Departmentof Mathematics and Statistics
DDU Gorakhpur University, Gorakhpur

National Education Policy-2020
Syllabus

of

STATISTICS

(Effective from Academic Session 2021-2022)

for

ThreeYearsB.A./B.Sc. Programme

Course Structure of statistics as Major Subject in B.A. /B.Sc. Programme

SEMESTER-WISE TITLES OF THE PAPERS OF STATISTICS AS MAJOR SUBJECT IN B.A. /B.Sc. PROGRAMME					
Year	**Sem.**	**Course Code**	**Paper Title**	**Theory/Practical**	**Credits**
I	I	STAT 101	Basics of Statistics	Theory	02
		STAT 102 (B060101T)	Descriptive Statistics (Univariate) and Theory of Probability	Theory	04
		STAT 103 (B060102P)	Descriptive Data Analysis Lab (Univariate)	Practical	02
	II	STAT 104 (B060201T)	Descriptive Statistics (Bivariate) and Probability Distributions	Theory	04
		STAT 105 (B060202P)	Descriptive Data Analysis Lab (Bivariate)	Practical	02
II	III	STAT 201 (B060301T)	Theory of Estimation and Sampling Survey	Theory	04
		STAT 202 (B060302P)	Sampling Survey Lab	Practical	02
	IV	STAT 203 (B060401T)	Testing of Hypothesis and Applied Statistics	Theory	04
		STAT 204 (B060402P)	Test of Significance and Applied Statistics Lab	Practical	02
III	V	STAT 301 (B060501T)	Multivariate Analysis and Non-parametric Methods	Theory	04
		STAT 302 (B060502T)	Analysis of Variance and Design of Experiment	Theory	04
		STAT 303 (B060503P)	Non-paramertic Methods and DOE Lab	Practical	02
	VI	STAT 304 (B060601T)	Statistical Computing and Introduction to Statistical Software	Theory	04
		STAT 305 (B060602T)	Operations Research	Theory	04
		STAT 306 (B060603P)	Operations Research and Statisical Computing Lab	Practical	02

Subject Prerequisties:

1. To study this subject a student must had the subject(s) Mathematics in class 12th.
2. Mathematics subject must be compulsory in UG as a combination of Subjects for the candidates offering Statistics.

Programme Outcomes (POs) :

Students having Degree in B.A./ B.Sc. (with Statistics) should have knowledge of different concepts and fundamentals of Statistics and ability to apply this knowledge in various fields of industry, monitoring, policy making, administration, government organisations etc. They may pursue their future career in the field of Statistics and Research.

Programme Specific Outcomes (PSOs)

After completing B.Sc. (with Statistics) the student should have

PSO1. Knowledge of different concepts, principles, methodologies and tools (skills) of Statistics.

PSO2. Ability to collect, tabulate, represent graphically, analyze and interpret data/information by using appropriate statistical tools.

PSO3. Ability to identify and solve a wide range of problems in real life/industry related to Statistics.

PSO4. Familiarity with computational techniques and statistical software including programming language (e.g. R) for mathematical and statistical computation.

PSO5. Capability to use appropriate statistical skills in interdisciplinary areas such as finance, health, agriculture, government, business, industry, telecommunication and bio-statistics.

PSO6. Ability to compete with industrial/private sector demand in the field of data analysis, marketing survey, etc. in professional manner and pursue their future career in the field of Statistics.

PSO7. Ability to develop original thinking for formulating new problems and providing their solutions. As a result, they will be able to pursue higher studies or research in the field of Statistics.

Programme:**B.A/B.Sc.**	Year:**First**	Semester: **First**

Subject:**STATISTICS**

CourseCode:-**STAT101**	CourseTitle: **Basics of Statistics**

Courseoutcomes:
After completing this course a student will have:
CO1. Knowledge of Statistics, Data Science, its scope and importance in various fields.
CO2. Ability to understand concepts of Statistical computing.
CO3.Knowledge of methods for summarising data sets.
CO4.Ability to describPrinciple of mathematical induction, Polynomials
CO5.Ability to understand Definite integrals and its properties.
CO6.Ability to understand the concept of Method of least squares.
CO7.Ability to understand Error in numerical computations.
CO8.Ability to identify the appropriate method (i.e. union, intersection, conditional, etc.) for solving a problem.
CO9.Ability to apply basic calculus of finite differences, Difference operators.
CO10.Ability to understand the concept of Concept of linear inequalities and Algebraic Solutions of Linear Inequalities in One Variable and their Graphical Representation.

Credits:**02**	Core: **Compulsory**
Max.Marks:**25+75**	Min.PassingMarks: As per UGC/ University CBCSnorm.

TotalNo.ofLectures-Tutorials-Practical(inhoursperweek):**2-0-0**.

Unit	Topics	No. of Lectures
	Assignment on "Eminent Statisticians" should be included under Continuous Internal Evaluation (CIE).	
Basic Statistics		
I	Introduction to Statistics. Data Science,Data to Decision,Data and information.Introduction to Statistical Softwares. Introduction to Statistical computing.Application of Data Science in various disciplines.Role of Data Science in modern era. Random Variables – Discrete and Continuous.	**08**
II	Set theory: Definition of sets, representation of sets, universal set, empty set, singleton set, finite and infinite set, equal set, cardinal number of finite set, equivalent set, set of set, subsets, proper subset, superset, power set, improper set, comparibility of sets, union and intersection of sets, complement of sets, de morgan's law, disjoint sets, difference and symmetric difference, algebra of sets, duality, counting principle, venn diagram and its applications.	**07**

III	Principle of mathematical induction, Polynomials, Linear polynomial, quadratic polynomial, cubic polynomial, roots of polynomial, Quadratic equations, Factorisation,Determinants and its applications, matrix theory, types of matrices: Horizontal matrix, vertical matrix, square matrix, row matrix, column matrix, null matrix, identity matrix, diagonal matrix, scalar matrix, sub matrix, triangular matrix, comparable matrix, Operation on matrices: Matrix addition, subtraction, product of matrices, difference of two matrices, transpose of a matrix, inverse of a matrix by adjoint method.	08
IV	Definite integrals and its properties. Beta and Gamma functions.Method of least squares, fitting of straight line, polynomials, exponential curves. Error in numerical computations ,Calculus of finite differences, Difference operators.Concept of linear inequalities and Algebraic Solutions of Linear Inequalities in One Variable and their Graphical Representation,Algebra of summation.	07

SuggestedReadings:
Mathematical statistics, Ray Sharma Chaudhary, Ram Prasad and sons,2004.
Senior Secondary School mathematics, R S Agrawal, Bharti Bhawan, 1995.
Advanced Engineering Mathematics, Erwin Kreyszig, Wiley, 2015.
Mathemathics ,R.D.Sharma,Dhanpat Rai Publications,1998.
Mathematics,Sudhir Kumar Pundir,Shri Balaji Publication,2013.
Course Books published in Hindi may be prescribed by the Universities.
Suggested Online Links/Readings:
http://heecontent.upsdc.gov.in/SearchContent.aspx
https://swayam.gov.in/explorer?searchText=statistics
https://nptel.ac.in/course.html
https://www.edx.org/search?q=statistics

Thiscoursecanbeoptedasanelectivebythestudentsoffollowingsubjects:
Open to ALL

Suggested Continuous Evaluation Methods:
Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Assessment and Presentation of Assignment/Research Orientation assignment	(05 marks)
Class Test-I (Objective Questions)	(04 marks)
Class Test-II (Descriptive Questions)	(04 marks)
Class Test-III (Objective Questions)	(04 marks)
Class Test-IV (Descriptive Questions)	(04 marks)
Class Interaction	(04 marks)

Course prerequisites: To study this course, a student must have the subject **Mathematics in class 12th.**

Programme:**B.A/B.Sc.**	Year:**First**	Semester: **First**

Subject:**STATISTICS**		
CourseCode:- **STAT 102 (B060101T)**	CourseTitle:**Descriptive Statistics (Univariate)and Theory of Probability**	

Courseoutcomes:

After completing this course a student will have:

CO1. Knowledge of Statistics, its scope and importance in various fields.

CO2. Ability to understand concepts of sample vs. population and difference between different types of data.

CO3. Knowledge of methods for summarising data sets, including common graphical tools (such as boxplots, histograms and stemplots). Interpret histograms and boxplots.

CO4. Ability to describe data with measures of central tendency and measures of dispersion.

CO5. Ability to understand measures of skewness and kurtosis and their utility and significance.

CO6. Ability to understand the concept of probability along with basic laws and axioms of probability.

CO7. Ability to understand the terms mutually exclusive and independence and their relevance.

CO8. Ability to identify the appropriate method (i.e. union, intersection, conditional, etc.) for solving a problem.

