CGF, $\sqrt{\beta_1}$,nad β_2. 4.8; Lack of memory property and applications. 4.9: Examples based on above topics.	**14**	**17**

INTERNAL COMPONENTS **MARKS**

1) TEST :15 Marks

2) ASSIGNMENT/ PRESENTATION : 10 Marks

3) SEMINAR / ATTENDENCE : 05 Marks

INTERNAL MARKS TOTAL : 30 Marks

- Books Recommended :

1.	Mathematical Statistics with Applications(2nd Ed.)	John E. Freund's ,Irvin Miller,Maryless Miller	Pearson Education
2.	Introduction to Mathematical Statistics	Hogg R.V. and Craig A.T.	MacMillan Pub.Co.
3.	Introduction to Probability Theory	Hoel P.,Prot S.C. and Stone C.J.	Houghton Miffin Company Boston
4.	Probability & Statistics: Theory and Applications	Fraser D.A.S.	North Scituate Mass. Duxbury Press.
5.	Fundamentals of Mathematical Statistics	Gupta & Kapoor	Sultan Chand Pub. New Delhi
6.	Introduction to the Theory of Statistics	Mood A.M.,Graybill F.A. and Boes F.A.	McGraw Hill Pub.
7.	Mathematical Statistics	John E. Fruend and Ronald E Walpole	Prentice Hall Pub.

B. SC. [STATISTICS]
SEMESTER - III
STAT-CC- 304 Applied Statistics –II

Credits : 04

Internal Marks: 30
External Marks:70 **Max : 60 Lectures**

UNIT	CONTENTS	Lect.	Marks
Unit –1	**INDEX NUMBERS:** 1.1 Definition and Meaning of Index Number. 1.2 Uses of Index Numbers. 1.3 Classification of Index Numbers. 1.4 Steps in the construction of Index Numbers. 1.5 Methods of constructing Index Numbers: 1.6 Simple Aggregative Method, Average of Price Relatives Method (Arithmetic Mean & Geometric Mean), Weighted Aggregative Methods- Laspeyre's, Paasche's, Fisher's, Marshal-Edgeworth's, Dorbish- Bowley's, Walsh's Methods. 1.7 Quantity Index Numbers and Value Index Numbers. 1.8 Tests of Perfection or Consistency of Index Numbers- Time Reversal Test and Factor Reversal Test. 1.9 Fixed Base and Chain Base Index Numbers. 1.10 Results on Index Numbers (L < F < P; L < ME <P). 1.11 Cost of Living / Consumer's Price Index Numbers. 1.12 Steps in construction of Cost of Living Index Number. 1.13 Methods of constructing Cost of Living Index Number: Aggregate Expenditure Method, Family Budget Method. 1.14 Simple examples based on above topics.	**16**	**18**
Unit –2	**TIME SERIES ANALYSIS:** 2.1 Meaning and Definition of Time Series. Components of Time Series - Secular Trend, Periodic Changes, Cyclical variation, Irregular or Random Component. 2.2 Models of Decomposition of Time Series- Additive Model and Multiplicative Models . Uses of Time Series. 2.3 Estimation of Components: Methods of Measurement of Trend- Graphical Method, Method of Semi-Averages, Least Squares method and Method of Moving Averages with determination of the period of moving average. Comparison of these methods. 2.4 Methods of Measuring Seasonal Variations- Ratio to Simple Average, Method, Ratio to Trend Method, Ratio to Moving Average Method, Link Relative method. Examples based on Trend analysis and Seasonal Variation. **FORECASTING METHODS:** 2.5 Meaning and uses of forecasting. 2.6 Method of Fitting of straight line by semi- average, least squares methods, exponential smoothing. 2.7 Fitting of second degree parabola, Growth curves like - $Y = ab^X$, $Y = a X^b$, 2.8 Input – output analysis, its assumptions and construction of Input	16	18

	–output tables. 2.9 Numerical examples based on all above topics.		
Unit –3	**VITAL STATISTICS:** 3.1 Vital Events, Vital Statistics. 3.2 Methods of Obtaining Vital statistics-Census and Vital Statistics Registers. 3.3 Complete and Abridged Life Tables. 3.4 Functions of the Life Table and their inter relationships. 3.5 Construction of Life tables. **DEMAND ANALYSIS:** 3.6 Meaning of Demand and Supply. Law of Demand and Supply. Market Equilibrium, Equilibrium Price and quantity. 3.7 Elasticity of Demand & Supply. 3.8 Marginal Revenue, Average Revenue and Total Revenue. 3.9 Idea of Problem of Monopoly, Examples.	14	17
Unit –4	**Simple Random Sampling With Replacement (SRSWR):** 4.1 Definition, Procedures to select a Simple Random Sample using – i. Random Numbers Table ii.MS Excel- Suitability of SRS, 4.2 To Prove following Results 1.E $(\bar{y}) = \bar{Y}$ 2.V $(\bar{y})_{SRSWR} = \frac{\sigma^2}{n}$ 3. V $(\bar{y})_{SRSWOR} < V (\bar{y})_{SRSWR}$ 4.3 Unbiased estimators of SE $(\bar{y})$ and SE $(\hat{Y})$. 4.4 Idea of Sampling Fraction and Finite Population Correction. 4.5 Advantages and Disadvantages of SRS. 4.6 Computations of Examples based on above topics.	14	17

INTERNAL COMPONENTS **MARKS**

1) TEST :15 Marks

2) ASSIGNMENT/ PRESENTATION : 10 Marks

3) SEMINAR / ATTENDENCE : 05 Marks

INTERNAL MARKS TOTAL : 30 Marks

Books Recommended:

1.	Basic Statistics	B. L. Agrawal	New Age International Publication
2.	Statistics – Theory, Methods and Applications	D.C. Sancheti, V.K.Kapoor	Sultan Chand & sons NewDelhi
3.	Business Statistics	G.U.Shenoy, U.K.Shrivastava, S.C.Sharma	Wiley Eastern Publication.
4.	Fundamentals of Mathematical Statistics	S.C. Gupta & V.K. Kapoor	Sultan Chand Pub. New Delhi
5.	Fundamentals of Statistics-Vol. II	A.M. Goon, M.K.Gupta & B. Dasgupta	World Press Pvt.Ltd.
6.	Introduction to the Theory of Statistics	Mood A.M.,Graybill F.A. and Boes F.A.	McGraw Hill Pub.
7.	Mathematical Statistics	John E. Fruend and Ronald E Walpole	Prentice Hall Pub.
8	પ્રયુક્ત આંક્ડાશાસ્ત્ર	પ્રો. આર. ટી. રતાણી.	ગુજ. ગ્રંથ નિર્માણ બોર્ડ, ગાંધીનગર
9	આંક્ડાશાસ્ત્રીય પદ્ધતિઓ	ડો. પી. એન. અરોરા, સુમીત અરોરા અને અમિત અરોરા,	એસ. ચાંદ એણ્ડ સન્સ, નઈ દિલ્લી.

B. SC [STATISTICS]
SEMESTER III
STAT – CC – 305 Practicals in Statistics

Credits :06

Internal Marks: 00
External Marks:100 **Max. Lectures: 90**

SECTION – A

	CONTENTS OF PRACTICALS	Session
1	Computation and interpretation of measures of central tendency and positional measures such as quartiles, Deciles, Percentiles [for ungrouped and grouped data] Tracing median and quartiles from Ogive curve	1 pr.
2	Computation and interpretation of absolute measures of dispersioni. Range ii. Inter-quartile Range iii. Quartile Deviation iv. Mean Deviation v. Standard Deviation and relative measures based on them for ungrouped and grouped data, potential outliers in raw data.	2 pr.
3	Computation of raw moments and central moments of first four order, skewness coefficient $\sqrt{\beta_1}$ and kurtosis coefficient β_2 and interpretation of types of skewness as well as i.$\beta_2 = 3$ ii. $\beta_2 > 3$ iii. $\beta_2 < 3$.	2 pr.
4	Applications of Binomial probability distribution. Application of Binomial distribution as a sum of independent Bernoulli random variables.	2 pr.
5	Fitting of a Binomial Probability Distribution and testing its goodness of fit	1 pr.
6	Applications of Poisson probability distribution. Application based on approximation to Binomial.	1 pr.
7	Fitting of Poisson Probability Distribution and testing its goodness of fit	1 pr.
8	Computation of Area under the normal probability curve.	2 pr.

	SECTION – B	
1	Construction of Index Number (Unweighted) :SAM, AMPR & GMPR	1 pr.
2	Construction of Index Number using Weighted- Aggregative Methods – Laspeyre's, Paasche's, Fisher's, Marshal-Edgworth's, Dorbish-Bowley's & Walsh's methods and Weighted Average of Price Relative Methods.	2 pr.
3	Test of Reversibility of Index Numbers- Time Reversal Test and Factor Reversal Test.	1 pr.
4	Construction of Cost of living and fixed Base - Chain Base Index Numbers.	1 pr.
5	Measurement of Trend: Graphical, Least squares & moving average methods of trend analysis from time series.	2 pr.
6	Measurement of Seasonal Variation – Ratio to Simple Average, Trend method .	1 pr.
7	Construction of Life table.	1 pr.
8	Link Relatives method for computing Seasonal Indices.	1 pr.
9	Method of Fitting Growth curves like: $Y = ab^X$,	1 pr.
10	Simple Random Sampling With Replacement.	1 pr.

B.Sc. Semester IV – STATISTICS

STRUCTURE OF CORE COURSE

Course Type	Paper No.	Title of Paper	Total Marks EXT.+ INT* = TOTAL	Passing Standards EXT.+ INT= TOTAL	Total Teaching Hours (in 15weeks)	Exam. Hrs	Credits
Core Course STATISTICS THEORY	STAT-CC- 403	Mathematical Statistics - III	70+ 30* = 100	28+12* = 40 marks	15 Weeks × 4 lect.= 60 hrs	02 hrs 30 min.	04
Core Course STATISTICS THEORY	STAT – CC - 404	Applied Statistics -III	70+ 30 = 100 marks	28+12 = 40 marks	15 Weeks × 4 lect.= 60 hrs	02hrs 30 min.	04
Core Course STATISTICS PRACTICAL	STAT – CC - 405	Practicals in Statistics [Sec. C & D]	= 100 [Only External]	= 40 marks [Only External]	15 Weeks × 6 lect.= 90 hrs	02 × 03hrs = 6 hrs	06
						TOTAL	14

(1) In a week, there will be two laboratory sessions each of three hours' duration for conduction of course **STAT – PRAC - 405 -** Section A & Section B.

