MAA SHAKUMBHARI UNIVERSITY, SAHARANPUR

माँ शाकुम्भरी विश्वविद्यालय, सहारनपुर

SYLLABUS OF THE SUBJECT: STATISTICS
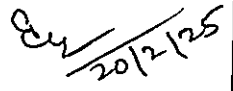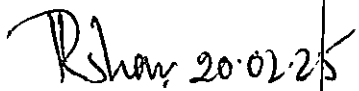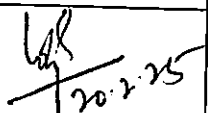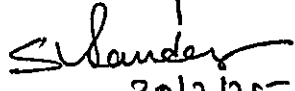
For Four Years Undergraduate Program (FYUP)

(As per guidelines of Common Minimum Syllabus by U.P. Government according to National Education Policy-2020 amended with GO-2090/70-3-2024-09(01) Dated: 02-09-2024) w.e.f. session 2025-2026

Members of the Board of Studies (BOS)

S.No.	Name	Signature
1.	Prof. Garima Jain, **Dean**, Science Faculty	*signature* 20/2/25
2.	Prof. Ram Kishan, **Convenor**, D.A.V. (P.G.) College, Muzaffarnagar	*signature* 20.01.25
3.	Prof. Hare Krishna, **External Expert**, C.C.S. University, Meerut	
4.	Prof. V.K. Tyagi, **External Expert**, M.M. (P.G.) College, Modinagar	*signature* 20.2.25
5.	Dr. S.K. Pandey, **Member**, R.K. College, Shamli	*signature* 20/2/25

SUBJECT: STATISTICS

Semester-wise Titles of the Papers in FYUP (Statistics)

Program	Year	Sem.	Paper Code	Paper Title	Theory/ Practical	Credits
Certificate in Descriptive Statistics and Probability	I	I	0120601	Descriptive Statistics (Univariate) and Theory of Probability	Theory	04
			0120680	Descriptive Data Analysis Lab (Univariate)	Practical	02
		II	0220601	Descriptive Statistics (Bivariate) and Probability Distributions	Theory	04
			0220680	Descriptive Data Analysis Lab (Bivariate)	Practical	02
Diploma in Mathematical & Applied Statistics with Statistical Inference	II	III	0320601	Theory of Estimation and Sampling Survey	Theory	04
			0320680	Sampling Survey Lab	Practical	02
		IV	0420601	Testing of Hypothesis and Applied Statistics	Theory	04
			0420680	Test of Significance and Applied Statistics Lab	Practical	02
B.Sc.	III	V	0520601	Multivariate Analysis and Non-Parametric Methods	Theory	04
			0520602	Analysis of Variance and Design of Experiment	Theory	04
			0520680	Non-parametric Methods and DOE Lab	Practical	02
		VI	0620601	Statistical Computing and Introduction to Statistical Software	Theory	04
			0620602	Operations Research	Theory	04
			0620680	Operations Research and Statistical Computing Lab	Practical	02
B.Sc. (Honours)	IV	VII	0720601	Population Studies	Theory	04
			0720602	Distribution Theory	Theory	04
			0720603	Survey Sampling	Theory	04

				0720604	Programming with R	Theory	04
				0720680	Practical Lab	Theory	04
			VIII	0820601	Probability Theory	Theory	04
				0820602	Statistical Inference-I	Theory	04
				0820603	Linear Models and Experimental Designs	Theory	04
				0820604	Statistical Quality Control and Reliability Theory	Theory	04
				0820680	Practical Lab	Theory	04
			OR				
B.Sc. (Honours with Research)	IV		VII	0720601	Population Studies	Theory	04
				0720602	Distribution Theory	Theory	04
				0720603	Survey Sampling	Theory	04
				0720680	Practical Lab	Practical	04
				0720665	Research Project	Project	04
			VIII	0820601	Probability Theory	Theory	04
				0820602	Statistical Inference-I	Theory	04
				0820603	Linear Models and Experimental Designs	Theory	04
				0820680	Practical Lab	Practical	04
				0820665	Research Project	Project	04

::Subject Prerequisites::

To study this subject a student must have taken Mathematics in class 12th.

::Program 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.