CO9. Ability to apply basic probability principles to solve real life problems.

CO10. Ability to understand the concept of random variable (discrete and continuous), concept of probability distribution.

Credits:**04**	Core: **Compulsory**
Max.Marks:**25+75**	Min.PassingMarks: As per UGC/ University

TotalNo.ofLectures-Tutorials-Practical(inhoursperweek):**4-0-0**.		

Unit	Topic	No.of Lectures
Part-A: Descriptive Statistics (Univariate)		
I	Introduction to Statistics, Meaning of Statistics, Importance of Statistics, Scope of Statistics in various fields,Concept of Statistical population, Attributes and Variables (Discrete and Continuous), Characteristics of data- Concept & Types of Measurement – Nominal, Ordinal, Ratio and Interval, systematic & random errors of measurement, accuracy & precision in statistics, Collection of data -Primary data & Secondary data – designing a questionnaire and schedule.	**08**
II	Presentation of data : Classification, Tabulation, Diagrammatic & Graphical Representation of Grouped data, Frequency distributions, Cumulative frequency distributions and their graphical representations, Histogram, Frequency polygon and Ogives. Stem and Leaf plot, Box Plot.	**07**

III	Measures of Central tendency: Arithmetic mean, Median, Mode, Geometric Mean and HarmincMean,their properties, Merits and Demerits of these Measures, Measures of Location: Fractiles, Quartiles, Deciles, Percentiles, Measures of Dispersion: Range, Mean Deviation, Absolute Deviation, Standard Deviation, Quartile Deviation, their properties, merits and demerits. Relative measures of dispersions: Coefficient of range, coefficient of mean deviation, coefficient of quartile deviation and coefficient of variation.	**08**
IV	Moments and Factorial moments, realtion between raw moments, central moments and moments about arbitrary point, Shephard's correction for moments, Skewness and Kurtosis,their different measures and significance.	**07**

Part-B: Theory of Probability		
V	Random experiment, Trial, Sample point and Sample space, Events, Operations of events, Concept of equally likely, Mutually exclusive and Exhaustive events. Definition of Probability: Classical, Relative frequency and Axiomatic approaches.Discrete Probability Space, Properties of Probability under Set Theory Approach, Independence of Events, Conditional Probability, Total and Compound Probability theorems, Bayes theorem and its Applications	**08**
VI	Random Variables – Discrete and Continuous, Probability Mass Function (pmf) and Probability density function (pdf), Cumulative distribution function (cdf). Joint distribution of two random variables, Marginal and Conditional distributions, Independence of random variables.	**07**
VII	Expectation of a random variable and its properties, Expectation of sum of random variables and product of independent random variables, Variance and covariance, their properties, Conditional expectation, Conditional Variance and related problems.	**08**
VIII	Moments, Moment generating function (m.g.f.) & their properties, Continuity theorem for m.g.f. (without proof). Chebyshev's inequality, Weak law of large numbers for a sequence of independently and identically distributed random variables and their applications (Statement Only), Central Limit Theorem.	**07**

SuggestedReadings:

Part A:

Gupta, S.C. and Kapoor, V.K. (2000). Fundamentals of Mathematical Statistics (10th ed.), Sultan Chand and Sons.

Goon, A.M., Gupta, M.K. and Dasgupta, B. (2013). Fundamental of Statistics, Vol I, World Press, Kolkata.

Goon, A.M., Gupta, M.K. and Dasgupta, B. (2011). Fundamental of Statistics, Vol II, World Press, Kolkata.

Hanagal, D. D. (2009). Introduction to Applied Statistics: A Non-Calculus Based Approach. Narosa Publishing Comp. New Delhi.

Miller, I. and Miller, M. (2006). John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.

Mood, A.M. Graybill, F.A. and Boes, D.C. (2011). Introduction to the Theory of Statistics, 3rd Edn., Tata McGraw-Hill Pub. Co. Ltd.

Part B:

David, S. (1994) : Elementary Probability, Cambridge University Press.

Dudewicz, E.J. and Mishra, S.N. (2008). Modern Mathematics Statistics, Wiley.

Gupta, S.C. and Kapoor, V.K. (2000). Fundamentals of Mathematical Statistics (10th ed.), Sultan Chand and Sons.

Hanagal, D. D. (2009). Introduction to Applied Statistics: A Non-Calculus Based Approach. Narosa Publishing Comp. New Delhi.

Johnson, S. and Kotz, S. (1972). Distribution in Statistics Vol. I-II & III, Houghton and Mifflin.

Lipschutz, S., Lipson, M. L. and Jain, K. (2010). Schaum's Outline of Probability. 2nd Edition. McGraw Hill Education Pvt. Ltd, New Delhi.

Meyer, P. (2017). Introductory Probability and Statistical Applications (2nd ed.), New Delhi, Oxford & IBH Publishing Co. Pvt. Ltd.

Mood A.M., Graybill F.A. and Boes D.C. (2007). Introduction to the Theory of Statistics (3rd ed.), New Delhi , Tata McGraw Hill Publishing Co. ltd.

Mukhopadhyay, P. (1996). Mathematical Statistics, New Delhi, New Central Book Agency Pvt. Ltd.

Parzen, E.S. (1992). Modern Probability Theory and its Applications. Wiley Interscience.

Pitman, J. (1993). Probability. Narosa Publishing House.

Rao, C.R. (2009). Linear Statistical Inference and its Applications, 2nd Edition, Wiley Eastern.

Rohatgi, V.K. and Saleh, A.E. (2008). An introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.

Suggested Online Links/Readings:
http://heecontent.upsdc.gov.in/SearchContent.aspx
https://swayam.gov.in/explorer?searchText=statistics
https://nptel.ac.in/course.html
https://www.edx.org/search?q=statistics
https://www.coursera.org/search?query=statistics&

Thiscoursecanbeoptedasanelectivebythestudentsoffollowingsubjects:
Open to ALL

Suggested Continuous Evaluation Methods:
Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests.
The marks shall be as follows:

Assessment and Presentation of Assignment/Research Orientation assignment	**(05 marks)**
Class Test-I (Objective Questions)	**(04 marks)**
Class Test-II (Descriptive Questions)	**(04 marks)**
Class Test-III (Objective Questions)	**(04 marks)**
Class Test-IV (Descriptive Questions)	**(04 marks)**
Class Interaction	**(04 marks)**

Course prerequisites: To study this course, a student must have the subject **Mathematics in class 12th.**

Programme:**B.A/B.Sc.**	Year:**First**	Semester: **First**

Subject:**STATISTICS**

CourseCode:- **STAT 103 (B060102P)**	CourseTitle:**Descriptive Data Analysis Lab (Univariate)**

Courseoutcomes:

After completing this course a student will have:

CO1. Ability to represent/summarise the data/information using appropriate Graphical methods including common graphical tools (such as boxplots, histograms and stemplots) and also to draw inferences from these graphs

CO2. Acquire the knowledge to identify the situation to apply appropriate measure of central tendency as per the nature and need of the data and draw meaningful conclusions regarding behavior of the data.

CO3. Acquire the knowledge to identify the situation to apply appropriate measure of dispersion as per the nature and need of the data and draw meaningful conclusions regarding heterogeneity of the data.

CO4. Ability to measure skewness and kurtosis of dataanddefine their significance.

CO5. Acquire the knowledge to compute conditional probabilities based on Bayes Theorem .

Credits:**02**	Core: **Compulsory**
Max.Marks:**25+75**	Min.PassingMarks: As per UGC/ University CBCSnorm.

TotalNo.ofLectures-Tutorials-Practical(inhoursperweek):**0-0-4**.	

	List of Practicals	No.of Lectures
	1. Problems based on graphical representation of data by Histogram, Frequency polygons, frequency curves and Ogives, Stem and Leaf Plot, Box Plot. 2. Problems based on calculation of Measures of Central Tendency. 3. Problems based on calculation of Measures of Dispersion. 4. Problems based on calculation of Moments, Measures of Skewness and Kurtosis. 5. Computation of conditional probabilities based on Bayes theorem	**60**

SuggestedReadings:
As suggested for paper code STA 102(B060101T).
Thiscoursecanbeoptedasanelectivebythestudentsoffollowingsubjects: **Open to ALL**

Suggested Continuous Evaluation Methods: (25 Marks)

Continuous Internal Evaluation shall be based on Practical File/Record, Class Activities and Overall performance. The marks shall be as follows:

Practical File/Record	**(05 marks)**
Field Activity*	
(a) Theme/Objective of the Activity	**(02 marks)**
(b) Report Preparation#	**(08 marks)**
(c) Presentation&	**(05 marks)**
Class Interaction	**(05 marks)**

Suggested Practical Examination Evaluation Methods: (75 Marks)

Practical Examination Evaluation shall be based on Viva-voce and Practical Exercises. The marks shall be as follows:

Practical Exercise (Major%) 01 x 25 Marks	**25 Marks**
Practical Exercise (Minor%) 02 x 15 Marks	**30 Marks**
Viva-voce	**20 Marks**

% There shall be 04-05 Practical Exercises in Examination comprising 01 as Major (Compulsory) and 03-04 as Minor (Students have to attend any 02).