(2) Course **STAT – PRAC - 405** consists of TWO Section A & Section B of practicals in statistics based on STAT – CC – 403 and STAT – CC – 404 designed to make students proficient in real life applications of some statistical methods .

(3) There will be **Two Semester-End Practical Examination papers based on** Section A & Section B, **each of three hours** duration, in the batches of 20 students per batch and **every written practical paper carries 40 marks each**. During the written practical examination, there will be a compulsory VIVA - VOCE Examination and Journal Assessment for every practical batch. The **Viva - voce and Term-work Assessment will carry 10 marks**.

In all Statistics Practical Course **STAT – PRAC - 405 carries Total 100 marks**.

B. Sc. (Statistics)
SEMESTER - IV
STAT-CC- 403 [Mathematical Statistics - III]

Credits: 04

Internal Marks: 30
External Marks:70 **Max Lectures: 60**

UNIT	CONTENTS	Lect.	Marks
Unit –1	**Generalized Gamma probability Distribution**:	**16**	**18**

1.1 Definition of Gamma distribution of the forms:

$$1) f(x;\alpha,\beta) = \begin{cases} \frac{1}{\beta^{\alpha}\Gamma\alpha}\ e^{-x/\beta}\ (x)^{\alpha-1}, & 0 < x < \infty, \alpha > 0, \beta > 0 \\ = 0 & otherwise \end{cases}$$

$$2)\ f(x;\alpha,p) = \begin{cases} \frac{\alpha^{p}}{\Gamma p}\ e^{-\alpha x}\ (x)^{p-1} & 0 < x < \infty, \alpha > 0, p > 0 \\ = 0 & otherwise \end{cases}$$

1.2 Mean and variance of gamma distribution.

1.3 Moment Generating Function of distribution, first four central moments , β_1 and β_2.

1.4 Cumulant Generating Function of distribution.

1.5 Additive Property of Gamma distribution.

1.6 The probability distribution of sum of independent exponential variates.

1.7 Applications of exponential probability distribution.

Beta distributions:

1.8 **Beta distribution of first kind:** Definition of beta distribution of first kind with p.d.f. -

$$f(X = x) = \begin{cases} \frac{x^{m-1}\ (1-x)^{n-1}}{\beta\ (m,n)}, & 0 < x < 1, m, n > 0 \\ 0 & otherwise \end{cases}$$

1.9 Derivation for r[th] raw moment, μ_1', μ_2', μ_3' *and* μ_4', hence, $\beta 1$ *and* $\beta 2$.

1.10 Derivation for Harmonic Mean of distribution.

1.11 Beta distribution of second kind: Definition of the Beta distribution of **second kind** with p.d.f.

$$f(X = x) = \begin{cases} \frac{1}{\beta\ (m,n)}\ \frac{x^{m-1}}{(1+x)^{m+n}}, & 0 < x < \infty, m, n > 0 \\ 0 & otherwise \end{cases}$$

1.12 Derivation for r[th] raw moment, hence, Mean, variance.

1.13 Derivation for Harmonic Mean of distribution.

1.14 Examples and Problems based on above topics.

Unit –2	**Hyper geometric distribution:** 1.1 Definition of hyper geometric distribution. 1.2 Conditions for occurrence of distribution. 1.3 Derivation of probability mass function. 1.4 Recurrence formula for successive probability. 1.5 Expression for mean and variance of distribution. 1.6 r^{th} factorial moment, Hence, its mean and variance. 1.7 Factorial M.G.F. and its use to find mean and variance. 1.8 Limiting form of distribution to binomial distribution. 1.9 Simple examples based on topics.	**16**	**18**
Unit-3	**Compound Distribution & study of Power Series Distribution(p.s.d.)** 3.1 Definition of Power Series Distribution(g.p.s.d). 3.2 Derivation for M. G. Function of p.s.d.. 3.3 Recurrence Relation for cumulants of p.s.d.. 3.4 Particular case of p.s.d.: 3.4.1 Binomial distribution, 3.4.2 Poisson Distribution, 3.4.3 Negative binomial distribution, 3.4.4 Logarithmic Series distribution. 3.5 Examples based on topics.	**14**	**17**
Unit –4	**Geometric distribution:** 4.1 Definition of probability distribution of number of failures preceding the first success. 4.2 Definition of probability distribution of number of trials required to get the first success. 4.3 Moment Generating Function (M. G. F.). 4.4 Cumulant generating function (C.G. F.). 4.5 First four central moments, β_1 and β_2, of the probability distribution. 4.6 Forgetfulness property of Geometric distribution . 4.7 Examples based on topics.	**14**	**17**

INTERNAL COMPONENTS **MARKS**

1) TEST :15 Marks

2) ASSIGNMENT/ PRESENTATION : 10 Marks

3) SEMINAR / ATTENDENCE : 05 Marks

INTERNAL MARKS TOTAL : 30 Marks

- **Books Recommended** :

1.	Mathematical Statistics with Applications(2nd Ed.)	John E. Freund's, Irvin Miller, Maryless Miller	Pearson Education
2.	Introduction to Mathematical Statistics	Hogg R.V. and Craig A.T.	MacMillan Pub.Co.
3.	Introduction to Probability Theory	Hoel P., Prot S.C. and Stone C.J.	Houghton Miffin Company Boston
4.	Probability & Statistics: Theory and Applications	Fraser D.A.S.	North Scituate Mass. Duxbury Press.
5.	Fundamentals of Mathematical Statistics	Gupta S.C. & Kapoor V.K.	Sultan Chand Pub. New Delhi
6.	Introduction to the Theory of Statistics	Mood A.M., Graybill F.A. and Boes F.A.	McGraw Hill Pub.
7.	Mathematical Statistics	John E. Fruend and Ronald E Walpole	Prentice Hall Pub.

B. Sc. (Statistics)
SEMESTER - IV
STAT-CC- 404 [Applied Statistics –III]

Credits: 04

Internal Marks: 30
External Marks:70 **Max : 60 Lectures**

UNIT	CONTENTS	Lect	Marks
Unit –1	**NON-PARAMETRIC TESTS :** 1.1 Meaning of nominal, ordinal, Interval and ratio scales of data. 1.2 Meaning of non-parametric inference. 1.3 Distinction between parametric and Non-parametric methods. 1.4 Advantages and disadvantages of non parametric methods. 1.5 Purpose, type of data required, Procedure, test statistic used and decision methodology of the following Non parametric tests using one sample – • Run test for one Sample. • Sign test for one Sample. • Sign test for two dependent samples. • Kolmogorov-Smirnov one sample test, 1.6 Purpose, type of data required, Procedure, test statistic used and decision methodology of the following Non parametric tests using one sample 1.6.1 Median test for two samples. 1.6.2 Wilcoxon's signed rank test for paired samples. 1.6.3 Run test for two samples. 1.6.4 Mann-Whitney U-test for two independent samples. 1.7 Numerical Examples based on topics.	**16**	**18**
Unit –2	**TESTS OF SIGNIFICANCE & LARGE SAMPLE TESTS** 2.1 Population, Sample, Parameter, Statistic. 2.2 Sampling distribution & Standard Error of test Statistic. 2.3 Hypothesis, Statistical hypothesis. 2.4 Null and Alternative Hypotheses, Simple and Composite Hypotheses. 2.5 Critical Region, Types I and Type II Error. 2.6 Level of Significance, Criteria for testing a hypothesis. **Large Sample Tests** 2.7 Single Mean Z –test. 2.8 Difference of two Means Z- test. 2.9 Single Proportion Z –test and 210 Difference of two Proportions Z –test. 2.11 Examples based on topics.	**14**	**17**
	EXACT SAMPLING TESTS-	**16**	**18**

Unit –3	**3.1 – χ^2- Test** 3.1.1 Goodness of Fit Test. 3.1.2 Independence of attribute Test [r x s –Contingency Table, 2X2 C.T.]. 3.1.3 Test of Single Population Variance. 3.1.4 Yates continuity corrections for 2x2 C.T. **3.2 – t- Test:** 3.2.1 For testing significance of Single Population Mean. 3.2.2 Idea of two independent samples and two dependent samples. 3.2.3 Significance of difference in Means of Two Normal populations having equal variances. 3.2.4 Paired t-Test for testing the significance of two dependent samples. 3.2.5 Examples based on topics. **3.3 – F- Test:** Significance of difference of variances of two Normal populations. 3.4 Examples based on topics 3.15, 3.25, 3.3.		
Unit –4	ANALYSIS OF VARIANCE TECHNIQUES- 4.1 Concept of analysis of variance. 4.2 Three Principals of Experimentation. 4.3 Concepts and definitions of terms related to ANOVA. 4.2 Model for one way classified data. Assumption and interpretation. 4.3 Model for two way classified data. Assumption and interpretation. 4.4 Concept of resolution of total sum of squares into components in case of one way and two way linear models. 4.5 Analysis of one way model: hypothesis, only expressions for Various Sum of squares, MSS, F- Ratio, Preparation of Analysis of variance table, and its interpretation. 4.6 Analysis of Two way model: hypothesis, only expressions for Various S.S., MSS, F- Ratio, and its interpretation from Analysis of variance table. 4.7 Examples based on topics.	**14**	**17**

INTERNAL COMPONENTS **MARKS**

1) TEST :15 Marks

2) ASSIGNMENT/ PRESENTATION : 10 Marks

3) SEMINAR / ATTENDENCE : 05 Marks

INTERNAL MARKS TOTAL : 30 Marks

Books Recommended:

1.	Basic Statistics	B. L. Agrawal	New Age International Publication
2.	Statistics – Theory, Methods and Applications	D.C. Sancheti, V.K.Kapoor	Sultan Chand & sons NewDelhi
3.	Business Statistics	G.U.Shenoy, U.K.Shrivastava, S.C.Sharma	Wiley Eastern Publication.
4.	Fundamentals of Mathematical Statistics	S.C. Gupta & V.K. Kapoor	Sultan Chand Pub. New Delhi
5.	Fundamentals of Statistics- Vol. II	A.M. Goon, M.K.Gupta & B. Dasgupta	World Press Pvt.Ltd.
6.	Introduction to the Theory of Statistics	Mood A.M.,Graybill F.A. and Boes F.A.	McGraw Hill Pub.
7.	Mathematical Statistics	John E. Fruend and Ronald E Walpole	Prentice Hall Pub.
8	Non Parametric Methods for the Behavioral Sciences	Sidney Siegel	. International Student Ed. McGraw Hill Kogakusha Ltd.
9	Non Parametric Statistical Inference,	J.D. Gibbons	McGraw Hill Book Company, New York.
10	Applied Non Parametric Statistics	Daniel	Houghton Mifflin Company Roston.

