Shri Agrasen Kanya P.G. College
Varanasi
(An Autonomous College)

Syllabus of the Subject

Statistics

For First Three Years of Under-Graduate (UG) Programme

As per guidelines of Common Minimum Syllabus prepared by Department of Higher Education, Uttar Pradesh Government according to the National Education Policy- 2020 (NEP-2020).

w.e.f. the Session 2021-2022)

B. Sc. / B. A. (Statistics)

Course Structure

Year	Sem.	Course Code	Paper Title	Theory/Practical	Credits
I	I	**B060101T**	Descriptive Statistics (Univariate) and Theory of Probability	Theory	04
		B060102P	Descriptive Data Analysis Lab (Univariate)	Practical	02
	II	**B060201T**	Descriptive Statistics (Bivariate) and Probability Distributions	Theory	04
		B060202P	Descriptive Data Analysis Lab (Bivariate)	Practical	02
II	III	**B060301T**	Theory of Estimation and Sampling Survey	Theory	04
		B060302P	Sampling Survey Lab	Practical	02
	IV	**B060401T**	Testing of Hypothesis and Applied Statistics	Theory	04
		B060402P	Test of Significance and Applied Statistics Lab	Practical	02
III	V	**B060501T**	Multivariate Analysis and Non-parametric Methods	Theory	04
		B060502T	Analysis of Variance and Design of Experiment	Theory	04
		B060503P	Non-parametric Methods and DOE Lab	Practical	02
	VI	**B060601T**	Statistical Computing and Introduction to Statistical Software	Theory	04
		B060602T	Operations Research	Theory	04
		B060603P	Operations Research and Statistical Computing Lab	Practical	02

:: Subject Prerequisties ::

To study this subject a student must had the subject(s) Mathematics in class 12th

:: Programme Outcomes (POs) ::

Students having Degree in 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. 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

- Knowledge of different concepts, principles, methodologies and tools (skills) of Statistics.
- Ability to collect, tabulate, represent graphically, analyze and interpret data/information by using appropriate statistical tools.
- Ability to identify and solve a wide range of problems in real life/industry related to Statistics.
- Familiarity with computational techniques and statistical software including programming language (e.g. R) for mathematical and statistical computation.
- Capability to use appropriate statistical skills in interdisciplinary areas such as finance, health, agriculture, government, business, industry, telecommunication and bio-statistics.
- 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.
- 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.

:: List of All Papers in All Six Semesters::

Programme	Year	Semester	Course Title		Credits	Teaching Hours
Certificate in Descriptive Statistics and Probability	I	First	Theory(B060101T) Descriptive Statistics (Univaritate) and Theory of Probability	Part-A: Descriptive Statistics (Univariate)	04	60
				Part-B: Theory of Probability		
			Practical(B060102P): Descriptive Data Analysis Lab (Univariate)		02	60
		Second	Theory(B060201T) Descriptive Statistics (Bivariate) and Probability Distributions	Part-A: Descriptive Statistics (Bivariate)	04	60
				Part-B: Probability Distributions		
			Practical(B060202P): Descriptive Data Analysis Lab (Bivariate)		02	60

Programme	Year	Semester	Course Title		Credits	Teaching Hours
Diploma in Mathematical & Applied Statistics with Statistical Inference	II	Third	Theory(B060301T) Theory of Estimation and Sampling Survey	Part-A: Sampling Distributions and Theory of Estimation	04	60
				Part-B: Sampling Survey		
			Practical(B060302P): Sampling Survey Lab		02	60
		Fourth	Theory(B060401T) Testing of Hypothesis and Applied Statistics	Part-A: Testing of Hypothesis and Tests of Significance	04	60
				Part-B: Applied Statistics		
			Practical(B060402P): Test of Significance and Applied Statistics Lab		02	60

Programme	Year	Semester	Course Title	Credits	Teaching Hours
B.Sc.	III	Fifth	Theory-I(B060501T) Multivariate Analysis and Non-parametric Methods	04	60
			Theory-II(B060502T) Analysis of Variance and Design of Experiment	04	60
			Practical(B060503P): Non-parametric Methods and DOE Lab	02	60
		Sixth	Theory-I(B060601T) Statistical Computing and Introduction to Statistical Software	04	60
			Theory-II(B060602T) Operations Research	04	60
			Practical(B060603P): Operations Research and Statistical Computing Lab	02	60