Course prerequisites: To study this course, a student must have opted/passed the **paper code:STA 102(B060101T).**

*A minor project/survey with application of techniques studied in **STAT 102**(B060101T).
e.g.
It may be a survey based study (with sample size not more than 50 and 10 questions) addressing the local area on social, economical, educational, occupational, marital, behavioural issues; knowledge, attitude, practices towards various aspects; industrial, pollution, traffic, etc. status.
A student have to develop a questionnaire then collect, classify and tabulate the data. Thereafter, represent the data graphically and/or calculate some descriptive statistics (univariate) and make some inferences (if possible).

#Report may be hand-written or in typed format. Headings of the report may be decided by the supervisor.

& Presentation may be verbal or by using ppt etc.

Programme:**B.A/B.Sc.**	Year:**First**	Semester: **Second**

Subject:**STATISTICS**

CourseCode:- **STAT 104 (B060201T)**	CourseTitle:**Descriptive Statistics (Bivariate) and Probabiity Distributions**

Courseoutcomes:

After completing this course a student will have:

CO1. Knowledge of the method of least squares for curve fitting to theoretically describe experimental data with a function or equation and to find the parameters associated with the model.

CO2. Knowledge of the concepts of correlation and simple linear regression and Perform correlation and regression analysis.

CO3. Ability to interpret results from correlation and regressionand their properties.

CO4. Ability to compute and interpret rank correlation. .

CO5. Ability to understand concept of qualitative data and its analysis.

CO6. Knowledge of discrete distributions. Discuss appropriate distributionnegative binomial, Poisson, etc. with their properties and application of discrete distribution models to solve problems.

CO7. Knowledge of continuous distributions. Discuss the appropriate distribution (i.e. uniform, exponential, normal, etc.) with their properties and application of continuous distribution models to solve problems.

Credits:**04**	Core: **Compulsory**

Max.Marks:**25+75**	Min.PassingMarks: As per UGC/ University CBCSnorm.

TotalNo.ofLectures-Tutorials-Practical(inhoursperweek):**4-0-0**.

Unit	Topic	No.of Lectures
Part-A: Descriptive Statistics (Bivariate)		
I	Bivariate data, Principles of least squares, Most plausible values, Meaning of curve fitting, Fitting of straight line, parabola, logarithmic, power curves and other simple forms by method of least squares.	**08**
II	Bi-variate frequency table, Correlation, Types of relationships, Scatter diagram, Karl-Pearson's Correlation Coefficient and its properties.	**07**
III	Rank correlation and its coefficient (Spearman and Kendall Measures). Regression analysis through both types of regression equations for X and Y variables. Fitting of plane of regression for trivariate data, Multiple and Partial correlations.	**08**
IV	Attributes: Notion and Terminology, Contingency table, Class frequencies and Ultimate class frequencies, Consistency, Association of Attributes, Independence, Measures of association for 2X2 table, Chi-square, Karl Pearson's and Tschuprow's Coefficient of Association.	**07**

	Part-B: Probability Distributions	
V	Discrete Probability Distributionsand their properties: Bernoulii, Binomial distribution, Poisson distribution (as limiting case of Binomial distribution), Hypergeometric, Geometric and Negative Binomial, Uniform and Multinomial distributions.	**08**
VI	Continuous Probability Distributions and their properties: Exponential, Gamma, Beta distributions, Cauchy, Laplace, Pareto, Weibull, Log normal. Transformations of variables (Univariate and Bivariate Case)	**07**
VII	Normal distribution and its properties, Standard Normal variate, Normal distribution as limiting case of Binomial and Poisson distribution,Distribution of mean of Normal Variates.	**08**
VIII	Computation of probabilities using table of Normal distribution.BivariateNormal Distribution and its properties: Marginal and Conditional distribution and Moment Generating Function.	**07**

SuggestedReadings:

Part A:

Goon, A.M., Gupta, M.K. and Dasgupta, B. (2013). Fundamental of Statistics, Vol I, World Press, Kolkata.

Goon, A.M., Gupta, M.K. and Dasgupta, B. (2011). Fundamental of Statistics, Vol II, World Press, Kolkata.

Gupta, S.C. and Kapoor, V.K. (2000). Fundamentals of Mathematical Statistics (10th ed.), Sultan Chand and Sons.

Hanagal, D. D. (2009). Introduction to Applied Statistics: A Non-Calculus Based Approach. Narosa Publishing Comp. New Delhi.

Miller, I. and Miller, M. (2006). John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.

Mood, A.M. Graybill, F.A. and Boes, D.C. (2011). Introduction to the Theory of Statistics, 3rd Edn., Tata McGraw-Hill Pub. Co. Ltd.

Weatherburn, C.E. (1961). A First Course in Mathematical Statistics, The English Lang. Book Society and Cambridge Univ. Press.

Part B:

David, S. (1994) : Elementary Probability, Cambridge University Press.

Dudewicz, E.J. and Mishra, S.N. (2008). Modern Mathematics Statistics, Wiley.

Gupta, S.C. and Kapoor, V.K. (2000). Fundamentals of Mathematical Statistics (10th ed.), Sultan Chand and Sons.

Hanagal, D. D. (2009). Introduction to Applied Statistics: A Non-Calculus Based Approach. Narosa Publishing Comp. New Delhi.

Johnson, S. and Kotz, S. (1972). Distribution in Statistics Vol. I-II & III, Houghton and Mifflin.

Lipschutz, S., Lipson, M. L. and Jain, K. (2010). Schaum's Outline of Probability. 2nd Edition. McGraw Hill Education Pvt. Ltd, New Delhi.

Meyer, P. (2017). Introductory Probability and Statistical Applications (2nd ed.), New Delhi, Oxford & IBH Publishing Co. Pvt. Ltd.

Mood A.M., Graybill F.A. and Boes D.C. (2007). Introduction to the Theory of Statistics (3rd ed.), New Delhi , Tata McGraw Hill Publishing Co. ltd.

Mukhopadhyay, P. (1996). Mathematical Statistics, New Delhi, New Central Book Agency Pvt. Ltd.

Parzen, E.S. (1992). Modern Probability Theory and its Applications. Wiley Interscience.

Pitman, J. (1993). Probability. Narosa Publishing House.

Rao, C.R. (2009). Linear Statistical Inference and its Applications, 2nd Edition, Wiley Eastern.

Rohatgi, V.K. and Saleh, A.E. (2008). An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.

Suggested Online Links/Readings:

http://heecontent.upsdc.gov.in/SearchContent.aspx
https://swayam.gov.in/explorer?searchText=statistics
https://nptel.ac.in/course.html
https://www.edx.org/search?q=statistics
https://www.coursera.org/search?query=statistics&

This course can be opted as an elective by the students of following subjects:
Open to ALL

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Assessment and Presentation of Assignment/ Research Orientation assignment	**(05 marks)**
Class Test-I (Objective Questions)	**(04 marks)**
Class Test-II (Descriptive Questions)	**(04 marks)**
Class Test-III (Objective Questions)	**(04 marks)**
Class Test-IV (Descriptive Questions)	**(04 marks)**
Class Interaction	**(04 marks)**

Course prerequisites: To study this course, a student must have opted/passed the **paper code : STAT 102(B060101T).**

Programme:**B.A/B.Sc.**	Year:**First**	Semester: **Second**

Subject:**STATISTICS**

CourseCode: - **STAT 105 (B060202P)**	CourseTitle:**Descriptive Data Analysis Lab (Bivariate)**

Courseoutcomes:
After completing this course a student will have:
CO1. Ability to deal with the problems based on fitting of curves by Method of least squares e.g. fitting of straight line, second degree polynomial, power curve, exponential curve etc.
CO2. Ability to deal with problems based on determination of Regression lines and calculation of Correlation coefficient – grouped and ungrouped data.
CO3. Ability to deal with the problems based on determination of Rank correlation.
CO4. Ability to fit binomial,Poisson and Normal distributions for given data..

Credits:**02**	Core: **Compulsory**
Max.Marks:**25+75**	Min.PassingMarks: As per UGC/ University CBCSnorm.

TotalNo.ofLectures-Tutorials-Practical(inhoursperweek):**0-0-4**.