B. SC. [STATISTICS]
SEMESTER - IV

STAT – PRAC - 405: Practicals in Statistics **Credits : 06**
Internal Marks: 00 **Session: 6 Lectures**
External Marks:100 **Time: 90 Lectures**

SECTION – A

	CONTENTS OF PRACTICALS	Session
1	Applications of Hyper geometric probability model.	1 pr.
2	Applications of geometric probability model.	1 pr.
3	Model sampling from a geometric probability distribution.	1 Pr.
4	Fitting of Geometric Distribution	1 pr.
5	Sign test for Single sample .	1 Pr.
6	Two Sample Sign Test and Wilcoxon Signed Rank Test	2 pr.
7	Run test for one Sample and Two sample.	2 pr.
8	Median test.	1 pr.
9	Mann-Whitney U-test for two independent samples,	1 pr.
10	Kolmogorov-Smirnov one sample test for goodness of fit.	1 pr.

SECTION – B

CONTENTS OF PRACTICALS

1	**Large Sample Tests-I** : Testing the significance of Single population Mean & Testing the significance of Difference of two Means.	2 pr.
2	**Large Sample Tests-II :** Testing the significance of Single population proportion & Testing the significance of Difference of two proportion s.	1 pr.
3	χ^2- Test for goodness of fit.	1 pr.
4	χ^2- Test - Independence of attributes for r x s – Contingency Table.	1 Pr.
4	χ^2- Applications: Test for independence of two attributes: For2 x 2 Contingency Table, Yates correction and Establishing $Z^2 = \chi^2$ with 1 d.f., Test for testing the significance of the variance from normal population	2 pr.
5	t- Test – (Single Population Mean, Difference of two Means)	2 pr.
6	Paired t-Test.	1 pr.
7	Analysis of Variance [One and Two way classification] .	2 Pr.

Bachelor of Science (B. Sc.) Semester – V

Core Course – STATISTICS

The proposed syllabus and pattern were designed to be effective from June 2018 & revised syllabus from June 2019.

STRUCTURE OF SEMESTER – V- CORE COURSE- STATISTICS

Course Type	Paper No.	Title of Paper	Total Marks EXT.+ INT* = TOTAL	Passing Standards EXT.+ INT= TOTAL	Total Teaching Hours (in 15weeks)	Exam. Hrs	Credits
Core Course STATISTICS THEORY	Paper STAT - CC- 503	Mathematical Statistics- IV	70+ 30* = 100	28+12* = 40 marks	15 Weeks x 4 lect.= 60 hrs	02 hrs 30 min.	04
Core Course STATISTICS THEORY	Paper STAT – CC - 504	Sampling Techniques & S. Q. C.	70+ 30*= 100	28+12* = 40 marks	15 Weeks x 4 lect.= 60 hrs	02hrs 30 min.	04
Core Course STATISTICS THEORY	Paper STAT – CC - 505	Some Probability distribution Models	70+ 30*= 100	28+12* = 40 marks	15 Weeks x 4 lect.= 60 hrs	02hrs 30 min.	04
Core Course STATISTICS THEORY	Paper STA – CC - 506	Statistical Inference –I	70+ 30*= 100	28+12* = 40 marks	15 Weeks x 4 lect.= 60 hrs	02hrs 30 min.	04
Subject Elective Course STATISTICS THEORY	Paper STAT – SEC - 501	Industrial Statistics	70+ 30*= 100	28+12* = 40 marks	15 Weeks x 3 lect.= 45 hrs	02hrs 30 min.	03
Core Course STATISTICS PRACTICAL	STAT – PRAC – 507 – Paper - I	Practicals in Statistics – I Sections A & B	= 100 [Only External]	= 40 marks [Only External]	15 Weeks x 6 lect.= 90 hrs	02 x 03hrs = 6 hrs	06
	STAT – PRAC – 507 – Paper - II	Practicals in Statistics – II Sections C & D	= 100 marks [Only External]	= 40 marks [Only External]	15 Weeks x 6 lect.= 90 hrs	02 x 03hrs = 6 hrs	06

IMPORTAN REMARKS:

(3) In a week, there will be four theory periods each of one hour's duration for direct classroom teaching of each of courses STAT – CC – 503 to STAT – CC – 506 and for STAT – EC – 501, there will be three theory periods each of one hour duration.

(2) In a week, there will be four laboratory sessions each of three hours' duration for conduction of course STAT – CC–507 Section A, Section B, Section C & Section D .

(3) Course **-PRA – STAT – 507 – Paper – I** consists of two Sections A and B of practicals in statistics based on STAT – CC – 503 and STA – CC – 504 and **Paper – II -PRA – STAT – 507** - consists of two Sections C and D of practicals in statistics based on STA – CC – 505 and STA – CC – 506 designed to make students analytically more proficient in real life applications of some statistical methods .

(4) There will be **Four Semester-End Practical Examination papers each of three hours'** duration in the batches of 20 students per batch and **every written practical paper carries 40 marks each**. During the written practical examination, there will be a compulsory viva - voce Examination and Journal Assessment for every practical batch. The **Viva - voce and Term-work Assessment will carry 10 marks**.

In all Statistics Practical Course **STAT–PRAC-507 paper I & Paper II will be of six hours duration and carries 200 marks**.

B. Sc. Sem. V [Statistics]
STAT-CC- 503 [Mathematical Statistics –IV]

Credits: 04

Internal Marks: 30
External Marks:70 **Max. Lectures: 60**

UNIT	CONTENTS	Lect.	Marks
Unit –1	**CONVERGENCE-:** 1.1 **Markov's Inequality:** If g(X) is a non-negative function of a r.v. X , $E\{g(X)\} < \infty$ and if $k > 0$ then $P\{g(X) \geq k\} \leq E\{g(X)\}/k$. 1.2 Chebychev's inequality for discrete probability distribution in the forms: $P\{\| X - \mu \| \geq k\sigma\} \leq 1/k^2$ and $P\{\| X - \mu \| < k\sigma\} \geq 1-1/k^2$, where $\mu = E(X)$ and $\sigma^2 = V(X)$. 1.3 Chebychev's inequality for continuous probability distribution in the forms $P\{\| X - \mu \| \geq k\sigma\} \leq 1/k^2$ and $P\{\| X - \mu \| < k\sigma\} \geq 1-1/k^2$, where $\mu = E(X)$ and $\sigma^2 = V(X)$. **CHARECTERISTIC FUNCTION:** 1.4 Idea of Characteristic function and its properties, 1.5 Derivation of Inversion theorem of characteristic function. 1.6 Derivation of Inversion formula. 1.7 Kendall's form of uniqueness theorem. 1.8 Examples and problems based on WLLN.	**14**	**17**
Unit –2	**LAWS OF NUMBERS & CENTRAL LIMIT THEOREM:** 2.1 Statement and proof of WLLN based on Chebychev's theorem. 2.2 De-moirvé Laplace Theorem, 2.3 Examples based on above theorems. 2.4 Lindberg –Levy's Central limit theorem with proof, 2.5 Liapounoff's C.L.T.(without proof), Examples based on topics. 2.6 Concept of convergence in probability, convergence in distribution, strong convergence , convergence almost surely, i.e. strong convergence. 2.7 Applications of WLLN and CLT. 2.8 Examples and problems based on WLLN.	**16**	**18**
Unit –3	**DETAIL STUDY OF NORMAL DISTRIBUTIONS**: 3.1: Definition of Normal probability distribution with p.d.f., 3.2: Definition of standard normal distribution with p.d.f., 3.3: Derivation of Raw and central moments of normal distribution, 3.4: Properties – i. Distribution of linear combination of independent normal r. v.'s, ii. Derivation for μ_{2n} and μ_{2n+1}, 3.5: Derivation of mean deviation about mean, 3.6: Quartiles and quartile deviation of normal distribution, 3.7: Area property and use of normal probability tables, 3.8: Examples based on above topics.	**14**	**17**

Unit - 4	**CAUCHY DISTRIBUTION:** 4.1 Definition of Cauchy distribution with p. d. f.: $f(x) = \frac{\lambda}{\pi}\frac{1}{1+\left(\frac{x-\mu}{\lambda}\right)^2}, \quad -\infty < x < \infty, -\infty < \mu < \infty, \lambda > 0$ $otherwise$ Notation : X~ C(μ, λ) 4.2 Nature of probability curve, Non- existence of mean, 4.3 Definition of standard Cauchy distribution, derivation of Distribution function, 4.4 Derivation for Quartile deviation and characteristic function, 4.5 Additive property of Cauchy distribution, distribution of sample mean. **LAPLACE DISTRIBUTION:** 4.6 Definition of Laplace distribution with P. d. f : $f(x) = \frac{\lambda}{2} e^{[-\lambda\|x-\mu\|]}, \quad -\infty < x < \infty, -\infty < \mu < \infty, \lambda > 0$ $otherwise$ Notation : X ~ Lap. (μ, λ) 4.7 Nature of probability curve, 4.8 Distribution function, quartiles and quartile deviation, 4.9 Definition of standard Laplace distribution, 4.10 Derivation of m.g.f, and c.g.f., hence, moments and $\beta_1, \beta_2, \gamma_1, \gamma_2$. of distribution, 4.11 Characteristic function of distribution, and 4.12 M.D. about mean of distribution, 4.13 Examples based on above topics.	**16**	**18**

INTERNAL COMPONENTS **MARKS**

1) TEST :15 Marks

2) ASSIGNMENT/ PRESENTATION : 10 Marks

3) SEMINAR / ATTENDENCE : 05 Marks

INTERNAL MARKS TOTAL : 30 Marks

- **Books Recommended :**

1.	**Mathematical Statistics with Applications(2nd Ed.)**	**John E. Freund's ,Irvin Miller,Maryless Miller**	**Pearson Education**
2.	**Introduction to Mathematical Statistics**	**Hogg R.V. and Craig A.T.**	**MacMillan Pub.Co.**
3.	**Introduction to Probability Theory**	**Hoel P.,Prot S.C. and Stone C.J.**	**Houghton Miffin Company Boston**
4.	**Probability & Statistics: Theory and Applications**	**Fraser D.A.S.**	**North Scituate Mass. Duxbury Press.**
5.	**Fundamentals of Mathematical Statistics**	**Gupta & Kapoor**	**Sultan Chand Pub. New Delhi**
6.	**Introduction to the Theory of Statistics**	**Mood A.M.,Graybill F.A. and Boes F.A.**	**McGraw Hill Pub.**
7.	**Mathematical Statistics**	**John E. Fruend and Ronald E Walpole**	**Prentice Hall Pub.**