Programme/Class: **Certificate**	Year: **First**	Semester: **First**
Subject: **STATISTICS**		
Course Code: -**B060101T**	Course Title: **Descriptive Statistics (Univariate) and Theory of Probability**	

Course outcomes:

After completing this course a student will have:

- ✓ Knowledge of Statistics, its scope and importance in various fields.
- ✓ Ability to understand concepts of sample vs. population and difference between different types of data.
- ✓ Knowledge of methods for summarising data sets, including common graphical tools (such as boxplots, histograms and stemplots). Interpret histograms and boxplots.
- ✓ Ability to describe data with measures of central tendency and measures of dispersion.
- ✓ Ability to understand measures of skewness and kurtosis and their utility and significance.
- ✓ Ability to understand the concept of probability along with basic laws and axioms of probability.
- ✓ Ability to understand the terms mutually exclusive and independence and their relevance.
- ✓ Ability to identify the appropriate method (i.e. union, intersection, conditional, etc.) for solving a problem.
- ✓ Ability to apply basic probability principles to solve real life problems.
- ✓ Ability to understand the concept of random variable (discrete and continuous), concept of probability distribution.

Credits: **04**	Core: **Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: .....
Total No. of Lectures-Tutorials-Practical (in hours per week): **6-0-0**.	

Unit	Topic	No. of Lectures
	Part-A: Descriptive Statistics (Univariate)	
I	Introduction to Statistics, Meaning of Statistics, Importance of Statistics, Scope of Statistics in Industry, Introduction and contribution of Indian Scholars in Statistics. Concept of Statistical population, Attributes and Variables (Discrete and Continuous), Different types of scales – Nominal, Ordinal, Ratio and Interval, Primary data – designing a questionnaire and schedule, collection of primary data, checking their consistency, Secondary data.	**06**
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.	**08**
III	Measures of Central tendency and Dispersion and their properties, Merits and Demerits of these Measures.	**10**

IV	Moments and Factorial moments, Shephard's correction for moments, Measures of Skewness and Kurtosis and their significance, Measures based on quartiles.	**06**
	Part-B: Theory of Proability	
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.	**04**
VI	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.	**09**
VII	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.	**08**
VIII	Expectation of a random variable and its properties, Expectation of sum of random variables and product of independent random variables, Conditional expectation and related problems. 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)	**09**

Suggested Readings:

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 the subject **Mathematics/Elementary Mathematics in class 12th.**

Suggested equivalent online courses:
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Further Suggestions:
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Programme/Class: **Certificate**	Year: **First**	Semester: **First**
Subject: **STATISTICS**		
Course Code: -**B060102P**	Course Title: **Descriptive Data Analysis Lab (Univariate)**	

Course outcomes:

After completing this course a student will have:

- ✓ 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
- ✓ 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.
- ✓ 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.
- ✓ Ability to measure skewness and kurtosis of data and define their significance.
- ✓ Acquire the knowledge to compute conditional probabilities based on Bayes Theorem .

Credits: **02**	Core: **Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: .....

Total No. of Lectures-Tutorials-Practical (in hours per week): **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**

Suggested Readings:
As suggested for paper code B060101 T.

This course can be opted as an elective by the students of following subjects:
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 B060101T.**

Suggested equivalent online courses:

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Further Suggestions:

In practical classes a series of lectures for MS-Excel may be organized for Students and they may be asked to use it to perform practical problems assigned to them.

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*A minor project/survey with application of techniques studied in 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 has 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/Class: **Certificate**	Year: **First**	Semester: **Second**
Subject: **STATISTICS**		
Course Code: -**B060201T**	Course Title: **Descriptive Statistics (Bivariate) and Probabiity Distributions**	

Course outcomes:

After completing this course a student will have:

- ✓ 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.
- ✓ Knowledge of the concepts of correlation and simple linear regression and Perform correlation and regression analysis.
- ✓ Ability to interpret results from correlation and regression.
- ✓ Ability to compute and interpret rank correlation. .
- ✓ Ability to understand concept of qualitative data and its analysis.
- ✓ Knowledge of discrete distributions. Discuss appropriate distribution negative binomial, Poisson, etc. with their properties and application of discrete distribution models to solve problems.
- ✓ 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.
- ✓ Knowledge of the formal definition of order statistics, derive the distribution function and probability density function of the r^{th} order statistic and joint distribution of r^{th} and s^{th} order statistics.
- ✓ Ability to identify the application of theory of order statistics in real life problems.