::Program 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 newproblems 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 EIGHT SEMESTERS

Program	Year	Semester	Course Title		Credits	Teaching Hours
Certificate in Descriptive Statistics and Probability	I	First	Theory (0120601): Descriptive Statistics (Univariate) and Theory of Probability	Part-A: Descriptive Statistics (Univariate)	04	60
				Part-B: Theory of Probability		
			Practical (0120680): Descriptive Data Analysis Lab (Univariate)		02	60
		Second	Theory (0220601): Descriptive Statistics (Bivariate) and Probability Distributions	Part-A: Descriptive Statistics (Bivariate)	04	60
				Part-B: Probability Distributions		
			Practical (0220680): Descriptive Data Analysis Lab (Bivariate)		02	60
Diploma in Mathematical & Applied Statistics with Statistical Inference	II	Third	Theory (0320601): Theory of Estimation and Sampling Survey	Part-A: Sampling Survey	04	60
				Part-B: Sampling Distributions and Theory of Estimation		
			Practical (0320608): Sampling SurveyLab		02	60
		Fourth	Theory (0420601): Testing of Hypothesis and Applied Statistics	Part-A: Testing of Hypothesis and Tests of Significance	04	60
				Part-B: Applied Statistics		
			Practical (0420680): Test of Significance and Applied Statistics Lab		02	60
B.Sc.	III	Fifth	Theory-I (0520601): Multivariate Analysis and Non-parametric Methods		04	60
			Theory-II (0520602): Analysis of Variance and Design of Experiment		04	60
			Practical (0520680): Non-parametric Methods and DOE Lab		02	60
		Sixth	Theory-I (0620601): Statistical Computing and Introduction to Statistical Software		04	60
			Theory-II (0620602): Operations Research		04	60

				Practical (0620680): Operations Research and Statistical Computing Lab	02	60
B.Sc. (Honours)	IV	Seventh		Theory-I (0720601): Population Studies	04	60
				Theory-II (0720602): Distribution Theory	04	60
				Theory-III (0720603): Survey Sampling	04	60
				Theory-IV (0720604): Programming with R	04	60
				Practical Lab (0720680)	04	60
		Eight		Theory-I (0820601): Probability Theory	04	60
				Theory-II (0820602): Statistical Inference-I	04	60
				Theory-III (0820603): Linear Models and Experimental Designs	04	60
				Theory-IV (0820604): Statistical Quality Control and Reliability Theory	04	60
				Practical Lab (0820680)	04	60

OR

				Theory-I (0720601): Population Studies	04	60
B.Sc. (Honours with Research)	IV	Seventh		Theory-II (0720602): Distribution Theory	04	60
				Theory-III (0720603): Survey Sampling	04	60
				Practical Lab (0720680)	04	60
				Research Project (0720665)	04	60
		Eight		Theory-I (0820601): Probability Theory	04	60
				Theory-II (0820602): Statistical Inference-I	04	60
				Theory-III (0820603): Linear Models and Experimental Designs	04	60
				Practical Lab (0820680)	04	60
				Research Project (0820665)	04	60

Program/Class: Certificate	Year: First	Semester: First

Subject: STATISTICS	

Paper Code: 0120601	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 summarizing data sets, including common graphical tools (such as boxplots, histogram and stem plots). Interpret histogram and boxplot.

❖ 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 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): 4-0-0.	

Unit	Topics	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.	6
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.	8
III	Measures of Central tendency and Dispersion and their properties, Merits and Demerits of these Measures.	10

IV	Moments, Shephard's correction for moments, Measures of Skewness and Kurtosis and their significance, Measures based on quartiles.	6

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.	4
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.	9
VII	RandomVariables–Discrete and Continuous, Probability Mass Function (p.m.f.) and Probability density function (pdf), Cumulative distribution function (c.d.f.). Joint distribution of two random variables, Marginal and Conditional distributions, Independence of random variables.	8
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).	9

Suggested Readings:

Part A:

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

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

- Gupta, S.C. and Kapoor, V.K. (2000). Fundamentals of Mathematical Statistics, 10th Edn, 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, 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, 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 Edn.), 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 Edn, 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.

- 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.aspxhttps://swayam.gov.in/explorer?searchText=statistic shttps://nptel.ac.in/course.htmlhttps://www.edx.org/search?q=statisticshttps://www.coursera.org/search?query=statistics&

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on written Assignment, Presentation, Class test, Quiz, Essay, Exhibition etc. as per NEP revised guidelines.

Course Prerequisite:

To study this course, student must have passed Mathematics in 12th .

Program/Class: **Certificate**	Year: **First**	Semester: **First**
Subject: **STATISTICS**		
Paper Code: **0120680**	Course Title: **Descriptive Data Analysis Lab (Univariate)**	

Course outcomes:

After completing this course, a student will have:

❖ Ability to represent/summaries the data/information using appropriate Graphical methods including common graphical tools (such as boxplots, histograms and stem plots) 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: 0120601.

Practical Examination Evaluation Method (100 Marks):

Practical Examination Evaluation shall be based on Practical record, Practical Exercises and Viva-voce.

Program/Class: Certificate	Year: First	Semester: Second
	Subject: STATISTICS	
Paper Code: 0220601	Course Title: Descriptive Statistics (Bivariate) and Probability 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 parameter 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 like 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.

❖ 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): 4-0-0.