	B. Sc. Sem. V [Statistics] **STAT-CC- 504 [Sampling Techniques & S. Q. C.]** **Internal Marks: 30** **Credits:04** **External Marks:70** **Max. Lectures : 60**		
UNIT	**CONTENTS**	**Lect.**	**Marks**
Unit-1	**Introduction to Statistical Quality Control (SQC)** 1.1 Introduction, Meaning and purpose of Statistical Process Control, idea of Seven Statistical Quality Control (PC) Tools of SQC, Quality of a product, need of quality control. **Control chart:** 1.2 Statistical basis of control chart, 3- σ limits, justification of 3- σ limits and, Criteria for detecting lack of control. 1.3 Chance Causes and assignable causes of variation. 1.4 Statistical basis of control charts, exact probability limits, k- σ limits, Justification for the use of 3- σ limits for normal distribution and using Chebychev's inequality for non normal distributions, Control charts for continuous variables, Decisions preparatory to control charts. Criteria for detecting lack of Control . **Control charts for variables, attributes and Acceptance Sampling Plans:** **$\bar{X}$ Chart, R chart and σ- charts:** 1.5 Purpose of R and $\bar{X}$ chart. 1.6 Construction of R, s - chart and $\bar{X}$ chart when the Process. Standard deviation (σ) is not given, estimate of σ for future use. Construction of $\bar{X}$ -chart based on $\bar{s}$, drawing of control chart. Plotting sample means, revision of control limits of $\bar{X}$ chart, if necessary. **1.8** Examples and problems based on control charts.	**16**	**18**
Unit -2	**Control charts for attributes [p, d = np, c and u- charts] :** 2.1 Construction of p-chart (for fixed and variable sample size), d or np –chart, c-chart and u-chart (for variable sample size), when the standard is known and unknown. **Single Sampling Plan:** 2.2 Evaluation of probability of acceptance using - (i) Hyper geometric, (ii) Binomial & (iii) Poisson distributions. 2.3 Derivation of OC, AOQ and ATI. Graphical determination of AOQL, Determination of a single sampling plans by lot quality , Producer's Risk & Consumer's Risk. **Double Sampling Plan:** 2.4 Scheme of double sampling plan, Comparison of SSP and DSP, Evaluation of probability acceptance using Poisson approximation. 2.5 Examples, problems and Application of control charts and Acceptance sampling plans.	**14**	**17**
Unit	**Simple Random Sampling:** 3.1 Simple random sampling without replacement, 3.2 Concept of Sampling Fraction and Finite Population Correction,	**14**	**17**

– 3 **Unit - 3**	3.3 Simple random sampling without replacement for proportions. 3.4 Proof of the following results: 1) Sample proportion is an unbiased estimator of Population proportion 2) Np is an unbiased estimator of NP. 3) Var (p) = $\frac{(N-n)}{N-1}$. $\frac{P(1-P)}{n}$ and SE (p). **Determination of Sample Size (in case of SRS)** 3.5 Determination of sample size for estimating population mean and population proportion when – (i) Margin of error and confidence coefficient is given. (ii) Coefficient of variation and confidence coefficient is given. **Systematic Sampling:** 3.6 Real life situation where systematic sampling is appropriate, Technique of drawing a sample using systematic sampling, 3.7 Estimation of population mean and population total, Standard errors of these estimators, distinction between SRSWOR and systematic sampling through real life situations. 3.8 Examples and problems.		
Unit-4	**Stratified Random Sampling** 4.1 Introduction 4.2 Real life situations. 4.3 Stratified random sampling as a sample drawn from individual stratum using SRSWOR in each stratum. 4.4 Proof of the following results. a) $\bar{y}_{st}$ as an unbiased estimator of population mean $\bar{Y}$. b) N $\bar{y}_{st}$as an unbiased estimator of population total. 4.5 Standard error of $\bar{y}_{st}$ & N $\bar{y}_{st}$ and their estimation. 4.6 Problem of allocation, proportional allocation, Neyman's allocation, Derivation of the expressions for the standard errors of the above estimators when these allocations are used. 4.7 Gain in precision due to stratification, comparison with SRSWOR, Stratification with proportional allocation & stratification with Neyman's allocation. 4.8 Cost & variance analysis in stratified random sampling, minimization of variance for fixed cost, minimization of cost for fixed variance, 4.9 Optimum allocation, Neyman's allocation as a particular case of optimum allocation in cost and variance analysis. **Cluster Sampling:** 4.10 Real life situation where Cluster sampling is appropriate. 4.11 Technique of drawing a sample using Cluster sampling. 4.12 Examples and problems.	**16**	**18**

INTERNAL COMPONENTS **MARKS**

1) TEST :15 Marks

2) ASSIGNMENT/ PRESENTATION : 10 Marks

3) SEMINAR / ATTENDENCE : 05 Marks

INTERNAL MARKS TOTAL : 30 Marks

Books Recommended:

1. **Cochran W.G**. : Sampling Techniques, Wiley Eastern Ltd. New Delhi.
2. **Sukhatme P.V. & B.V.** : Sampling Theory of Surveys with Application, Indian Society of Agricultural Statistics, New Delhi Pub.
3. **Murty M.N. :** Sampling Methods, ISI, Kolkata,1977.
4. **Gupta S.C. & Kapoor V.K.:** Fundamentals of Applied Statistics, S. Chand Sons, New Delhi.
5. **B. L. Agrawal** , : Basic Statistics New Age International Publication, Delhi.
6. **G.U.Shenoy, U.K.Shrivastava, S.C.Sharma, :** Business Statistics , Wiley Eastern Publication.
7. **Duncan A.J.** : Quality Control & Industrial Statistics, D.B. Taraporevale Sons & Co. Pvt. Ltd., Bombay.
8. **Grant E.L. & Leavenworth** : Statistical Quality Control, Mc-Graw Hill Kogakusha, Ltd., New Delhi.
9. **Montgomery :** Statistical Quality Control, John Wiley & Sons Inc. New York (3rd Ed.),1996
10. **R. C. Gupta** : Statistical Quality Control.

B. Sc. Sem. V [Statistics]
STA-CC- 505 [Some Probability distribution Models]

Credits:04

Internal Marks: 30
External Marks:70 **Max. Lectures: 60**

UNIT	CONTENTS	Lect.	Marks
Unit –1	**TRUNCATED DISTRIBUTION :** 1.1 Concept of truncated distribution as conditional distribution, 1.2 Concept of Truncation to right, left and both sides, **TRUNCATED BINOMIAL DISTRIBUTION:** 1.3 Binomial distribution B(n, p, truncated at X = 0), [Zero value is not observable], Expression for its mean and variance, 1.4 B(n, p, truncated at X = n) [value n is not observable], and Expression for its mean and variance, 1.5 B(n, p, both ends truncated distribution i.e. X < a and X > b are truncated) [values below a and above b are not observable], Expression for its mean and variance, **TRUNCATED POISSON DISTRIBUTION:** 1.6 Truncated Poisson distribution P(λ, at X = 0) [Zero value is not observable], 1.7 Derivation of the expression for its mean and variance, 1.8 Example based on topic.	**16**	**18**
Unit-2	**EXACT SAMPLING DISTRUBITION:** **Chi-square Distribution:** 2.1 Idea of sampling distribution, 2.2 Definition of Chi- square random variable as a sum of i. i. d. standard normal random variates, 2.3 Derivation of p. d. f. of χ^2 with n d. f. using m. g. f. technique, 2.4 Nature of probability curve, 2.5 Computation of probability using χ^2 table, 2.6 Derivations of Mean, variance, moment generating function, 2.7 Derivations of Cumulant generating function, First four central moments, β_1, β_2, 2.8 Mode of the distribution, 2.9 Additive property theorem, 2.10 Normal approximation: $\frac{\chi^2 - n}{\sqrt{2n}}$ with proof, 2.11 Distribution of $\frac{\chi_1^2}{\chi_1^2 + \chi_2^2}$ and $\frac{\chi_1^2}{\chi_2^2}$, where, χ_1^2 and χ_2^2 are two independent chi square random variables. 2.12 Applications and examples based on above topics.	**16**	**18**
Unit –3	**OTHER SAMPLING DISTRIBUTIONS:** **Detailed study of Student's t – distribution:** 3.1 Definition of t- r.v. with n d.f. in the form $t = \frac{U}{\sqrt{\chi_n^2/n}}$, 3.2 Derivation of p.d.f., 3.3 Nature of probability curve, 3.4 Derivation of Mean, variance, and μ_{2n}, 3.5 Derivation of first four moments, β_1, β_2 of distribution, 3.6 Derivation for mode of the distribution, 3.7 Use of t- tables for calculation of probabilities, Statement of	**14**	**17**

	Normal approximation, Properties of t- distribution, Applications of t –distribution. **TRUNCATED NORMAL DISTRIBUTION:** 3.8 Idea of truncated normal distribution N(μ, σ^2) , 3.9 Derivation of truncated normal distribution which is truncated to the left of a real number X = a and its mean, 3.10 Deduction of truncated normal distribution which is truncated to the left of μ from N(μ, σ^2) and its mean, Distribution of p.d.f. of $\lvert X \rvert$, if X is S.N.V. 3.11 Idea of Doubly truncated normal distribution.		
Unit –4	**Detailed study of Snedecor's F- distribution:** 4.1 Definition of F r.v. with n_1 & n_2 d.f. as $F_{n_1,n_2} = \frac{\chi_1^2/n_1}{\chi_2^2/n_2}$, 4.2 Derivation of p. d. f., 4.3 Distribution of 1/F, 4.4 Use of F-tables for calculations of probabilities, 4.5 Interrelations among - χ^2, t and F- variates. 4.6 Use of statistical table to compute F- probabilities, 4.7 Relation between F and beta distribution of second kind, 4.8 Applications of F- distribution, 4.9 Examples based on topics.	**14**	**17**

INTERNAL COMPONENTS **MARKS**

1) TEST :15 Marks

2) ASSIGNMENT/ PRESENTATION : 10 Marks

3) SEMINAR / ATTENDENCE : 05 Marks

INTERNAL MARKS TOTAL : 30 Marks

Books Recommended:

1.	Mathematical Statistics with Applications(2nd Ed.)	John E. Freund's ,Irvin Miller,Maryless Miller	Pearson Education
2.	Introduction to Mathematical Statistics	Hogg R.V. and Craig A.T.	MacMillan Pub.Co.
3.	Introduction to Probability Theory	Hoel P.,Prot S.C. and Stone C.J.	Houghton Miffin Company Boston
4.	Probability & Statistics: Theory and Applications	Fraser D.A.S.	North Scituate Mass. Duxbury Press.
5.	Fundamentals of Mathematical Statistics	Gupta & Kapoor	Sultan Chand Pub. New Delhi
6.	Introduction to the Theory of Statistics	Mood A.M.,Graybill F.A. and Boes F.A.	McGraw Hill Pub.
7.	Mathematical Statistics	John E. Fruend and Ronald E Walpole	Prentice Hall Pub.
8	An Introduction to Probability Theory and Mathematical Statistics,	Rohatgi V.K. and Ehsanes Saleh A. K. MD. (2003).	Wiley Eastern , 2nd Ed..