Credits: **04**	Core: **Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: .....

Total No. of Lectures-Tutorials-Practical (in hours per week): **6-0-0**.

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.	**08**
III	Rank correlation and its coefficient (Spearman and Kendall Measures) Regression analysis through both types of regression equations for X and Y variables.	**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.	**06**

Part-B: Probability Distributions		
V	Discrete Probability Distributions: Binomial distribution, Poisson distribution (as limiting case of Binomial distribution), Hypergeometric, Geometric and Negative Binomial, Uniform and Multinomial distributions, fitting of Binomial, Poisson and Uniform distributions.	**10**
VI	Continuous Probability Distributions: Exponential, Gamma, Beta distributions. Cauchy, Laplace, Pareto, Weibull, Log normal distributions.	**10**
VII	Normal distribution and its properties, Standard Normal variate, Normal distribution as limiting case of Binomial distribution, fitting of Normal distribution.	**06**
VIII	Order Statistics, Distributions of minimum, r^{th} and maximum order statistic, Joint distribution of r^{th} and s^{th} order statistics (in continuous case), Distribution of sample range & sample median for uniform and exponential distributions.	**04**

Suggested Readings:

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. David,

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

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 B060101T.**

Suggested equivalent online courses:

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Further Suggestions:

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Programme/Class: **Certificate**	Year: **First**	Semester: **Second**
Subject: **STATISTICS**		
Course Code: -**B060202P**	Course Title: **Descriptive Data Analysis Lab (Bivariate)**	

Course outcomes:

After completing this course a student will have:

1. 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.
2. Ability to deal with problems based on determination of Regression lines and calculation of Correlation coefficient – grouped and ungrouped data.
3. Ability to deal with the problems based on determination of Rank correlation.
4. Ability to fit binomial and poisson distribution for given data..

Credits: **02**	Core: **Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: .....

Total No. of Lectures-Tutorials-Practical (in hours per week): **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 and poisson distribution.	**60**

Suggested Readings:

As suggested for paper code B060201T.

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 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**

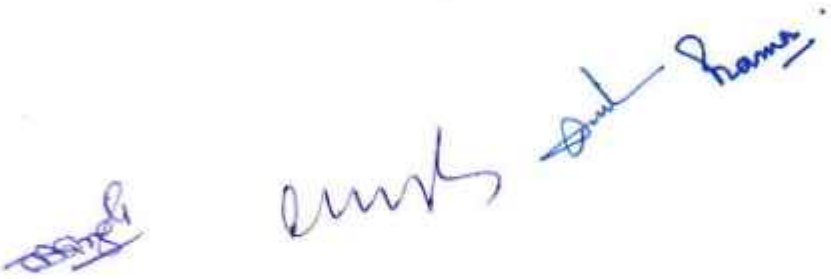
% There shall be 04-05 Practical Exercises in Examination comprising 01 as Major (Compulsory) and 03-04 as Minor (Students have to attend any 02).

Course prerequisites: To study this course, a student must have opted/passed the **paper code B060201T.**
Suggested equivalent online courses: .....
Further Suggestions: **In practical classes a series of lectures for any statistical software (e.g. SPSS) may be organized for students and they may be asked to use it to perform practical problems assigned to them.**

*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 has 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/Class: **Diploma**	Year: **Second**	Semester: **Third**
Subject: **STATISTICS**		
Course Code: -**B060301T**	Course Title: **Theory of Estimation and Sampling Survey**	

Course outcomes:

After completing this course a student will have:

- Knowledge of the concept of Sampling distributions.
- Ability to understand the difference between parameter & statistic and standard error & standard deviation.
- Knowledge of the sampling distribution of the sum and mean.
- Ability to understand the t, f and chi-square distribution and to identify the main characteristics of these distributions.
- Knowledge of the concept of Point and Interval Estimation and discuss characteristics of a good estimator.
- Ability to understand and practice various methods of estimations of parameters.
- Ability to understand the concept of sampling and how it is different from complete enumeration.
- Knowledge of various probability and non-probability sampling methods along with estimates of population parameters
- Ability to identify the situations where the various sampling techniques shall be used.
- Knowledge of sampling and non-sampling errors.
- Knowledge of regression and ratio methods of estimation in simple random sampling (SRS).