Unit	Topics	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 the method of Least squares.	8
II	Bi-variate frequency table, Correlation, Types of relationships, Scatter diagram, Karl-Pearson's Correlation Coefficient and its properties.	8
III	Spearman's Rank correlation and its coefficient, Regression analysis through both types of regression equations for X and Y variables.	8

IV	Attributes: Notion and Terminology, Contingency table, Class frequencies and Ultimate class frequencies, Consistency, Association of Attributes, Independence, Measures of association for 2×2 table, Chi-square and Karl Pearson's Coefficient of Association.	6
Part-B: Probability Distributions		
V	Discrete Probability Distributions: Binomial distribution, Poisson distribution (as limiting case of Binomial distribution) and their properties in detail. Introduction to Geometric, Negative Binomial, Hypergeometric, and Uniform distributions.	10
VI	Continuous Probability Distributions: Exponential, Gamma, Beta and Cauchy distributions with their basic properties.	6
VII	Normal distribution and its properties, Standard Normal variate, Normal distribution as limiting case of Binomial distribution.	8
VIII	Fitting of Binomial and Poisson distributions. Introduction to Order Statistics, Distributions of minimum and maximum order statistics.	6

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 Edn., Sultan Chand and Sons.

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

- 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 Edn., 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 Edn., 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.

- Meyer, P. (2017). Introductory Probability and Statistical Applications, 2nd Edn., 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 Edn., 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.aspxhttps://swayam.gov.in/explorer?searchText=statisticshttps://nptel.ac.in/course.htmlhttps://www.edx.org/search?q=statisticshttps://www.coursera.org/search?query=statistics&

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on written Assignment, Presentation, Class test, Quiz, Essay, Exhibition etc.

Course Prerequisite:

To study this course, student must have passed Semester I.

Program/Class: Certificate	Year: First	Semester: Second
Subject: STATISTICS		
Paper Code: 0220680	Course Title: Descriptive Data Analysis Lab (Bivariate)	

Course Outcomes:

After completing this course, a student will have:

❖ Ability to deal with the problems based on fitting of curves by the Method of Least squares, e.g., fitting of straight line, second degree polynomial, power curve, exponential curve etc.

❖ Ability to deal with problems based on determination of Regression lines and calculation of Correlation coefficient–grouped and ungrouped data.

❖ Ability to deal with the problems based on determination of Rankcorrelation.

❖ 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.

Topics	No. of Lectures
1. Problems based on fitting of curves by the 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 ungroupeddata. 3. Problems based on determination of Rank correlation. 4. Fitting of Binomial and Poisson distribution.	60

Suggested Readings:

As suggested for Paper Code: 0220601.

Practical Examination Evaluation Method (100 Marks):

Practical Examination Evaluation shall be based on Practical record, Practical Exercises and Viva-voce.

Further Suggestions:

In practical classes a series of lectures for any statistical software (e.g., Excel or R) may be organized for students and they may be asked to use it to perform practical problems assigned to them.

Program/Class: Diploma	Year: Second	Semester: Third
	Subject: STATISTICS	
Paper Code: 0320601	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.

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

Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0.

Unit	Topics	No. of Lectures
	Part-A: Sampling Survey	
I	Types of population, Sample, Principal Steps in Sample Survey, Benefit of Sampling Survey, Sampling vs. Complete enumeration: Sampling units and Sampling frame, Precision and efficiency of estimators. Types of Sampling Methods: Probability Sampling, Non-Probability Sampling: Purposive, Quota, Voluntary and Snowball Sampling.	6
II	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.	8

III	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. Comparison between SRS & Stratified Sampling in terms of Variance	8
IV	Systematic Sampling: Estimation of Population mean and Population total, standard errors of these estimators.	8
Part-B: Sampling Distributions and Theory of Estimation		
V	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 distributions.	4
VI	Central limit theorem (Statement only), Sampling distribution of Z, t, F, and Chi-square without derivations, Simple properties of these distributions and their interrelationship.	8
VII	Point estimation: Characteristics of a good estimator: Unbiasedness, Consistency, Sufficiency and Efficiency. Problems and examples, Interval estimation.	10
VIII	Method of Maximum Likelihood and properties of Maximum Likelihood estimators (without proof), Method of Least squares and method of Moments for estimation of parameters.	8

Suggested Readings:

Part- A

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

- Cochran, W.G. (2007). Sampling Techniques, 3rd Edn., John Wiley & Sons, New Delhi.

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

- Des Raj and Chandhok, P. (1998). Sample Survey Theory, Narosa Publishing House.

- Gupta, S.C. and Kapoor, V.K. (2000). Fundamentals of Mathematical Statistics, 10th Edn., 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, 2nd Edn., Iowa State University Press.