B. Sc. Sem. V [Statistics]
STA-CC- 506 [Statistical Inference –I]

Credits: 04

Internal Marks: 30
External Marks:70 **Max : 60 Lectures**

UNIT	CONTENT	Lect.	Marks
Unit –1	**Point Estimation:** 1.1 Population, random sample, Target and Sampled population, 1.2 Statistic, estimator and estimates. 1.3 Concept of Point estimation. 1.4 Properties of Estimators – Consistency fundamental property, 1.5 Sufficient conditions of consistency. 1.6 Unbiasness- Unbiased and biased estimators, Bias of an estimator. 1.7 Concept of Mean Square Error (MSE), proof of the results: Two distinct unbiased estimators of a parametric function $\Psi(\theta)$ can give rise to infinitely many unbiased estimators of $\Psi(\theta)$. 1.8 If T is an unbiased estimator of θ and $\Psi(\theta)$ is linear parametric function of θ, then $\Psi(T)$ is an unbiased estimator $\Psi(\theta)$. 1.9 Examples based on topics.	**16**	**18**
Unit –2	2.1 Relative efficiency e, $0 < e \leq 1$. Use of mean square error to define relative efficiency of biased estimators. **Unbaised Estimator:** 2.2 Concept of UMVUE and MVBUE, 2.3 Notation of Uniformly Minimum Variance Unbiased Estimator (UMVUE) , 2.4 Uniqueness of UMVUE, whenever it exists. 2.5 Examples based on above topics. 2.5 Distinguish between a likelihood function and a joint p. d. f., regular p. d. f. 2.6 Cramer – Rao Inequality: Statement and proof of Cramer-Rao inequality. 2.7 Examples to find lower bound for variance of any unbiased estimator of any parametric function.	**16**	**18**
Unit –3	**Minimum Variance Best Estimator (MVBU):** 3.1 Concept and definition of MVBE Estimator. 3.2 Necessary and sufficient condition for the existence of the MVB estimator. 3.3 Standard Error of the MVB estimator. 3.4 Examples based on above topics. 3.5 To highlight the fact that - If T is the MVB estimator of θ and $\Psi(\theta)$ is a linear function of θ then $\Psi(T)$ is the MVB estimator of $\Psi(\theta)$. 3.6 If T is the MVB estimator of θ, then there exists no MVB estimator of $\Psi(\theta)$ provided $\Psi(\theta)$ is any non- linear function of θ. **Sufficiency :** 3.7 Importance of a sufficient statistic , 3.8 Concept and technical definition of single sufficiency , 3.9 Example showing sufficient and non- sufficient statistic using the technical definition.	**14**	**17**

	3.10 Neyman's factorization theorem (Statement only) , 3.11 Applications of Neyman's factorization theorem , 3.12 To highlight the fact that- "If T is a sufficient statistic of θ and g is a one- one and on to function of T then g(T) is sufficient for g(θ)". 3.13 Examples and problems based on above topics.		
Unit -4	**Methods of Estimation**: 4.1 Method of moments , 4.2 Advantages and pitfalls of Method of moments, 4.3 Examples based on Method of moments. 4.4 Concept and Method of maximum likelihood, 4.5 Concentration of its intuitive appeal by an illustration, 4.6 Properties of maximum likelihood estimators (m. l. e.), 4.7 To find ML estimators in case of non regular probability distributions, 4.8 Relation between MLE and sufficient statistic. 4.9 Examples and problems based on above topics.	**14**	**17**

INTERNAL COMPONENTS **MARKS**

1) TEST :15 Marks

2) ASSIGNMENT/ PRESENTATION : 10 Marks

3) SEMINAR / ATTENDENCE : 05 Marks

INTERNAL MARKS TOTAL : 30 Marks

Books Recommended:

1.	Fundamentals of Mathematical Statistics	Gupta & Kapoor	Sultan Chand Pub. New Delhi
2.	Introduction to Mathematical Statistics	Hogg R.V. and Craig A.T.	MacMillan Pub.Co.
3.	A First Course on Parametric Inference	Kale B.K. (2005)	2nd Narosa Publishing House
4.	Theory of point estimation.	Lehmann E. L.	
5.	Introduction to the Theory of Statistics	Mood A.M.,Graybill F.A. and Boes F.A.	McGraw Hill Pub.
6.	First course in Mathematical Statistics.	Roussas G. G.	
7.	An Introduction to Probability Theory and Mathematical Statistics,	Rohatgi V.K. and Ehsanes Saleh A. K. MD. (2003).	Wiley Eastern , 2nd Ed..

B. Sc. Sem. V [Statistics]
ELECTIVE COURSE
STAT-SEC- 501 [Industrial Statistics]

Credits : 03

Internal Marks: 30
External Marks:70 **Max. Lectures: 45**

UNIT	CONTENTS	Lect.	Marks
Unit 1	Introduction, Meaning and purpose of Statistical Process Control, Quality of a product, need of quality control. **Control chart:** Statistical basis of control chart, 3- σ limits, justification of 3- σ limits and, Criteria for detecting lack of control, Chance Causes and assignable causes of variation, Criteria for detecting lack of Control : **Note: Mathematical justification for (ii) is not expected.** **Control charts for variables:** Preliminary decisions, Control charts for continuous variables , **$\bar{X}$ Chart, R chart and σ- charts:** Purpose of R and $\bar{X}$ chart, Construction of R and $\bar{X}$ chart, when the Process Standard deviation (σ) is not given., Construction of σ- chart when the standard is not given, Examples, problems and Application of control charts.	**12**	**18**
Unit 2	**Control charts for attributes :** Idea of lot control and process control, Distinction between product control and process control, Construction of p-chart, d-chart, np-chart(for fixed sample size), Interpretations of p- chart, Low and High spot points, Construction of C-chart when the standard is known and unknown, Applications of C- chart , Examples, Application of control charts.	**12**	**18**
Unit –3	**Acceptance Sampling for Attributes:** Introduction of Sampling Acceptance, Concept of sampling inspection plan, Comparison between 100% inspection and sampling inspection, Explanation of the terms - Producer's risk, Consumer's risk, Acceptance - Quality Level (AQL), LTFD, Average Outgoing Quality (AOQ), AOQL, Average Sample Number (ASN), Average Total inspection (ATI),Operating characteristic (OC) curve , AOQ curve, ATI curve.	**11**	**17**
Unit - 4	**Single Sampling Plan:** Evaluation of probability of acceptance using - (i) Hyper geometric, & (ii) Poisson . Derivation of OC- Curve, AOQ and ATI Curves. Graphical determination of AOQL, Examples of determination of a single sampling plans by lot quality , Concept & Examples of Producer's risk and Consumer's Risk. **Double Sampling Plan:** Scheme of double sampling plan, Comparison of SSP and DSP, Evaluation of probability acceptance using Poisson approximation, Example of probability of acceptance only.	**10**	**17**

INTERNAL COMPONENTS	MARKS
1) TEST	:15 Marks
2) ASSIGNMENT/ PRESENTATION	: 10 Marks
3) SEMINAR / ATTENDENCE	: 05 Marks

INTERNAL MARKS TOTAL : 30 Marks

Books Recommended:

1. **Gupta S.C. & Kapoor V.K.:** Fundamentals of Applied Statistics, S. Chand Sons, New Delhi.
2. **A.M.Goon, M.K. Gupta & B. Dasgupta, :**Fundamental of Statistics, Vol.II , World Press Pvt.Ltd.
3. **B. L. Agrawal** , : Basic Statistics New Age International Publication, Delhi.
4. **D.C. Sancheti, V.K.Kapoor, :** Statistics –Theory, Methods and Applications- Sultan Chand & sons NewDelhi
5. **G.U.Shenoy, U.K.Shrivastava, S.C.Sharma, :** Business Statistics , Wiley Eastern
6. **Duncan A.J.** : Quality Control & Industrial Statistics, D.B. Taraporevale Sons & Co. Pvt. Ltd., Bombay.
7. **Grant E.L. & Leavenworth** : Statistical Quality Control, Mc-Graw Hill Kogakusha, Ltd., New Delhi.
8. **Montgomery :** Statistical Quality Control, John Wiley & Sons Inc. New York (3rd Ed.),1996
9. **R. C. Gupta** : Statistical Quality Control.

B. Sc. Sem. V [Statistics]
PRAC – STAT – 507 [Practicals in Statistics - I]

Internal Marks: 00 **Session: 6 Lectures**
External Marks:100 **Max : 90 Lectures**

SECTION – A

	CONTENTS OF PRACTICALS	Session
1	Model sampling from Normal and Cauchy distributions.	[2 Pr]
2	Model sampling from Binomial distributions.	[1 Pr]
3	Simple Random Sampling [SRSWOR]	[2 Pr]
4	Simple Random Sampling–Estimation of Sample size.[for Variable and Attribute data]	[2 Pr]
5	Stratified Sampling – Estimation of Mean and Standard Error.	[1 Pr]
6	Stratified Sampling - Proportional allocation and Optimum allocation	[2 Pr]
7	Stratified Sampling-Gain in precision due to stratification & Cost function Aspect.	[1 Pr]
8	Systematic Sampling -Estimation of population mean, population total and standard errors, comparison with SRSWOR	[1Pr]

SECTION – B

	CONTENTS OF PRACTICALS	Session
1	Construction of $\bar{X}$ and R charts, $\bar{X}$ and σ charts and estimation of process S.D.	[3 Pr]
2	Construction of control chart based on proportion of defective p), percentage defective(100 p) –charts. Number of defectives (d = np), when n is fixed.	[2 Pr]
3	Construction of control chart based on number of defects (C- chart).	[1 Pr]
4	Construction of control chart based on number of defectives (p - chart) & number of defects, when the number of inspected articles (n) is variable.	[2 Pr]
5	Single Sampling Plan – OC – curve, AOQ- curve, ASN- curve, ATI- curve.	[2 Pr]
6	Single Sampling Plan – Computation of Consumer's Risk & Producer's Risk based on AQL and LTPD, Determination of SSP.	[1 Pr]
7	Construction of control chart based on defects per units (u- chart) when n is variable.	[1 Pr]