Credits: **04**	Core: **Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: .....

Total No. of Lectures-Tutorials-Practical (in hours per week): **6-0-0.**

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. The sampling distribution for the sum of independent random variables of Binomial, Poisson and Normal distribution.	**04**
II	Central limit theorem, sampling distribution of Z. Sampling distribution of t, f, and chi-square without derivations, Simple properties of these distributions and their interrelationship.	**09**
III	Point estimation: Characteristics of a good estimator: Unbiasedness, consistency, sufficiency and efficiency. Problems and examples, Interval estimation.	**08**
IV	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	**09**

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.	**08**
VII	Systematic Sampling: Estimation of Population mean and Population total, standard errors of these estimators Two stage sampling with equal first stage units: Estimation of Population mean and its variance	**08**
VIII	Regression and ratio methods of estimation in simple random sampling, Cluster sampling with equal clusters, Estimators of population mean and their mean square errors.	**06**

Suggested Readings:

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&

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 B0602011T.**

Suggested equivalent online courses:

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Further Suggestions:

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Programme/Class: **Diploma**	Year: **Second**	Semester: **Third**
Subject: **STATISTICS**		
Course Code: -**B060302P**	Course Title: **Sampling Techniques Lab**	

Course outcomes:

After completing this course a student will have:

1. Ability to draw a simple random sample with the help of table of random numbers.
2. Ability to estimate population means and variance in simple random sampling.
3. Ability to deal with problems based on Stratified random sampling for population means (proportional and optimum allocation).
4. Ability to deal with problems based on Systematic random sampling
5. Ability to deal with problems based on two stage sampling
6. Ability to deal with problems based on Ratio and regression estimation of population mean and total.

Credits: **02**	Core: **Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: .....

Total No. of Lectures-Tutorials-Practical (in hours per week): **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 and regression estimation of population mean and total.	**60**

Suggested Readings:
As suggested for paper code B060301T.

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 Practical File/Record, Class Activities and Overall performance. The marks shall be as follows:

Practical File/Record	**(05 marks)**
Assignment based on B060301T	**(05 marks)**
Case Study* based on 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 B060301T.**

Suggested equivalent online courses:
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Further Suggestions:
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*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/Class: **Diploma**	Year: **Second**	Semester: **Fourth**
Subject: **STATISTICS**		
Course Code: -**B060401T**	Course Title: **Testing of Hypothesis and Applied Statistics**	

Course outcomes:

After completing this course a student will have:

- ✓ 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.
- ✓ Ability to understand the concept of MP, UMP and UMPU tests
- ✓ 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).
- ✓ Familiarity with different aspects of Applied Statistics and their use in real life situations.
- ✓ Ability to understand the concept of Time series along with its different components.
- ✓ Knowledge of Index numbers and their applications along with different types of Index numbers.
- ✓ Familiarity with various demographic methods and different measures of mortality and fertility.
- ✓ Ability to understand the concept of life table and its construction.
- ✓ 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. Passing Marks: .....

Total No. of Lectures-Tutorials-Practical (in hours per week): **6-0-0**.

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	**08**
II	Power of a test, Definitions of Most Powerful (MP), Uniformly Most Powerful (UMP) and Uniformly Most Powerful Unbiased (UMPU) tests.	**08**
III	Test of significance: Large sample tests for (Attributes and Variables) proportions and means (i) for one sample (ii) for two samples Correlation coefficient in case of (a) $p=p_0$ (b) $p_1=p_2$.	**10**
IV	Small sample test based on t, f and chi-square distributions.	**04**

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.	**09**
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 aggregative and weighted average method. Laspeyre's, Paasche's and Fisher's index number, time and factor reversal tests of index numbers, consumer price index.	**09**
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, standardized death rates Complete life table, its main features and construction.	**06**
VII	Introduction to Statistical Quality Control, Process control, tools of statistical quality control, +3 control limits, Principle underlying the construction of control charts. Control charts for variables, 'X' and 'R' charts, construction and interpretation. Control charts for attributes 'p' and 'c' charts, construction and interpretation	**06**