	Topic	No.of Lectures
	1. Problems based on fitting of curves by Method of least squares e.g. fitting of straight line, second degree polynomial, power curve, exponential curve etc. 2. Problems based on determination of Regression lines and calculation of Correlation coefficient – grouped and ungrouped data. 3. Problems based on determination of Rank correlation. 4. Fitting of Binomial,Poissonand Normal distributions.	**60**

SuggestedReadings:
As suggested for paper code:STAT 104(B060201T).

Thiscoursecanbeoptedasanelectivebythestudentsoffollowingsubjects:
Open to ALL

Suggested Continuous Evaluation Methods:
Continuous Internal Evaluation shall be based on Practical File/Record, Class Activities and Overall performance. The marks shall be as follows:

Practical File/Record	**(05 marks)**
Field Activity[*]	
(a) Theme/Objective of the Activity	**(02 marks)**
(b) Report Preparation[#]	**(08 marks)**
(c) Presentation[&]	**(05 marks)**
Class Interaction	**(05 marks)**

Suggested Practical Examination Evaluation Methods: (75 Marks)
Practical Examination Evaluation shall be based on Viva-voce and Practical Exercises. The marks shall be as follows:

Practical Exercise (Major[%]) 01 x 25 Marks	**25 Marks**
Practical Exercise (Minor[%]) 02 x 15 Marks	**30 Marks**
Viva-voce	**20 Marks**

% There shall be 04-05 Practical Exercises in Examination comprising 01 as Major (Compulsory) and 03-04 as Minor (Students have to attend any 02).

Course prerequisites: To study this course, a student must have opted/passed the **paper code STAT 104(B060201T).**

*A minor project/survey with application of techniques studied in B060201T.

e.g.

It may be a survey based study (with sample size not more than 50 and 10 questions) addressing the local area on social, economical, educational, occupational, marital, behavioural issues; knowledge, attitude, practices towards various aspects; industrial, pollution, traffic, etc. status.

A student have to develop a questionnaire then collect, classify and tabulate the data. Thereafter, represent the data graphically and/or calculate some descriptive statistics (bivariate) and make some inferences (if possible).

#Report may be hand-written or in typed format. Headings of the report may be decided by the supervisor.

& Presentation may be verbal or by using ppt etc.

Programme:**B.A/B.Sc.**	Year:**Second**	Semester: **Third**

Subject:**STATISTICS**		
CourseCode:- **STAT 201 (B060301T)**	CourseTitle:**Theory of Estimation and Sampling Survey**	

Courseoutcomes:

After completing this course a student will have:

CO1. Knowledge of the concept of Sampling distributions.

CO2. Ability to understand the difference between parameter & statistic and standard error & standard deviation.

CO3. Knowledge of the sampling distribution of the sum and mean.

CO4. Ability to understand the t, F and chi-square distribution and to identify the main characteristics of these distributions.

CO5. Knowledge of the concept of Point and Interval Estimation and discuss characteristics of a good estimator.

CO6. Ability to understand and practice various methods of estimations of parameters.

CO7. Ability to understand the concept of sampling and how it is different from complete enumeration.

CO8. Knowledge of various probability and non-probability sampling methods along with estimates of population parameters

CO9. Ability to identify the situations where the various sampling techniques shall be used.

CO10. Knowledge of sampling and non-sampling errors.

CO11. Knowledge of ratio methods of estimation in simple random sampling (SRS).

Credits:**04**	Core: **Compulsory**
Max.Marks:**25+75**	Min.PassingMarks: As per UGC/ University CBCSnorm.

TotalNo.ofLectures-Tutorials-Practical(inhoursperweek):**4-0-0**.		

Unit	Topic	No.of Lectures
Part-A: Sampling Distributions and Theory of Estimation		
I	Sampling Distributions: The concept of sampling distribution, Parameter, Statistic and Standard error, sampling distribution of Chi-Square, t, F and Z,properties of these distributions and their inter-relationships.	**08**
II	Point estimation: Characteristics of a good estimator: Unbiasedness, consistency, sufficiency and efficiency. Related Problems and examples	**07**
III	Method of Maximum Likelihood and properties of maximum likelihood estimators (without proof), Method of minimum Chi-square. Method of least squares and methods of moments for estimation of parameters,Cramer-Rao inequality and its use in finding MVU estimator.	**08**
IV	Interval Estimation,Confidence Interval and Confidence limits,Concept of best confidence intervals,Confidence Intervals for large samples with examples.	**07**

	Part-B: Sampling Survey	
V	Sampling vs. Complete enumeration: Sampling units and Sampling frame, Precision and efficiency of estimators, Simple Random sampling with and without replacement, Use of random number tables in selection of simple random sample, Estimation of population mean and proportion, Derivation of expression for variance of these estimators, Estimation of variances, Sample size determination.	**08**
VI	Stratified random sampling, Problem of allocation, proportional allocation, optimum allocation. Derivation of the expressions for the standard error of the usual estimators when these allocations are used, Gain in precision due to Stratification, Role of sampling cost in the sample allocation, Minimization of variance for fixed cost.	**07**
VII	Systematic Sampling: Estimation of Population mean and Population total, standard errors of these estimators, Ratio methods of estimation in simple random sampling.	**08**
VIII	Cluster sampling with equal clusters, Estimators of population mean and their mean square errors, Two stage sampling with equal first stage units: Estimation of Population mean and its variance. Non-sampling errors.	**07**

SuggestedReadings:

Part-A

Ferund J.E (2001) : Mathematical Statistics, Prentice Hall of India.

Freedman, D., Pisani, R. and Purves, R. (2014). Statistics. 4th Edition. Norton & Comp.

Goon, A.M., Gupta, M.K. &Dasgupta, B. (2002). Fundamentals of Statistics, Vol. I. ,Kolkata, The World Press.

Gupta, S.C. and Kapoor, V.K. (2000). Fundamentals of Mathematical Statistics (10th ed.), Sultan Chand and Sons.

Hanagal, D. D. (2009). Introduction to Applied Statistics: A Non-Calculus Based Approach. Narosa Publishing Comp. New Delhi.

Hogg, R.V., McKean, J.W. & Craig, A.T. (2009). Introduction to Mathematical Statistics (6th ed.), Pearson.

Kendall, M.G. and Stuart, A. (1979). The Advanced Theory of Statistics, Vol.2. Inference and Relationship. 4th Edition. Charles Griffin & Comp.

Kendall, M.G., Stuart, A. and Ord, J.K. (1994). The Advanced Theory of Statistics, Vol. 1. Distribution Theory. 6th Edition. Halsted Press (Wiley Inc.).

Kenney, J.F. and Keeping, E.S. (1947). Mathematics of Statistics. Part I. 2nd Edition. Chapman & Hall.

Kenney, J.F. and Keeping, E.S. (1951). Mathematics of Statistics. Part II. 2nd Edition. Chapman & Hall.

Mood A.M., Graybill F.A. and Boes D.C. (2007). Introduction to the Theory of Statistics (3rd ed.), New Delhi , Tata McGraw Hill Publishing Co. ltd.

Tanner, M. (1990). An Investigation for a Course in Statistics. McMillan, New York.

Tanur, J.M. (1989) Statistics. A Guide to the Unknown. 3rd Edition, Duxbury Press.

Yule, G.U. and Kendall, M.G. (1973). An Introduction to the Theory of Statistics.14th Edition. Charles Griffin & Comp.

Part-B

Ardilly, P. and Yves T. (2006). Sampling Methods: Exercise and Solutions. Springer.

Cochran, W.G. (2007). Sampling Techniques. (Third Edition). John Wiley & Sons, New Delhi.

Cochran, W.G. (2008). Sampling Techniques (3rd ed.), Wiley India.

Des Raj. (1976). Sampling Theory. Tata McGraw Hill, New York. (Reprint 1979).

DesRaj and Chandhok, P. (1998). Sample Survey Theory, Narosa Publishing House.

Gupta, S.C. and Kapoor, V.K. (2000). Fundamentals of Mathematical Statistics (10th ed.), Sultan Chand and Sons.

Mukhopadyay, P. (2007). Survey Sampling. Narosa Publisher, New Delhi.
Murthy, M. N. (1977). Sampling Theory and Statistical Methods. Statistical Pub. Society, Kolkata.

Singh, D. and Choudhary, F.S. (1977). Theory and Analysis of Sample Survey Designs. Wiley Eastern Ltd, New Delhi. (Reprint 1986)

Sukhatme, P.V. and Sukhatme, B.V. (1970). Sampling Theory Surveys with Applications (Second Edition). Iowa State University Press.

Sukhatme, P.V., Sukhatme, B.V., Sukhatme, S. &Asok, C. (1984): Sampling Theories of Survey with Applications, IOWA State University Press and ISAS.