B. Sc. Sem. V [Statistics]
PRAC – STAT – 507 [Practicals in Statistics - II]

Internal Marks: 00 **Session: 6 Lectures**
External Marks:100 **Max : 90 Lectures**

SECTION – C

	CONTENTS OF PRACTICALS	Sessions
1	Fitting of truncated binomial distribution.	[1 Pr]
2	Fitting of truncated Poisson distribution.	[1 Pr]
3	Applications of Normal probability distribution.	[2 Pr]
4	Fitting of Normal probability distribution.	[1 Pr]
5	Applications of F- distribution.	[2 Pr]
6	Estimation of parameters by method of moments.	[2 Pr]
7	Method of Scoring.	[1 Pr]
8	Relation between t- distribution and F- distribution.	[1 Pr]
9	Fisher's Z- transformation and its testing.	[1 Pr]

SECTION – D

	CONTENTS OF PRACTICALS	Sessions
1	Estimation of parameters by method of Maximum Likelihood.	[2 Pr]
2	Cramer –Rao Inequality to find a lower bound	[2 Pr]
3	Determination of MVBU Estimator and their S.E.	[2 Pr]
4	t- test for testing the significance of partial correlation coefficient.	[1 Pr]
5	t- test for testing the significance of regression coefficient.	[1 Pr]
6	t- test for testing the significance of observed sample correlation coefficient, when population correlation $\rho = 0$	[1 Pr]
7	To find Sufficient statistics and estimators of parametric function $\psi(\theta)$.	[1 Pr]

DETAILED CURRICULUM

BACHELOR OF SCIENCE SEMESTER – VI

STRUCTURE OF CORE COURSE- STATISTICS

Course Type	Paper No.	Title of Paper	Total Marks EXT.+ INT* = TOTAL	Passing Standards EXT.+ INT= TOTAL	Total Teaching Hours (in 15weeks)	Exam. Hrs	Credits
Core Course STATISTICS THEORY	Paper STAT - CC- 603	Mathematical Statistics - IV	70+ 30* = 100	28+12* = 40 marks	15 Weeks x 4 lect.= 60 hrs	02 hrs 30 min.	04
Core Course STATISTICS THEORY	Paper STAT – CC - 604	Design of Experiments	70+ 30*= 100	28+12* = 40 marks	15 Weeks x 4 lect.= 60 hrs	02hrs 30 min.	04
Core Course STATISTICS THEORY	Paper STAT – CC - 605	Statistical Inference - II	70+ 30*= 100	28+12* = 40 marks	15 Weeks x 4 lect.= 60 hrs	02hrs 30 min.	04
Core Course STATISTICS THEORY	Paper STAT – CC - 606	Advanced Operations Research Techniques	70+ 30*= 100	28+12* = 40 marks	15 Weeks x 4 lect.= 60 hrs	02hrs 30 min.	04
Subject Elective Course STATISTICS THEORY	Paper STAT – SEC - 601	Elementary Optimization Techniques.	70+ 30*= 100	28+12* = 40 marks	15 Weeks x 3 lect.= 45 hrs	02hrs 30 min.	03
Core Course STATISTICS PRACTICAL	STAT– PRAC – 607 – Paper - I	Practicals in Statistics – I Sections A & B	= 100 [Only External]	= 40 marks [Only External]	15 Weeks x 6 lect.= 90 hrs	02 x 03hrs = 6 hrs	06
	STAT– PRAC – 607 – Paper - II	Practicals in Statistics – II Sections C & D	= 100 [Only External]	= 40 marks [Only External]	15 Weeks x 6 lect.= 90 hrs	02 x 03hrs = 6 hrs	06

IMPORTANT REMARKS:

(4) In a week, there will be four theory periods each of one hour's duration for direct classroom teaching of each of courses STAT – CC – 603 to STAT – CC – 606 and for STAT– SEC – 601, there will be three theory periods each of one hour duration.

(2) In a week, there will be four laboratory sessions each of three hours' duration for conduction of course STAT – CC – 607 Section A, B, C & Section D .

(3) Course **STAT – PRAC – 607 – Paper - I** consists of two Sections A and B of practicals in statistics based on STAT – CC – 603 and STAT – CC – 604 and Course **STAT – PRAC – 607 – Paper - II** consists of two Sections C and D of practicals in statistics based on STAT – CC – 605 and STAT – CC – 606 designed to make students analytically more proficient in real life applications of some statistical methods .

(4) There will be **Four Semester-End Practical Examination papers each of three hours'** duration in the batches of 20 students per batch and **every written practical paper carries 40 marks each**. The **Viva - voce and Term-work Assessment will carry 10 marks**. In all Statistics Practical Course **STAT – PRAC - 607 Paper I & Paper II carries 200 marks**.

	B. Sc. Sem. VI [Statistics] **STAT-CC- 603 [Mathematical Statistics –IV]** **Internal Marks: 30** **External Marks:70** **Max : 60 Lectures**		
UNIT	**CONTENTS**	**Lect.**	**Marks**
Unit 1	**Detailed study of Negative Binomial Distribution:** 1.1 Definition of Negative Binomial distribution with p. m. f. $P(X=x)=\binom{x+k-1}{k-1}p^k q^x$, x = 0,1,2, …. $0<p<1$, q = 1 − p. Notation X~ NB (k, p), k ≥ 1. 1.2 Derivation of probability mass function, 1.3 Why is it called negative binomial? Justification, 1.4 Concept and Derivation of Probability Generating function, 1.5 First four raw and central moments and cumulants, 1.6 Concept and derivation of Factorial moments and f. m. g. f., 1.7 Recurrence relation for probabilities. 1.8 Additive property – NB (k, p) as the distribution of sum of k i. i. d. geometric r. v. s. with common parameter p. 1.9 Negative Binomial distribution obtained from Poisson distribution with gamma distributed parameter, 1.10 Poisson approximation to Negative Binomial distribution. 1.11 Examples based on topics	**16**	**18**
Unit 2	**Bivariate normal distribution:** 2.1 Definition of Bi variate Normal distribution, 2.2 Marginal probability density function of random variable X and Y, 2.3 Conditional p. d. f. of Y given X = x and X given Y= y, 2.4 Moment generating function of bivariate normal distribution, 2.5 Other simple properties of Bivariate Normal Distribution, 2.6 Simple examples based on topics. **Order Statistics:** 2.7 Idea and definition of order Statistics, 2.8 P.d.f. and CDF of Single order statistics, 2.9 Joint p. d.f. of r^{th} and s^{th} order statistics, Hence p. d. f. of $x_{(1)}$ and $x_{(n)}$. 2.10 Examples based on Uniform and Exponential distributions.	**16**	**18**
Unit 3	**Multiple Linear Regression :** 3.1 Notions of Multiple regression, Yule's notations (Trivariate case – Sample data only), 3.2 Fitting of regression planes by the method of least squares, 3.3 Definition, order, properties of Residuals with proofs, 3.5 Derivation of Variance of residual, 3.6 Testing the significance of Regression coefficients. 3.7 Simple examples,	**14**	**17**

Unit 4	**Multiple and Partial Correlation:** 4.1 Definition of Multiple correlation coefficient, Deriving the expression for multiple correlation coefficients, 4.2 Definition of Partial correlation coefficient, Deriving the expression for Partial correlation coefficients, Relation between total, partial and multiple correlation, Properties of multiple and partial correlation coefficient. 4.3 Equivalence of H_0: $\rho_{1.23} = 0$ and H_0: Partial regression coefficients are insignificant. 4.4 To estabilish equivalence of F test and F-test based on ANOVA. **Distribution of Sample Correlation** 4.5 Linear Orthogonal Transformation, Properties of Linear Orthogonal transformation, 4.6 Concept of Standard Error and Probable Error of sample Correlation coefficient, 4.7 Distribution of Sample correlation coefficient, when population correlation coefficient $\rho = 0$ with proof. 4.9 Fisher's Z – Transformation, Applications of Fisher's Z-Transformation, 4.10 Examples based on above topics.	**14**	**17**

INTERNAL COMPONENTS **MARKS**

1) TEST :15 Marks

2) ASSIGNMENT/ PRESENTATION : 10 Marks

3) SEMINAR / ATTENDENCE : 05 Marks

INTERNAL MARKS TOTAL : 30 Marks

Books Recommended:

1.	Mathematical Statistics with Applications(2nd Ed.)	John E. Freund's ,Irvin Miller,Maryless Miller	Pearson Education
2.	Introduction to Mathematical Statistics	Hogg R.V. and Craig A.T.	MacMillan Pub.Co.
3.	Introduction to Probability Theory	Hoel P.,Prot S.C. and Stone C.J.	Houghton Miffin Company Boston
4.	Probability & Statistics: Theory and Applications	Fraser D.A.S.	North Scituate Mass. Duxbury Press.
5.	Fundamentals of Mathematical Statistics	Gupta & Kapoor	Sultan Chand Pub. New Delhi
6.	Introduction to the Theory of Statistics	Mood A.M.,Graybill F.A. and Boes F.A.	McGraw Hill Pub.
7.	Mathematical Statistics	John E. Fruend & Ronald E Walpole	Prentice Hall Pub.