Suggested Readings:

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 B060301T.**

Suggested equivalent online courses:

Further Suggestions:

Programme/Class: **Diploma**	Year: **Second**	Semester: **Fourth**
Subject: **STATISTICS**		
Course Code: **-B060402P**	Course Title: **Tests of Significance and Applied Statistics Lab**	

Course outcomes:

After completing this course a student will have:

1. Ability to conduct test of significance based on t – test and Chi-square test.
2. Knowledge about Fisher's Z-transformation and its use in testing
3. Ability to deal with problems based on large sample tests.
4. Ability to deal with problems based on time series and calculation of its different components for forecasting.
5. Ability to deal with problems based on Index number.
6. Acquire knowledge about measurement of mortality and fertility.
7. Ability to deal with problems based on life table.
8. Ability to work with control charts for variables and attributes and draw inferences.

Credits: **02**	Core: **Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: .....

Total No. of Lectures-Tutorials-Practical (in hours per week): **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 logistic curve fitting. 11. Problems based on life table. 12. Problems based on control charts for variables and attributes.	**60**

Suggested Readings:
As suggested for paper code B060401T.

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 Practical File/Record, Class Activities and Overall performance. The marks shall be as follows:

Practical File/Record	**(05 marks)**
Assignment based on B060401T	**(05 marks)**
Case Study based on 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 B060401T.**

Suggested equivalent online courses:

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Further Suggestions:
Students may be asked to perform practical problems assigned to them by using MS-Excel/any Statistical software.

Programme/Class: **B.Sc.**	Year: **Third**	Semester: **Fifth**
Subject: **STATISTICS**		
Course Code:-**B060501T**	Course Title: **Multivariate Analysis and Non-parametric Methods**	

Course outcomes:

After completing this course a student will have:

- ✓ Ability to understand the basic concepts of vector space and matrices in order to study multivariate distribution.
- ✓ Knowledge of the applications of multivariate normal distribution and Maximum Likelihood estimates of mean vector and dispersion matrix.
- ✓ Knowledge of Principal Component Analysis and Factor Analysis.
- ✓ Ability to apply distribution free tests (Non-parametric methods) for one and two sample cases.

Credits: **04**	Core: **Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: .....

Total No. of Lectures-Tutorials-Practical (in hours per week): **6-0-0**.

Unit	Topic	No. of Lectures
I	Vector Space, Subspace, Linear Combination, Span, Linear Independence, Inner Product, Norm, Orthogonality, Dimension of Vector Space	**08**
II	Row and Column Rank, Rank of Matrix, Elementary operations on Matrices, Inverse of a matrix.	**07**
III	Multivariate Normal Distribution, Marginal and Conditional Distributions, Moment Generating and Characteristics functions	**08**
IV	Maximum Likelihood Estimation of Mean vector and Dispersion matrix, Independence and point sufficiency of these estimates.	**07**
V	Applications of Multivariate Analysis: Principal Components Analysis and Factor Analysis (Application Oriented discussion, derivations not required)	**08**
VI	Multiple and Partial correlations and Multiple Regresions.	**07**
VII	Non-parametric tests, Tests for randomness and test for goodness of fit. One sample tests : Sign test, Wilcoxon Signed rank tests.	**08**
VIII	Two sample tests : Run test, Kolmogorov – Smirnov's test, Median test and Mann-Whitney U test.	**07**

Suggested Readings:

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, 2nd Edn. (Reprint) John Wiley and 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&

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	**(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 B060301T and B060401T.**

Suggested equivalent online courses:

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Further Suggestions:

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Programme/Class: **B.Sc.**	Year: **Third**	Semester: **Fifth**
Subject: **STATISTICS**		
Course Code: -**B060502T**	Course Title: **Analysis of Variance and Design of Experiment**	

Course outcomes:

After completing this course a student will have:

- ✓ Knowledge of the concept of Analysis of Variance (ANOVA).
- ✓ Ability to carry out the ANOVA for One way and Two way Classification.
- ✓ Ability to carry out the post-hoc analysis.
- ✓ Knowledge of the concept of Design of experiment and its basic principles.
- ✓ Ability to perform the basic symmetric designs CRD, RBD and LSD with and without missing observations.
- ✓ Knowledge of the concept of factorial experiments and their practical applications.