Thompson, S.K. (2012). Sampling. John Wiley & Sons.

Suggested Online Links/Readings:
http://heecontent.upsdc.gov.in/SearchContent.aspx
https://swayam.gov.in/explorer?searchText=statistics
https://nptel.ac.in/course.html
https://www.edx.org/search?q=statistics
https://www.coursera.org/search?query=statistics&

Thiscoursecanbeoptedasanelectivebythestudentsoffollowingsubjects:
Open to ALL

Suggested Continuous Evaluation Methods:
Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests.
The marks shall be as follows:

Assessment and Presentation of Assignment/ Research Orientation assignment	(05 marks)
Class Test-I (Objective Questions)	(04 marks)
Class Test-II (Descriptive Questions)	(04 marks)
Class Test-III (Objective Questions)	(04 marks)
Class Test-IV (Descriptive Questions)	(04 marks)
Class Interaction	(04 marks)

Course prerequisites: To study this course, a student must have opted/passed the **paper code STAT 104(B060201T).**

Programme:**B.A/B.Sc.**	Year:**Second**	Semester: **Third**

Subject:**STATISTICS**		
CourseCode:- **STAT 202 (B060302P)**	CourseTitle:**Sampling Techniques Lab**	

Courseoutcomes:
After completing this course a student will have:
CO1. Ability to draw a simple random sample with the help of table of random numbers.
CO2. Ability to estimate population means and variance in simple random sampling.
CO3. Ability to deal with problems based on Stratified random sampling for population means (proportional and optimum allocation).
CO4. Ability to deal with problems based on Systematic random sampling
CO5. Ability to deal with problems based on two stage sampling
CO6. Ability to deal with problems based on Ratio estimation of population mean and total.

Credits:**02**	Core: **Compulsory**
Max.Marks:**25+75**	Min.PassingMarks: As per UGC/ University CBCSnorm.

TotalNo.ofLectures-Tutorials-Practical(inhoursperweek):**0-0-4**.		

	Topic	No.of Lectures
	1. Problems based on drawing a simple random sample with the help of table of random numbers. 2. Problems based on estimation of population means and variance in simple random sampling. 3. Problems based on Stratified random sampling for population means (proportional and optimum allocation). 4. Problems based on Systematic random sampling 5. Problems based on two stage sampling 6. Problems based on Ratio estimation of population mean and total.	**60**

SuggestedReadings:
As suggested for paper code STAT 201(B060301T).

Thiscoursecanbeoptedasanelectivebythestudentsoffollowingsubjects:
Open to ALL

Suggested Continuous Evaluation Methods:
Continuous Internal Evaluation shall be based on Practical File/Record, Class Activities and Overall performance. The marks shall be as follows:

Practical File/Record	**(05 marks)**
Assignment based on STA 201(B060301T)	**(05 marks)**
Case Study* based on STA 201(B060301T)	**(10 marks)**
Class Interaction	**(05 marks)**

Suggested Practical Examination Evaluation Methods: (75 Marks)
Practical Examination Evaluation shall be based on Viva-voce and Practical Exercises. The marks shall be as follows:

Practical Exercise (Major%) 01 x 25 Marks	**25 Marks**
Practical Exercise (Minor%) 02 x 15 Marks	**30 Marks**
Viva-voce	**20 Marks**

% There shall be 04-05 Practical Exercises in Examination comprising 01 as Major (Compulsory) and 03-04 as Minor (Students have to attend any 02).

Course prerequisites: To study this course, a student must have opted/passed the **paper code STAT 201(B060301T).**

*Student may be asked to prepare a case study on Application of a Sampling Technique in a particular situation along with its merits-demerits and comparative study with other options.

Programme:**B.A/B.Sc.**	Year:**Second**	Semester: **Fourth**

Subject:**STATISTICS**		
CourseCode:**- STAT 203 (B060401T)**	CourseTitle:**Testing of Hypothesis and Applied Statistics**	

Courseoutcomes:

After completing this course a student will have:

CO1. Knowledge of the terms like null and alternative hypotheses, two-tailed and one-tailed alternative hypotheses, significant and insignificant, level of significance and confidence, p value etc.

CO2. Ability to understand the concept of MP and UMP tests.

CO3. Ability to understand under what situations one would conduct the small sample and large sample tests (in case of one sample and two sample tests).

CO4. Familiarity with different aspects of Applied Statistics and their use in real life situations.

CO5. Ability to understand the concept of Time series along with its different components.

CO6. Knowledge of Index numbers and their applications along with different types of Index numbers.

CO7. Familiarity with various demographic methods and different measures of mortality and fertility.

CO8. Ability to understand the concept of life table and its construction.

CO9. Knowledge to understand the concept of statistical quality control and different control charts for variables and attributes.

Credits:**04**	Core: **Compulsory**
Max.Marks:**25+75**	Min.PassingMarks: As per UGC/ University CBCSnorm.

TotalNo.ofLectures-Tutorials-Practical(inhoursperweek):**4-0-0**.	

Unit	Topic	No.of Lectures
Part-A: Testing of Hypothesis and Tests of Significance		
I	Statistical Hypothesis (Simple and Composite), Testing of hypothesis. Type –I and Type – II errors, Significance level, p-values,Power of a test,Most Powerful(MP) test,Uniformly Most Powerful (UMP)Test,Uniformly Most Powerful Unbiased (UMPU)Test	**08**
II	Neyman Pearson Lemma(Statement and proof) and its use in finding BCR and UMPCR,Likelihood Ratio test and its reductions to standard test	**07**
III	Test of significance: Large sample tests for (Attributes and Variables) proportions and meansand variances (i) for one sample (ii) for two samples. Correlation coefficient in case of (a) $p=p_0$ (b) $p_1=p_2$,	**08**
IV	Small sample tests based on chi-square,t, F and Zdistributions.	**07**

	Part-B: Applied Statistics	
V	Introduction & Definition of Time Series, its different components, illustrations, additive and multiplicative models. Determination of trend by free hand curve, semi average method, moving average method, method of least squares, Analysis of Seasonal Component by Simple average method, Ratio to moving Average Ratio to Trend, Link relative method.	**08**
VI	Index number – its definition, application of index number, price relative and quantity or volume relatives, link and chain relative, problem involved in computation of index number, use of averages, simple aggregate and weighted average method. Laspeyre's, Paasche's, Fisher's and Marshall-Edgeworth index number, Criteria of an ideal index number: unit, time reversal, factor reversal and circular tests, consumer price index.	**07**
VII	Vital Statistics: Measurement of Fertility– Crude birth rate, general fertility rate, age-specific birth rate, total fertility rate, gross reproduction rate, net reproduction rate, Death rates: Crude death rate, Age specific death rate, standardized death rates. Complete life table, its main features and construction.	**08**
VIII	Introduction to Statistical Quality Control, Process control and Product control, tools of statistical quality control, 3σ control limits, Principle underlying the construction of control charts. Control charts for variables, '$\bar{X}$', 'R' and 'σ' charts,theirconstruction and interpretation, Control charts for attributes: charts for number of defects per unit (c-chart), fraction defectives and number of defectives,theirconstruction and interpretation.Samplinginspection for attributes – Single and Double Sampling plans: OC function, ASN, ATI, LTPD, Producer's risk, Consumer's risk	**07**

SuggestedReadings:
Part A

Ferund J.E (2001) : Mathematical Statistics, Prentice Hall of India.

Freedman, D., Pisani, R. and Purves, R. (2014). Statistics. 4th Edition. Norton & Comp.

Goon, A.M., Gupta, M.K. &Dasgupta, B. (2002). Fundamentals of Statistics, Vol. I. ,Kolkata, The World Press.

Gupta, S.C. and Kapoor, V.K. (2000). Fundamentals of Mathematical Statistics (10th ed.), Sultan Chand and Sons.

Hangal, D. D. (2009). Introduction to Applied Statistics: A Non-Calculus Based Approach. Narosa Publishing Comp. New Delhi.

Hogg, R.V., McKean, J.W. & Craig, A.T. (2009). Introduction to Mathematical Statistics (6th ed.), Pearson.

Kendall, M.G. and Stuart, A. (1979). The Advanced Theory of Statistics, Vol.2. Inference and Relationship. 4th Edition. Charles Griffin & Comp.

Kendall, M.G., Stuart, A. and Ord, J.K. (1994). The Advanced Theory of Statistics, Vol. 1. Distribution Theory. 6th Edition. Halsted Press (Wiley Inc.).

Kenney, J.F. and Keeping, E.S. (1947). Mathematics of Statistics. Part I. 2nd Edition. Chapman & Hall.