B. Sc. Sem. VI [Statistics]
STAT-CC- 604 [Designs of Experiments]
Internal Marks: 30
External Marks:70 **Max : 60 Lectures**

UNIT	CONTENTS	Lect.	Marks
Unit1	**ANALYSIS OF VARIANCE :** 1.1 One way classification and two way classification, 1.2 Least square Estimation of mean effects and Sum of squares using fixed effect model, 1.3 Preparation of analysis of variance (ANOVA) table. 1.4 Testing of equality of different factor of variations. 1.5 Concept of Design of experiment. 1.6 Introduction to basic terms of design of experiments. Experimental unit, Yield, treatments, blocks, Experimental error, extraneous factors, layout of an experiment. 1.7 Basic principles of design of experiments, Randomization, Replication and local control. 1.8 Examples.	**16**	**18**
Unit2	**STUDY OF BASIC DESIGNS – I** : **Completely Randomized Design (CRD):** 2.1 Idea and Lay-out Plan of CRD, Definition and model, $Y_{ij} = \mu + \alpha_i + \epsilon_{ij}$, 2.2 Least square estimation of mean effects, Sum of squares, preparation of analysis of variance (ANOVA) table. Testing of equality of treatment mean effects. Merits and Demerits of CRD. Examples. **Randomized Block Design (RBD):** 2.3 Lay-out Plan of RBD and Definition and model, $Y_{ij} = \mu + \alpha_i + \beta_j + \epsilon_{ij}$, 2.4 Least square estimation of mean effects, Sum of squares, Preparation of analysis of variance(ANOVA) table. Testing of equality of treatment effects. Merits and Demerits of RBD. **Latin Square Design(LSD) :** 2.5 Definition and Model. $Y_{ijk} = \mu + \alpha_i + \beta_j + \gamma_k + \epsilon_{ijk}$, i = 1,2,3….m , j = 1,2,3….m , k = 1,2,3….m 2.6 Assumptions and interpretation, Lay-out Plan of LSD, Estimation of parameters, Expected value of mean sum of squares, Components of variance and its interpretation. 2.7 Justification of use of F-test for testing of hypothesis $H_{01}: \alpha_1 = \alpha_2 = \cdots = \alpha_m$ $H_{02}: \beta_1 = \beta_2 = \cdots = \beta_m$ $H_{03}: \gamma_1 = \gamma_2 = \cdots = \gamma_m$ 2.8 Preparation of ANOVA table and F-test for H_{01}, H_{02}, H_{03}. Testing for equality of two specified treatment effects. Use of critical difference testing for equality of two row effects, two column effects and treatments effects. 2.9 Merits and demerits of LSD. Examples. 2.10 Applications of principles of design of experiment in CRD, RBD and LSD. 2.11 Simple Examples.	**16**	**18**

Unit 3	**MISSING PLOT TECHNIQUES IN BASIC DESIGNS:** 3.1 Situations were missing plot technique is applicable. 3.2 Estimation of missing plots by minimizing error sum of squares using least square method, 3.3 Estimation of missing yield (Plot) in RBD and LSD with one missing observation and 3.4 Estimation of missing yield (Plot) in RBD and LSD with Two missing observation two missing observations. **Efficiency of a Design:** 3.5 Concept an definition of Efficiency of a design. 3.6 Comparison of efficiencies between RBD and CRD. 3.7 Comparison of efficiencies between LSD and RBD, LSD and CRD. 3.8 Simple Numerical Problems. Examples. **BALANCED INCOMPLETE BLOCK DESIGN:** 3.9 Definition of IBD and BIBD, Proof of parametric relations of BIBD. Lay-out Plan of BIBD, 3.10 Examples based on above topics.	**14**	**17**
Unit 4	**FACTORIAL EXPERIMENTS :** 4.1 Concept and Definition of factorial experiments. 4.2 Concept and Definition of main effect and interactions. 4.3 2^2 Factorial Experiment, Estimation of its Main effects and Interaction, Anlysis of 2^2 Factorial Experiment , Anlysis of 2^2 Factorial Experiment , 4.4 2^3 Factorial Experiment. , Estimation of its Main effects and Interaction 4.5 Yate's method, **CONFOUNDING IN FACTORIAL DESIGNS:** 4.6 Concept and Definition of confounding, Idea and concept of Total Complete confounding, Complete confounding in 2^3 Factorial Experiment, Complete confounding in 2^4 Factorial Experiment , 4.7 Concept and Definition of Partial confounding, 4.8 Examples based on Complete confounding only.	**14**	**17**

INTERNAL COMPONENTS **MARKS**

1) TEST **:15 Marks**

2) ASSIGNMENT/ PRESENTATION **: 10 Marks**

3) SEMINAR / ATTENDENCE **: 05 Marks**

INTERNAL MARKS TOTAL : 30 Marks

Books Recommended:

1.	Fundamentals of Applied Statistics	**Gupta S.C. & Kapoor V.K**	S. Chand Sons, New Delhi
2.	Basic Statistics	**B. L. Agrawal**	New Age International Publication, Delhi.
3.	Experimental Designs ,	**Federer W.T.**	Oxford & IDH Publishing Co. N. Delhi.
4.	Experimental Design,	**Cochran W.G. & Cox G.M**	John Wiley & sons Inc. New Delhi.
5.	Design & Analysis of Experiments	**Montgomery D.C**	John Wiley & Sons Inc., New Delhi,2001
6.	Design & Analysis of Experiments	**Das M.N. & Giri N.C.**	Wiley Eastern Ltd., New Delhi
7.	Statistical Methods	**Snedecor G.W.& Cochren W.G**	Affiliated East West Press, New Delhi.

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	B. Sc. Sem. VI [Statistics] **STAT-CC- 605 [Statistical Inference – II]** **Internal Marks: 30** **External Marks:70** **Max : 60 Lectures**		
UNIT	**CONTENTS**	**Lect.**	**Marks**
Unit 1	**Interval estimation & Concepts of Confidence Intervals:** 1.1 Concept of Random Interval, 1.2 Notion of interval estimation, definition of confidence interval, 1.3 Confidence coefficients, Confidence limits, length (width) of a Confidence interval, Pivotal quantity, 1.4 Interval estimation in the following cases: (i) For Mean (μ) of normal probability distribution (when σ known and σ is unknown) (ii) For Variance (σ^2) of normal probability distribution (when μ known and μ unknown), (iii) For Proportion (P) using normal approximation, 1.5 Examples based on above topics	**16**	**18**
Unit 2	**Construction of more Confidence Intervals**: 2.1 General method of deriving a confidence interval, 2.2 Derivation of Confidence interval for the Difference of two means $\mu_1 - \mu_2$ based on independent random samples. Of sizes n_1 and n_2 from two normal populations $N(\mu_1, \sigma^2)$ and $N(\mu_2, \sigma^2)$, 2.3 Derivation of Confidence interval for the Difference of two means $\mu_1 - \mu_2$ based on a r. s. from bi-variate normal population , 2.4 Derivation of Confidence interval for single proportion and the Difference of two proportions $P_1 - P_2$ using normal approximation, 2.5 Derivation of Confidence interval for the ratio of variances of two normal populations. 2.6 Examples based on above topics	**16**	**18**
Unit 3	**Parametric Testing of Hypotheses :** 3.1 Statistical hypothesis, problem of testing of hypothesis, 3.2 Definition and Illustrations of simple hypothesis, composite hypothesis, null and alternative hypotheses, 3.3 Problem of testing a hypotheses, Critical region, 3.4 Two types of errors in testing of hypotheses, and sizes of two types of errors. 3.5 Power function of the test when H_1 is simple, 3.6 Problem of controlling the probabilities of two types of errors. 3.7 Definition and illustrations of level of significance, or size of test , 3.8 Definition and illustrations of Power function of the test, p value of a test. 3.9 Examples. **Construction of Tests:** 3.10 Concept and definition of Best Critical Region, 3.11 Concept and Definition of Most Powerful test and , 3.12 Statement and Proof of Neyman – Pearson theorem (Lemma) for finding a Most powerful Test of LOS α for testing a simple H_0 against a simple H_1.	**14**	**17**

	3.13 Concept and definition of Uniformly Most Powerful Test of size α, 3.14 Examples of BCR, MP and UMP tests.		
Unit 4	**Linear Models and Linear Estimation:** 4.1 Linear models and explanation of their occurrence in Regression and Analysis of variance techniques. 4.2 Gauss- Markov Linear Model, full rank and less than full rank models, 4.3 In case of full rank Linear model – (1) $E\left(\underline{\hat{\beta}}\right) = \underline{\beta}$ (2) $V\left(\underline{\hat{\beta}}\right) = \sigma^2 (X'X)^{-1}$ (3) $\hat{\sigma}^2 = \frac{\underline{e}'\underline{e}}{n-k}$ 4.4 Concept and definition of Linear parametric function, 4.5 Estimability of a linear parametric function, 4.6 Rank condition for the estimability of a linear parametric function 4.7 Proof of – "All linear parametric functions in case of a full rank linear model are estimable" 4.8 Gauss – Markoff's theorem and its applications..	**14**	**17**

INTERNAL COMPONENTS **MARKS**

1) TEST :15 Marks

2) ASSIGNMENT/ PRESENTATION : 10 Marks

3) SEMINAR / ATTENDENCE : 05 Marks

INTERNAL MARKS TOTAL : 30 Marks

Books Recommended :

1.	Mathematical Statistics with Applications (2nd Ed.)	John E. Freund's ,Irvin Miller,Maryless Miller	Pearson Education
2.	Introduction to Mathematical Statistics	Hogg R.V. and Craig A.T.	MacMillan Pub.Co.
3.	Introduction to Probability Theory	Hoel P.,Prot S.C. and Stone C.J.	Houghton Miffin Company Boston
4.	Probability & Statistics: Theory and Applications	Fraser D.A.S.	North Scituate Mass. Duxbury Press.
5.	Fundamentals of Mathematical Statistics	Gupta & Kapoor	Sultan Chand Pub. New Delhi
6.	Introduction to the Theory of Statistics	Mood A.M.,Graybill F.A. and Boes F.A.	McGraw Hill Pub.
7.	Mathematical Statistics	John E. Fruend and Ronald E Walpole	Prentice Hall Pub.
8.	Linear Statistical Inference and its Applications	C. R. Rao	John Wiley
9.	Econimetrics Methods	J. Johnston	

B. Sc. Sem. VI [Statistics]
STAT-CC- 606 [Advanced Operations Research Techniques]
Credits : 04

Internal Marks: 30
External Marks:70 **Max : 60 Lectures**

UNIT	CONTENTS	Lect.	Marks
Unit 1	**Linear Programming Problem :** 1.1 Formulation of the linear programming problems. [3 or More variables] 1.2 Definition of Slack variable, Surplus variable, Artificial variable and Unrestricted variable, 1.3 Definition of a basic feasible solution (b.f.s. degenerate and non-degenerate solution) iv) Optimal solution v) basic and non basic variables vi) objective function vii) Constraints, & viii) non - negativity conditions. 1.4 Big M. method of solving L.P.P.& 1.5 Two phase methods of solving L.P.P. using modified objective function. 1.6 Modification and applications of L.P.P. Using artificial variable. **Theory of Duality:** 1.7 Writing a dual of primal problem. 1.8 Solution of L.P.P. by using its dual Conversion of primal to dual and Dual to primal , 1.9 Economic interpretation of Duality, 1.10 Examples and problems.	**16**	**18**
Unit 2	**Transportation Problem:** 2.1 Meaning of Balanced and unbalanced transportation problem, 2.2 Mathematical Formulation of Transportation problem, 2.3 Transportation problem as a special case of L.P.P. 2.4 Optimal solution of TP using uv-method (MODI), 2.5 Uniqueness and non uniqueness of optimal solution. 2.6 Degeneracy and method of resolving degeneracy. 2.7 Variants in TP- No allocation in a particular cell, 2.8 Maximization type transportation problem, **Assignment Problem:** 2.9 Meaning of Assignment Problem, Math. formulation of problem, 2.10 A.P. as a Special cases in the assignment problem: 2.11 Unbalanced assignment problem and maximization problem, 2.12 Travelling Salesman Problem , 2.13 Examples and problems	**16**	**18**
Unit 3	**Network Analysis:** 3.1 Concepts of Project and Network, , 3.2 Definition i) Event or node ii) Activity iii) critical activity iv) Project function v) Predecessor and successor activity vi) Predecessor and successor event , Properties of network, 3.3 Fulkerson's Rules for numbering the event's,, 3.4 Forward Pass and Backward Pass method of finding Earliest Occurrence Time and Latest Occurrence Time , **Critical Path Method[CPM]:** 3.5 Definition i) Earliest start time ii) Earliest finish time iii) latest start time iv) Latest finish time v) Critical path ,Float of an	**14**	**17**