Credits: **04**	Core: **Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: .....

Total No. of Lectures-Tutorials-Practical (in hours per week): **6-0-0**.

Unit	Topic	No. of Lectures
I	Definition of Analysis of Variance. Assumptions and Limitations of ANOVA. One way classification.	**08**
II	Two way classification with equal number of observations per cell. Duncan's multiple comparison tests.	**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 and LSD. Definition of Main effects and Interactions in 2^2 and 2^3 factorial experiments.	**08**
VIII	Preparation of ANOVA by Yates procedure. Estimates and tests for main and interaction effects (Analysis without confounding).	**07**

Suggested Readings:

Cochran, W. G. and Cox, G. M. (1957). Experimental Design. John Wiley & Sons, New York. Cochran, W.G. and Cox, G.M. (1959). 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.

Federer, W.T. (1955). Experimental Design: Theory and Applications. Oxford & IBH Publishing Company, Calcutta, Bombay and New Delhi.

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&

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	**(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 **Mathematics/Elementary Mathematics in Class 12 th.**

Suggested equivalent online courses:

Further Suggestions:

Programme/Class: **B.Sc.**	Year: **Third**	Semester: **Fifth**
Subject: **STATISTICS**		
Course Code: **-B060503P**	Course Title: **Non-parametric Methods and DOE Lab**	

Course outcomes:

After completing this course a student will have:

1. Ability to conduct test of significance based non-parametric tests.
2. Ability to deal with multivariate data.
3. Knowledge of Principal Component Analysis and Factor Analysis. Ability to perform ANOVA for one way and two classification.
4. Ability to perform post-hoc analysis.
5. Ability to conduct analysis of CRD, RBD and LSD with and without missing observations.
6. Ability to conduct analysis for Factorial experiments (without confounding).

Credits: **02**	Core: **Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: .....

Total No. of Lectures-Tutorials-Practical (in hours per week): **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 Rank and Inverse of a matrix. 4. Problems based on Mean vector and Dispersion matrix of a multivariate normal distribution. 5. Problems based on Principal Component Analysis 6. Problems based on Factor Analysis. 7. Problems based on Analysis of variance in one-way and two-way classification (with and without interaction terms). 8. Problems based on Analysis of a Latin square design. 9. Problems based on Analysis of variance in RBD and LSD with one or two missing observations. 10. Problems based on Factorial Experiment Practical.	**60**

Suggested Readings:
As suggested for paper code B060501T and B060502T.

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 Practical File/Record, Class Activities and Overall performance. The marks shall be as follows:

Practical File/Record	**(05 marks)**
Assignment based on B060501T/ B060502T	**(05 marks)**
Case Study based on 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 B060501T and B060502T.**

Suggested equivalent online courses:

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Further Suggestions:
Students may be asked to perform practical problems assigned to them by using MS-Excel/any Statistical software.

Programme/Class: **B.Sc.**	Year: **Third**	Semester: **Sixth**
Subject: **STATISTICS**		
Course Code: **-B060601T**	Course Title: **Statistical Computing and Introduction to Statistical Software**	

Course outcomes:

After completing this course a student will have:

- ✓ Basic Knowledge of SPSS and R programming with some basic notions for developing their own simple programs and visualizing graphics in R.
- ✓ Ability to perform data analysis for both univariate and multivariate data sets using R as well as SPSS

Credits: **04**	Core: **Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: .....

Total No. of Lectures-Tutorials-Practical (in hours per week): **6-0-0**.

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 and Lists	**08**
III	Data inputs: Entering data from the keyboard, Importing Data from Excel, SPSS, SAS, STATA, creating new variables, recoding variable, renaming variables.	**07**
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.	**08**
V	Using R: Wilcoxon signed rank sum test, Mann Whitney U test, Kruskal Wallis test, Analysis of Variance (One- way & Two way Anova), Karl Pearson correlation coefficient, Linear Regression : Simple and Multiple regression	**07**
VI	SPSS Environment, entering data, Importing and Exporting data, Data Preparation, Data Transformation. Descriptive Statistics, Explore, Graphs using SPSS	**08**
VII	Graphs using SPSS, Inferential Statistics- Parametric test: Test for Normality, t-test for single mean, t-test for difference between means, paired t-test.	**07**
VIII	Using SPSS: Non-parametric tests, Analysis of Variance (One-way & Two way Anova), Karl Pearson correlation coefficient, Linear Regression : Simple and Multiple regression	**07**

Suggested Readings:

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.