Kenney, J.F. and Keeping, E.S. (1951). Mathematics of Statistics. Part II. 2nd Edition. Chapman & Hall.

Mood A.M., Graybill F.A. and Boes D.C. (2007). Introduction to the Theory of Statistics (3rd ed.), New Delhi , Tata McGraw Hill Publishing Co. ltd.

Tanner, M. (1990). An Investigation for a Course in Statistics. McMillan, New York.

Tanur, J.M. (1989) Statistics. A Guide to the Unknown. 3rd Edition, Duxbury Press.

Yule, G.U. and Kendall, M.G. (1973). An Introduction to the Theory of Statistics.14th Edition. Charles Griffin & Comp.

Part B

Croxton F.E., Cowden D.J. and Klein, S. (1973). Applied General Statistics(3rd ed.), Prentice Hall of India Pvt. Ltd.

Gupta, S.C. and Kapoor, V.K. (2008). Fundamentals of Applied Statistics (4th ed.), Sultan Chand and Sons.

Montgomery D.C. (2009) : Introduction to Statistical Quality Control (6th ed.), Wiley India Pvt. Ltd.

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

Suggested Online Links/Readings:
http://heecontent.upsdc.gov.in/SearchContent.aspx
https://swayam.gov.in/explorer?searchText=statistics
https://nptel.ac.in/course.html
https://www.edx.org/search?q=statistics
https://www.coursera.org/search?query=statistics&

This course can be opted as an elective by the students of following subjects:
Open to ALL

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Assessment and Presentation of Assignment/ Research Orientation assignment	**(05 marks)**
Class Test-I (Objective Questions)	**(04 marks)**
Class Test-II (Descriptive Questions)	**(04 marks)**
Class Test-III (Objective Questions)	**(04 marks)**
Class Test-IV (Descriptive Questions)	**(04 marks)**
Class Interaction	**(04 marks)**

Course prerequisites: To study this course, a student must have opted/passed the **paper code STAT 201(B060301T).**

Programme:**B.A/B.Sc.**	Year:**Second**	Semester: **Fourth**

Subject:**STATISTICS**

CourseCode:- **STAT 204** **(B060402P)**	CourseTitle:**Tests of Significance and Applied Statistics Lab**

Courseoutcomes:

After completing this course a student will have:

CO1. Ability to conduct test of significance based on t – test and Chi-square test.

CO2. Knowledge about Fisher's Z-transformation and its use in testing

CO3. Ability to deal with problems based on large sample tests.

CO4. Ability to deal with problems based on time series and calculation of its different components for forecasting.

CO5. Ability to deal with problems based on Index number.

CO6. Acquire knowledge about measurement of mortality and fertility.

CO7. Ability to deal with problems based on life table.

CO8. Ability to work with control charts for variables and attributes and draw inferences.

Credits:**02**	Core: **Compulsory**

Max.Marks:**25+75**	Min.PassingMarks: As per UGC/ University CBCSnorm.

TotalNo.ofLectures-Tutorials-Practical(inhoursperweek):**0-0-4**.

Topic	No.of Lectures
1. Problems based on t – test. 2. Problems based on F-test. 3. Problems based on Chi-square test. 4. Problems based on Fisher's Z-transformation and its use in testing 5. Problems based on calculation of power curve. 6. Problems based on large sample tests. 7. Problems based on time series and its different components 8. Problems based on Index number. 9. Problems based on measurement of mortality and fertility. 10. Problems based on life table. 11. Problems based on control charts for variables and attributes.	**60**

SuggestedReadings:
As suggested for paper code:STAT 203(B060401T).

Thiscoursecanbeoptedasanelectivebythestudentsoffollowingsubjects:
Open to ALL

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on Practical File/Record, Class Activities and Overall performance. The marks shall be as follows:

Practical File/Record	**(05 marks)**
Assignment based on STA 203(B060401T)	**(05 marks)**
Case Study based on STA 203(B060401T)	**(10 marks)**
Class Interaction	**(05 marks)**

Suggested Practical Examination Evaluation Methods: (75 Marks)

Practical Examination Evaluation shall be based on Viva-voce and Practical Exercises. The marks shall be as follows:

Practical Exercise (Major%) 01 x 25 Marks	**25 Marks**
Practical Exercise (Minor%) 02 x 15 Marks	**30 Marks**
Viva-voce	**20 Marks**

% There shall be 04-05 Practical Exercises in Examination comprising 01 as Major (Compulsory) and 03-04 as Minor (Students have to attend any 02).

Course prerequisites: To study this course, a student must have opted/passed the **paper code STAT 203(B060401T).**

Programme: **B.A/B.Sc.**	Year: **Third**	Semester: **Fifth**

Subject: **STATISTICS**

CourseCode:- **STAT 301 (B060501T)**	CourseTitle: **Multivariate Analysis and Non-parametric Methods**

Courseoutcomes:
After completing this course a student will have:
CO1. Ability to understand the basic concepts of vector space and matrices in order to study multivariate distribution.
CO2. Knowledge of the applications of multivariate normal distribution and Maximum Likelihood estimates of mean vector and dispersion matrix.
CO3. Knowledge of Principal Component Analysis and Factor Analysis.
CO4. Knowledge of the formal definition of order statistics, derive the distribution function and probability density function of the rth order statistic and joint distribution of rth and s^{th} order statistics.
CO5. Ability to identify the application of theory of order statistics in real life problems.
CO6. Ability to apply distribution free tests (Non-parametric methods) for one and two sample cases.

Credits: **04**	Core: **Compulsory**
Max.Marks: **25+75**	Min.PassingMarks: As per UGC/ University CBCSnorm.

TotalNo.ofLectures-Tutorials-Practical(inhoursperweek): **4-0-0**.

Unit	Topic	No.of Lectures
I	Order Statistics, Distribution of minimum, rth and maximum order statistic, joint distribution of rth and sth order statistics in continuous case, distribution of Sample Median and Range and their examples related to for Uniform and Exponential distribution, Coverages and Tolrence limits, Quantiles.	**08**
II	Multivariate Normal Distribution and its properties, Marginal and Conditional Distributions, Moment Generating and Characteristics functions.	**07**
III	Sample from multivariate normal distribution, unbised estimators of Mean vector and Dispersion matrix, Maximum Likelihood Estimation of Mean vector and Dispersion matrix, Independence and point sufficiency of these estimates.	**08**
IV	Simple Linear Regression: Model and Assumptions, Least squares theory. Estimation of parameters-OLSE and MLE of parameters and its properties, estimation of error variance, test of hypotheses for parameters.	**07**
V	Multiple Linear Regression: Estimation of parameters in k variable linear Regression model (OLSE and MLE), ANOVA-Table, Tests Of Hypothesis, R square and Adjusted R square. Coefficient of determination.	**08**
VI	Non-parametric tests, Comparison with parametric tests, Tests for randomness and Kolmogorov–Smirnov's test for goodness of fit. One sample tests : Sign test, Wilcoxon Signed rank tests.	**07**

VII	Two sample tests: Wald-Wolfowitz Run test, Kolmogorov – Smirnov's test, Paired sample tests: Sign test, Wilcoxon signed rank test. Independent sample tests: Wilcoxon Rank sum test, Median test and Mann-Whitney U test.	**08**
VIII	Test for scale parameter: Mood's Test, Shukahtme Test. Kurskall Wallis test. Spearman's rank correlation test.	**07**

SuggestedReadings:

Anderson, T.W. (2003): An Introduction to Multivariate Statistical Analysis, 3rdEdn., John Wiley

Muirhead, R.J. (1982): Aspects of Multivariate Statistical Theory, John Wiley.

Kshirsagar, A.M. (1972): Multivariate Analysis, 1stEdn. Marcel Dekker.

Johnson, R.A. And Wichern, D.W. (2007): Applied Multivariate Analysis, 6thEdn., Pearson & Prentice Hall

Mukhopadhyay, P.: Mathematical Statistics.

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

Gibbons, J. D. and Chakraborty, S (2003): Nonparametric Statistical Inference. 4th Edition. Marcel Dekker, CRC.

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

David, H.A. (1981). Order Statistics (2nd ed.), New York, John Wiley.

Montgomery, D.C., Peck, E.A.and Vining, G.G.(2012).Introduction to Linear Regression Analysis, 5th Edition, Wiley.