	event, Total float, Independent float & Free float and their significance. Critical path method. **Project Evaluation and Review Technique [PERT]** : 3.6 Definitions of, i) Pessimistic time ii) Optimistic time iii) Most likely time, Estimation of Activity 's expected time and variance time using Beta distribution, PERT Analysis, finding Slacks of Events and Critical Path , Probability of meeting scheduled date, Calculation of expected time, S.D. of project duration. 3.7 Distinguish between PERT and C.P.M. **Sequencing Models:** 3.8 Introduction of sequencing problem, Basic Notations and terminology, General assumptions, 3.9 Processing n- jobs through Two machines, Johnsons and Bellman's procedure, 3.10 Processing n- jobs through Three machines, General model of Processing n- jobs through m- machines,. 3.11 Examples and problems based on both models.		
Unit 4	**Simulation and Idea of Replacement Models Simulation**: **:**4.1 Definition and meaning of Simulation, 4.2 Reasons for using simulation, simulation Process, 4.3 Advantages and Drawbacks of Simulation, 4.4 Applications of Simulation, 4.5 Monte-Carlo Simulation, 4.6 Simulation of Inventory Problems. **Replacement Models:** 4.7 Introduction and meaning of replacement problem, 4.8 Replacement of Item that deteriorate gradually- 4.8.1 Replacement policy when value of money does not change with time, 4.8.2 Replacement policy when value of money changes with time- Selection of best equipment amongst two 4. 9 Replacement of equipment that fails suddenly- 4.9.1 Individual replacement policy, 4.9.2 Group replacement policy. 4.10 Simple Examples based on above Topic. **Game Theory:** 4.11 Concept of Game, player, strategy, 4.12 Idea of a two-person zero sum game, 4.13 Definitions of saddle point, minimax & maximin principles, 4.14 Rules for finding the saddle point, 4.15 Game without saddle point and Mixed strategies game, 4.16 Principle of Dominance, 4.17 Algebraic method and graphical method of solving game, 4.18 Simple examples.	**14**	**17**

INTERNAL COMPONENTS **MARKS**

1) TEST **:15 Marks**

2) ASSIGNMENT/ PRESENTATION **: 10 Marks**

3) SEMINAR / ATTENDENCE **: 05 Marks**

INTERNAL MARKS TOTAL : 30 Marks

Reference Books Recommended:

1. **Gauss E.:** Linear Programming Method & Applications, Narosa Pub. House, New Delhi.
2. **Taha R.A.:** Operations Research an Introduction, 5th Ed.
3. **Gupta P.K. & Hira D.S.** : Operations Research, S. Chand & Co. ltd., New Delhi.
4. **Shrinath L.S. :** PERT-CPM Principles & Applications, Affiliated East West Press Pvt. Ltd., New Delhi.
5. **Kapoor V.K.:** Operations Research, S. Chand & Sons, New Delhi.
6. **Sharma S.D.:** Operations Research, Kedarnath Ramnath & Co., Meerut.
7 **Kanti Swaroop, P.K.Gupta, Man Mohan**. Operations Research, Sultan chand & sons, New Delhi.
8. **J.K. Sharma**: Operations Research- Theory & Applications.

B. Sc. Sem. VI [Statistics]
ELECTIVE COURSE
STAT-SEC- 601 [Elementary Optimization Techniques.]
Credits : 03

Internal Marks: 30
External Marks:70 **Max : 45 Lectures**

UNIT	CONTENTS	Lect.	Marks
Unit 1	**LINEAR PROGRAMMING MODELS** : Formulation of the linear programming problems. problems. Definition of - Slack variable, Surplus variable, artificial variable and Unrestricted variable Definition of i) a solution ii) feasible solution iii) a basic feasible solution (b.f.s. degenerate and non-degenerate solution) iv) Optimal solution v) basic and non basic variables vi) objective function vii) non - negativity conditions. Simplex Method & Big- M methods, modified objective function. Modification and applications of simplex method L.P.P. with artificial variable. Note: Example based on only 2 decision variable for both pure & mixed type is expected.	**12**	**18**
Unit 2	**TRANSPORTATION MODELS** : Definition of i) a feasible solution, ii) a basic feasible solution and iii) optimal solution. Statement of transportation problem, balanced and unbalanced transportation problem, Methods of obtaining initial basic feasible solution: 1) North west corner method. 2) Method of matrix minima (least cost method) 3) Vogel's Approximation Method (VAM). Examples and problems based on topics.	**11**	**17**
Unit 3	**ASSIGNMENT MODELS** : Assignment problem: Statement of assignment problem, relation to transportation problem and L.P.P, solution of assignment problem using Hungarian method. Special cases in the assignment problem: Unbalanced assignment problem, maximization problem , Examples and problems based on topics.	**10**	**17**
Unit 4	**SEQUENCING MODELS:** Introduction of sequencing problem, Basic Notations and terminology, General assumptions, Processing n- jobs through Two machines, Johnsons and Bellman's procedure, Processing n- jobs through Three machines, General model of Processing n- jobs through m- machines,. Examples and problems based on both models. **DECISION PROBLEMS:** Decision alternatives ,State of nature, Pay off,Types of Decision making: i. Decision making under certainty ii. Decision making under risk iii. Decision making under uncertainty ,Decision making under uncertainty: Maximin or Minimin criteria, Harwich criteria of realism, maximin or minimax criteria, Criteria of regret, Laplace or equally likely criteria, Decision under Risk: Expected Monetary Value (EMV), Expected Opportunity Loss(EOL)criteria , Examples and problems based on topics.	**12**	**18**

INTERNAL COMPONENTS	MARKS
1) TEST	:15 Marks
2) ASSIGNMENT/ PRESENTATION	: 10 Marks
3) SEMINAR / ATTENDENCE	: 05 Marks

INTERNAL MARKS TOTAL : 30 Marks

Reference Books :

1. **Kanti Swaroop, P.K.Gupta, Man Mohan:** Operations Research.
2. **J.**K. Sharma: Oprations Research- Theory and Applications.
3. **Gauss E.:** Linear Programming Method & Applications, Narosa Pub. House, New Delhi.
4. **Taha R.A.:** Operations Research an Introduction, 5th Ed.
5. **Gupta P.K. & Hira D.S.** : Operations Research, S. Chand & Co. ltd., New Delhi.
6. **Kapoor V.K.:** Operations Research, S. Chand & Sons, New Delhi.
7. **Sharma S.D.:** Operations Research, Kedarnath Ramnath & Co., Meerut

B. Sc. Sem. VI [Statistics]
STAT – PRAC – 607 – Paper - I
[Practicals in Statistics- I]

Internal Marks: 00 **Session: 6 Lectures**
External Marks:100 **Max : 90 Lectures**

SECTION – A

	CONTENTS OF PRACTICALS	Session
1	Applications of Negative binomial distribution.	[1 Pr]
2	Fitting of negative binomial distribution.	[2Pr]
3	Computation of probabilities using bi- variate normal distribution.	[2 Pr]
4	Multiple linear regression, interpretation of partial regression coefficient.	[2 Pr]
5	Analysis of variance table based on Multiple regression analysis.	[1 Pr]
6	Computing partial correlation coefficient and testing their significance from 0 and from non null values.	[2 Pr]
	SECTION – B	
1	Analysis of CRD and RBD	[2 Pr]
2	Analysis of LSD.	[1 Pr]
3	Efficiency of Designs.	[1Pr]
4	Missing Plot Technique in RBD (one and two missing observations).	[2 Pr]
5	Missing Plot Technique in LSD (one and two missing observations).	[2 Pr]
6	Analysis of 2^2 & 2^3 factorial experiment arranged in RBD.	[2 Pr]
7	Analysis of 2^3 factorial experiment with total confounding.	[1 Pr]

B. Sc. Sem. VI [Statistics]
STAT – PRAC – 607 – Paper - II
[Practicals in Statistics- II]

Internal Marks: 00 **Session: 6 Lectures**
External Marks:100 **Max : 90 Lectures**

SECTION – C

	CONTENTS OF PRACTICALS	Sessions
1	L.P.P. Formulation for 3 or more variable, Minimization & Maximization problems.	[1 Pr]
2	Solving a L.P.P. using Big – technique & Two- phase method.	[2 Pr]
3	Duality of L. P. P.- Primal – Dual conversion, Relationship between Primal – Dual optimal solution.	[1 Pr]
4	Solving Transportation Problem. using North-west corner, Least cost method & Vogel's approximation methods.	[1 Pr]
5	Optimality Criterion of Transportation Problem – MODI- method.	[1 Pr]
6	Maximization and Unbalanced Transportation Problem	[2 Pr]
7	Simulation –Inventory problem.	[1 Pr]
8	Replacement Problem- Item deteriorates gradually.	[1Pr]
9	Sequencing Problem (n-job 2 Machine & n-job 3 Machine.	[2 Pr]

SECTION – D

	CONTENTS OF PRACTICALS	Sessions
1	Solving Assignment Problem using Hungarian method.	[1 Pr]
2	Maximization and Unbalanced Assignment Problem	[1 Pr]
3	Network Analysis – CPM and PERT Analysis.	[2 Pr]
4	Confidence Intervals: (i) For Mean (μ) of normal probability distribution (when σ is known and unknown) (ii) For Variance(σ^2)of normal probability distribution(when μ known & unknown) (iii) For S. d. (σ) of normal probability distribution , (iv) For the Difference of two means $\mu_1 - \mu_2$ based on independent r. s. of sizes n_1 and n_2 from two normal populations $N(\mu_1, \sigma^2)$ and $N(\mu_2, \sigma^2)$. (v) For the Difference of two means $\mu_1 - \mu_2$ based on a r. s. from bi variate normal population (vi) For the ratio of variances of two normal populations.	[5 Pr]
5	Testing of hypothesis, Finding C.R., Type- I and Type- Ii errors, Power of the test, power function and power curve of the test, UMP test.	[3Pr]