Margan G A: SPSS for Introductory Statistics: Uses and Interpretation.

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	**(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 **Mathematics/Elementary Mathematics in class 12th.**

Suggested equivalent online courses:

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Further Suggestions:

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Programme/Class: **B.Sc.**	Year: **Third**	Semester: **Sixth**
Subject: **STATISTICS**		
Course Code: -**B060602T**	Course Title: **Operations Research**	

Course outcomes:

After completing this course a student will have:

- ✓ An idea about the historical background and need of Operations research.
- ✓ Ability to identify and develop operational research models from the verbal description of the real life problems.
- ✓ Knowledge of the mathematical tools that are needed to solve optimization problems.
- ✓ Ability of solving Linear programming problem, Transportation and Assignment problems, Replacement problems, Job sequencing, etc.
- ✓ Ability to solve the problems based on Game Theory.

Credits: **04**	Core: **Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: .....

Total No. of Lectures-Tutorials-Practical (in hours per week): **6-0-0**.

Unit	Topic	No. of Lectures
I	History & background of OR. General linear programming problems and their formulations. Solving LPP by Graphical Method.	**04**
II	Solving LPP by, Simplex method, Big–M method, Two phase Method, Degeneracy and Duality in LPP.	**10**
III	Transportation problem: North-west corner rule, Least cost method, Vogel's approximation method. Optimum solution: Stepping stone method.	**05**
IV	Assignment Problem: Hungarian Method, Travelling Salesman Problem.	**05**
V	Replacement problem: Individual and Group replacement.	**05**
VI	Job sequencing : n jobs – 2 machines, n jobs – k machines, 2 jobs – n machines.	**05**
VII	Game theory: Introduction, Competitive Situations, Characteristics of Competitive Games. Rectangular game, Two-Person Zero-Sum game, minimax-maximin principle, Solution to rectangular game using graphical method	**05**
VIII	Ddominance and modified dominance property to reduce the game matrix and solution to rectangular game with mixed strategy, LPP method.	**06**

Suggested Readings:

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

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	**(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 **Mathematics/Elementary Mathematics in class 12th.**

Suggested equivalent online courses:

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Further Suggestions:

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Programme/Class: **B.Sc.**	Year: **Third**	Semester: **Sixth**
Subject: **STATISTICS**		
Course Code: **-B060603P**	Course Title: **Operations Research and Statistical Computing Lab**	

Course outcomes:

After completing this course a student will have:

1. Knowledge of mathematical formulation of L.P.P
2. Ability of solving LPP using different methods.
3. Ability to solve Allocation Problem based on Transportation and .Assignment model.
4. Ability to solve problems based on Game Theory.
5. Ability to use programming language R as Calculator.
6. Knowledge of using R in simple data analysis.
7. Able to perform statistical analysis by using SPSS.

Credits: **02**	Core: **Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: .....

Total No. of Lectures-Tutorials-Practical (in hours per week): **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 Charne's Big M method involving artificial variables. 5. Allocation Problem based on Transportation model. 6. Allocation Problem based on Assignment model. 7. Problems based on Game payoff matrix. 8. Problem based on solving Graphical solution to mx2/ 2xn rectangular game. 9. Problem based on solving Mixed strategy game. 10. Problem based on solving game using LPP method. 11. Problem based on application of R as Calculator. 12. Problem based on application of R in simple data analysis 13. Problem based on application of SPSS in data analysis	**60**

Suggested Readings:
As suggested for paper code B060601T and B060602T.

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 Practical File/Record, Class Activities and Overall performance. The marks shall be as follows:

Practical File/Record	**(05 marks)**
Assignment based on B060601T/ B060602T	**(05 marks)**
Case Study based on 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 B060601T and B060602T.**

Suggested equivalent online courses:

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Further Suggestions:

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