Suggested Online Links/Readings:
http://heecontent.upsdc.gov.in/SearchContent.aspx
https://swayam.gov.in/explorer?searchText=statistics
https://nptel.ac.in/course.html
https://www.edx.org/search?q=statistics
https://www.coursera.org/search?query=statistics&

Thiscoursecanbeoptedasanelectivebythestudentsoffollowingsubjects:
Open to ALL

Suggested Continuous Evaluation Methods:
Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests.
The marks shall be as follows:

Assessment and Presentation of Assignment	(05 marks)
Class Test-I (Objective Questions)	(04 marks)
Class Test-II (Descriptive Questions)	(04 marks)
Class Test-III (Objective Questions)	(04 marks)
Class Test-IV (Descriptive Questions)	(04 marks)
Class Interaction	(04 marks)

Course prerequisites: To study this course, a student must have opted/passed the **paper code STAT 201(B060301T) and STAT 203(B060401T).**

Programme: **B.A/B.Sc.**	Year: **Third**	Semester: **Fifth**

Subject: **STATISTICS**		
CourseCode:**- STAT 302 (B060502T)**	CourseTitle:**Analysis of Variance and Design of Experiment**	

Courseoutcomes:

After completing this course a student will have:

CO1. Knowledge of the concept of Analysis of Variance (ANOVA).

CO2. Ability to carry out the ANOVA for One way and Two way Classification.

CO3. Ability to carry out the post-hoc analysis.

CO4. Knowledge of the concept of Design of experiment and its basic principles.

CO5. Ability to perform the basic symmetric designs CRD, RBD and LSD with and without missing observations.

CO6. Knowledge of the concept of factorial experiments and their practical applications.

Credits: **04**	Core: **Compulsory**
Max.Marks: **25+75**	Min.PassingMarks: As per UGC/ University CBCSnorm.

TotalNo.ofLectures-Tutorials-Practical(inhoursperweek): **6-0-0**.

Unit	Topic	No.of Lectures
I	Defintion of Analysis of Variance, Assumptions and Limitations of ANOVA, One way classification. Two way classification with one observation per cell.	**08**
II	Two way classification with equal number of observations per cell,Duncan'stest for multiple comparison.Analysis of covariance (One way classification only).	**07**
III	Principles of Design of Experiment: Randomization, Replication and Local Control, Choice of size and type of a plot using uniformity trials. Completely Randomised Design (CRD)	**08**
IV	Randomized Block Design (RBD), Concept and definition of efficiency of design, Comparison of efficiency between CRD and RBD.	**07**
V	Latin Square Design (LSD), Lay-out, ANOVA table, Comparison of efficiencies between LSD and RBD; LSD and CRD	**08**
VI	Missing plot technique: Estimation of missing plots by minimizing error sum of squares in RBD and LSD with one or two missing observations.	**07**
VII	Factorial Experiments: General description of factorial experiments, 2^2, 2^3 and 2^n factorial experiments arranged in RBD, Definition of Main effects and Interactions in 2^2 and 2^3 factorial experiments. Estimation of main and interaction effect, Yates procedure, ANOVA-Table.	**10**
VIII	Concept of confounding: Complete and Partial, confounding in 2-level factorial experiments. Introduction to 3-level factorial experiments.	**05**

SuggestedReadings:

Cochran, W. G. and Cox, G. M. (1957). Experimental Design. John Wiley & Sons, New York.

Cochran, W.G. and Cox, G.M. (2003). Experimental Design, Asia Publishing House

Das, M. N. and Giri, N. S. (1986). Design and Analysis of Experiments (2nd Edition). Wiley.

Dean, A. and Voss, D. (1999). Design and Analysis of Experiments. Springer-Verlag, New York.

Joshi, D.D. (1987). Linear Estimation and Design of Experiments. New Age International (P) Ltd. New Delhi.

Kempthorne, O. (1965). The Design and Analysis of Experiments, John Wiley

Montgomery, D.C. (2008). Design and Analysis of Experiments, John Wiley

Montgomery, D.C. (2017). Design and analysis of Experiments, 9Th Edition. John Wiley &Sons..

Suggested Online Links/Readings:
http://heecontent.upsdc.gov.in/SearchContent.aspx
https://swayam.gov.in/explorer?searchText=statistics
https://nptel.ac.in/course.html
https://www.edx.org/search?q=statistics
https://www.coursera.org/search?query=statistics&

Thiscoursecanbeoptedasanelectivebythestudentsoffollowingsubjects:
Open to ALL

Suggested Continuous Evaluation Methods:
Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Assessment and Presentation of Assignment	(05 marks)
Class Test-I (Objective Questions)	(04 marks)
Class Test-II (Descriptive Questions)	(04 marks)
Class Test-III (Objective Questions)	(04 marks)
Class Test-IV (Descriptive Questions)	(04 marks)
Class Interaction	(04 marks)

Course prerequisites: To study this course, a student must have opted/passed the **Mathematicsin Class 12th.**

Programme:**B.A/B.Sc.**	Year:**Third**	Semester: **Fifth**

Subject:**STATISTICS**

CourseCode:**- STAT 303 (B060503P)**	CourseTitle:**Non-parametric Methods and DOE Lab**

Courseoutcomes:

After completing this course a student will have:

CO1. Ability to conduct test of significance based non-parametric tests.

CO2. Ability to deal with multivariate data.

CO3. Knowledge of Principal Component Analysis and Factor Analysis. Ability to perform ANOVA for one way and two classification.

CO4. Ability to perform post-hoc analysis.

CO5. Ability to conduct analysis of CRD, RBD and LSD with and without missing observations.

CO6. Ability to conduct analysis for Factorial experiments (without confounding).

Credits:**02**	Core: **Compulsory**
Max.Marks:**25+75**	Min.PassingMarks: As per UGC/ University CBCSnorm.

TotalNo.ofLectures-Tutorials-Practical(inhoursperweek):**0-0-4**.

	Topic	No.of Lectures
	1. Problems based on Non-parametric tests for one sample. 2. Problems based on Non-parametric tests for two samples. 3. Problems based on Mean vector, Dispersion matrix,marginal and conditional distribution of a multivariate normal distribution. 4. Problems based on Analysis of variance in one-way and two-way classification (with and without interaction terms). 5. Problems based on Analysis of a CRD, RBD LSD. 6. Problems based on Analysis of variance in RBD and LSD with one or two missing observations. 7. Problems based on 2^2 and 2^3Factorial Experiment.	**60**

SuggestedReadings:
As suggested for paper code STAT 301(B060501T) and STAT 302(B060502T).

Thiscoursecanbeoptedasanelectivebythestudentsoffollowingsubjects:
Open to ALL.

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on Practical File/Record, Class Activities and Overall performance. The marks shall be as follows:

Practical File/Record	**(05 marks)**
Assignment based on STA 301/STA 302(B060501T/ B060502T)	**(05 marks)**
Case Study based on STA 301/STA 302(B060501T/ B060502T)	**(10 marks)**
Class Interaction	**(05 marks)**

Suggested Practical Examination Evaluation Methods: (75 Marks)

Practical Examination Evaluation shall be based on Viva-voce and Practical Exercises. The marks shall be as follows:

Practical Exercise (Major%) 01 x 25 Marks	**25 Marks**
Practical Exercise (Minor%) 02 x 15 Marks	**30 Marks**
Viva-voce	**20 Marks**

% There shall be 04-05 Practical Exercises in Examination comprising 01 as Major (Compulsory) and 03-04 as Minor (Students have to attend any 02).

Course prerequisites: To study this course, a student must have opted/passed the **paper code STAT 301(B060501T) and STAT 302(B060502T).**

Programme:**B.A/B.Sc.**	Year:**Third**	Semester: **Sixth**

Subject:**STATISTICS**		

CourseCode:- **STAT 304 (B060601T)**	Course Title: **Statistical Computing and Introduction to Statistical Software**

Course outcomes:

After completing this course a student will have:

CO1. Basic Knowledge of programming with some basic notions for developing their own simple programs and visualizing graphics inR.

CO2. Ability to perform data analysis for both univariate and multivariate data sets usingR

CO3. Ability to perform to perform numerical methods

Credits:**04**	Core: **Compulsory**
Max.Marks:**25+75**	Min.PassingMarks: As per UGC/ University CBCSnorm.

TotalNo.ofLectures-Tutorials-Practical(inhoursperweek):**4-0-0**.

Unit	Topic	No.of Lectures
I	Introduction to Computer: Generation of Computer, Basic Structure of Computer, Digital computer and its peripherals, number systems (Binary, Octal, Hexadecimal Systems). Flow chart for simple statistical problems.	**08**
II	Introduction to R Programming and R Studio, Installing R, R as a calculator. Creating a data set, Understanding a data set, Data structure: Vectors, Matrices, Arrays, Data Frames, Factors andLists. Simple matrix algebra in R	**07**
III	Data inputs: Entering data from the keyboard, Importing Data in R from external source, creating new variables, recoding variable, renaming variables, sorting data, merging and sub setting dataset, Missing values, Descriptive Statistics.	**08**
IV	Graphs using R, Inferential Statistics- Parametric test: Test for Normality, t-test for single mean, t-test for difference between means, paired t-test, Test for equality of two variances.	**07**
V	Using R/SPSS: Wilcoxon signed rank test, Wilcoxon rank sum test, Mann-Whitney U test, Kruskal Wallis test, Analysis of Variance (One-way &Two wayAnova), Correlation coefficients and their tests, Linear Regression: Simple and Multiple regression.	**08**
VI	Error in numerical computations,Calculus of finite differences, Difference operators, Interpolation with equal and unequal intervals, Newton's forward and backward interpolation formulae, Lagrange's interpolation formula.	**07**
VII	Solutions of algebraic and transcendental equations, Direct and iterative methods, Bisection method, Regula-falsi method, Newton- Raphson method, Iteration method	**08**
VIII	Numerical Integration, General Quadrature formula, Trapezoidal rule, Simpson's one-third and tree-eight formulae and Weddle's rules.	**07**

SuggestedReadings:

Chambers, J. (2008). Software for Data Analysis: Programming with R, Springer.

Crawley, M.J. (2017). The R Book, John Wiley & Sons.

Eckhouse, R.H. and Morris, L.R. (1975). Minicomputer Systems Organization, Programming and Applications, Prentice-Hall.

Matloff, N. (2011). The Art of R Programming, No Starch Press, Inc.

Eckhouse, R.H. and Morris, L.R. (1975). Minicomputer Systems Organization, Programming and Applications, Prentice-Hall.

S.S.Sastry,IntroductorymethodsofNumericalAnalysis

Suggested Online Links/Readings:
http://heecontent.upsdc.gov.in/SearchContent.aspx
https://swayam.gov.in/explorer?searchText=statistics
https://nptel.ac.in/course.html
https://www.edx.org/search?q=statistics
https://www.coursera.org/search?query=statistics&

Thiscoursecanbeoptedasanelectivebythestudentsoffollowingsubjects:
Open to ALL

Suggested Continuous Evaluation Methods:
Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests.
The marks shall be as follows:

Assessment and Presentation of Assignment	(05 marks)
Class Test-I (Objective Questions)	(04 marks)
Class Test-II (Descriptive Questions)	(04 marks)
Class Test-III (Objective Questions)	(04 marks)
Class Test-IV (Descriptive Questions)	(04 marks)
Class Interaction	(04 marks)

Course prerequisites: To study this course, a student must have had the subject **Mathematicsin class 12th.**

Programme:**B.A/B.Sc.**	Year:**Third**	Semester: **Sixth**

Subject:**STATISTICS**		
CourseCode:**- STAT 305 (B060602T)**	CourseTitle:**Operations Research**	

Courseoutcomes:
After completing this course a student will have:
CO1. An idea about the historical background and need of Operations research.
CO2. Ability to identify and develop operational research models from the verbal description of the real life problems.
CO3. Knowledge of the mathematical tools that are needed to solve optimization problems.
CO4. Ability of solving Linear programming problem, Transportation and Assignment problems, travelling salesman problem, Job sequencing, etc.
CO5. Ability to solve the problems based on Game Theory.

Credits:**04**	Core: **Compulsory**
Max.Marks:**25+75**	Min.PassingMarks: As per UGC/ University CBCSnorm.

TotalNo.ofLectures-Tutorials-Practical(inhoursperweek):**4-0-0**.

Unit	Topic	No.of Lectures
I	History & background of OR, Developing mathematical models, Mathematical programming, Linear programming, Convex sets, Convex and concave functions, Theorems on convexity, General linear programming problems and their formulations.Solving LPP by Graphical Method.	**08**
II	Solving LPP by, Simplex method, Big–M method, Two phase Method, Degeneracy and Duality in LPP.	**07**
III	Transportation problem: North-west corner rule, Least cost method, Vogel's approximation method. Optimum solution: Stepping stone method.	**08**
IV	Assignment Problem: Hungarian Method, balanced and unbalanced problem, maximization problems, Travelling Salesman Problem.	**07**
V	Inventory control, different costs involved in inventory control, factors affecting inventory control, Deterministic EOQ models without and with shortages.	**08**
VI	Job sequencing : n jobs – 2 machines, n jobs – k machines, 2 jobs – n machines.	**07**
VII	Game Theory: Competitive game, Two-Person Zero-Sum (Rectangular) game, Minimax-maximin criteria, Saddle points, Solution of rectangular game with and without saddle points.	**08**
VIII	Huge rectangular games, Dominance rules, Solution of huge rectangular games using rules of dominance, Graphical method for 2xn and mx2 games without saddle points.	**07**

SuggestedReadings:

Swarup, K., Gupta P.K. and ManMohan (2007). *Operations Research* (13th ed.), Sultan Chand & Sons.

Taha, H.A. (2007). *Operations Research*: *An Introduction(8th ed.)*, Prentice Hall of India.

Hadley, G: (2002) : Linear Programming, Narosa Publications

Hillier, F.A and Lieberman, G.J. (2010): Introduction to Operations Research- Concepts and cases, 9th Edition, Tata McGraw Hill

V. S. Verma, Linear Programming and Game Theory, NeelkamalPrakashan, Gorakhpur, 2011.

Suggested Online Links/Readings:
http://heecontent.upsdc.gov.in/SearchContent.aspx
https://swayam.gov.in/explorer?searchText=statistics
https://nptel.ac.in/course.html
https://www.edx.org/search?q=statistics
https://www.coursera.org/search?query=statistics&

Thiscoursecanbeoptedasanelectivebythestudentsoffollowingsubjects:
Open to ALL

Suggested Continuous Evaluation Methods:
Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Assessment and Presentation of Assignment	(05 marks)
Class Test-I (Objective Questions)	(04 marks)
Class Test-II (Descriptive Questions)	(04 marks)
Class Test-III (Objective Questions)	(04 marks)
Class Test-IV (Descriptive Questions)	(04 marks)
Class Interaction	(04 marks)

Course prerequisites: To study this course, a student must have had the subject **Mathematicsin class12th.**

Programme:**B.A/B.Sc.**		Year:**Third**	Semester: **Sixth**

Subject:**STATISTICS**			
CourseCode:- **STAT 306 (B060603P)**		CourseTitle:**Operations Research**	

Courseoutcomes:
After completing this course a student will have:
CO1. Knowledge of mathematical formulation of L.P.P
CO2. Ability of solving LPP using different methods.
CO3. Ability to solve Allocation Problem based on Transportation and .Assignment model.
CO4. Ability to solve problems based on Game Theory.
CO5. Ability to deal with the scaling procedures.
CO6. Ability to deal with tests based on reliability and valididty.
CO7. Ability to solve finite difference and numerical integration.

Credits:**02**	Core: **Compulsory**
Max.Marks:**25+75**	Min.PassingMarks: As per UGC/ University CBCSnorm.

TotalNo.ofLectures-Tutorials-Practical(inhoursperweek):**0-0-4**.

	Topic	No.of Lectures
	1. Problem based on Mathematical formulation of L.P.P. 2. Problem based on solving LPP using Graphical Method. 3. Problem based on solving LPP using Simplex Method 4. Problem based on solving LPP using Big-M and Two-phase method involving artificial variables. 5. Problems based on Transportation Problems. 6. Problem based on Assignment method. 7. Problem based on solving game using LPP method. 8. Problem based on job sequencing. 9. Problems based on 2xn and mx2 games. 10. Problem based on application of R as calculator. 11. Problem based on application of R. 12. Problem based on application of R for matrix algebra.	**60**

SuggestedReadings:
As suggested for paper code STAT 304(B060601T) and STAT 305(B060602T).

Thiscoursecanbeoptedasanelectivebythestudentsoffollowingsubjects:
Open to ALL

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on Practical File/Record, Class Activities and Overall performance. The marks shall be as follows:

Practical File/Record	**(05 marks)**
Assignment based on STAT 304/STAT 305(B060601T/ B060602T)	**(05 marks)**
Case Study based on STAT 304/STA 305(B060601T/ B060602T)	**(10 marks)**
Class Interaction	**(05 marks)**

Suggested Practical Examination Evaluation Methods: (75 Marks)

Practical Examination Evaluation shall be based on Viva-voce and Practical Exercises. The marks shall be as follows:

Practical Exercise (Major%) 01 x 25 Marks	**25 Marks**
Practical Exercise (Minor%) 02 x 15 Marks	**30 Marks**
Viva-voce	**20 Marks**

% There shall be 04-05 Practical Exercises in Examination comprising 01 as Major (Compulsory) and 03-04 as Minor (Students have to attend any 02).

Course prerequisites: To study this course, a student must have opted/passed the **paper code :STAT 304(B060601T) and STAT 305(B060602T).**