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

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

Part- B

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

- Freedman, D., Pisani, R. and Purves, R. (2014). Statistics, 4th Edn. Norton & Comp. Goon, A.M., Gupta, M.K. and 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 Edn., 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. and Craig, A.T. (2009). Introduction to Mathematical Statistics, 6th Edn., Pearson.

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

- 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 Edn., 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 Edn. Charles Griffin & Comp.

Suggested Online Links/ Readings:

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

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on written Assignment, Presentation, Class test, Quiz, Essay, Exhibition etc. as per NEP revised guidelines.

Program/Class: **Diploma**	Year: **Second**	Semester: **Third**
Subject: **STATISTICS**	
Paper Code: 0320680	CourseTitle: **Sampling Survey Lab**	

Course outcomes:

After completing this course, a student will have:

❖ Ability to draw a simple random sample with the help of table of random numbers.

❖ Ability to estimate population mean and variance in simple random sampling.

❖ Ability to deal with problems based on Stratified random sampling for population mean (Proportional and Optimum allocation).

❖ Ability to deal with problems based on Systematic random sampling.

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

Total No. of Lectures-Tutorials-Practical (in hours per week): **0-0-4.**

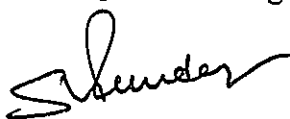|	Topic	No. of Lectures
	1. Problems based on drawing a simple random sample with the help of table of random numbers. 2. Problems based on estimation of population mean and variance in simple random sampling. 3. Problems based on Stratified random sampling for population mean (Proportional and Optimum allocation). 4. Problems based on Systematic random sampling.	60

Suggested Readings:

As suggested for Paper Code: 0320601.

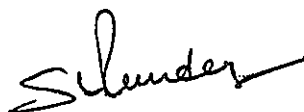**Practical Examination Evaluation Method (100 Marks):**

Practical Examination Evaluation shall be based on Practical record, Practical Exercises and Viva-voce.

Further Suggestions:

In practical classes a series of lectures for any statistical software may be organized for students and they may be asked to use it to perform practical problems assigned to them.

Program/Class: **Diploma**	Year: **Second**	Semester: **Fourth**
	Subject: **STATISTICS**	
Paper Code: **0420601**	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, level of significance and 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): **4-0-0**.

Unit	Topics	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	8
II	Neyman-Pearson Lemma, Power of a test, Definitions of Most Powerful (MP), Uniformly Most Powerful (UMP) and Uniformly Most Powerful Unbiased (UMPU) tests.	8
III	Test of Significance: large sample tests for (Attributes and Variables) proportions and means (i) for one sample (ii) for two samples.	6
IV	Small sample test based on t, F and Chi-square distributions.	8
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.	9
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.	9
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.	6
VIII	Introduction to Statistical Quality Control, Process control, tools of statistical quality control, 3σ control limits, Principle underlying the construction of control charts. Control charts for variables $\bar{X}$ and 'R' charts, construction and interpretation, Control charts for attributes 'p' and 'c' charts, construction and interpretation.	6

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. and 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 Edn., Sultan Chand and Sons.

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

- 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 Edn., 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 Edn., Prentice Hall of India Pvt. Ltd.

- Gupta, S.C. and Kapoor, V.K. (2008). Fundamentals of Applied Statistics, 4th Edn., 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.aspxhttps://swayam.gov.in/explorer?searchText=statisticshttps://nptel.ac.in/course.htmlhttps://www.edx.org/search?q=statisticshttps://www.coursera.org/search?query=statistics&

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on written Assignment, Presentation, Class test, Quiz, Essay, Exhibition etc. as per NEP revised guidelines.

Program/Class: **Diploma**	Year: **Second**	Semester: **Fourth**
	Subject: **STATISTICS**	
Paper Code: **0420680**	Course Title: **Tests of Significance and Applied Statistics Lab**	

Course outcomes:

After completing this course, a student will have:

- ❖ Ability to conduct test of significance based on t, F and Chi-square tests.
- ❖ Ability to deal with problems based on large sample tests.
- ❖ Ability to deal with problems based on time series and calculation of its different components for forecasting.
- ❖ Ability to deal with problems based on Index number.
- ❖ Acquire knowledge about measurement of mortality and fertility.
- ❖ Ability to deal with problems based on life table.
- ❖ 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.

List of Practicals	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 calculation of power function.	
5. Problems based on large sample tests.	
6. Problems based on time series and its different components.	60
7. Problems based on Index number.	
8. Problems based on measurement of mortality and fertility.	
9. Problems based on life table.	
10. Problems based on control charts for variables and attributes.	

Suggested Readings:

As suggested for Paper Code: 0420601.

Practical Examination Evaluation Method (100 Marks):

Practical Examination Evaluation shall be based on Practical record, Practical Exercises and Viva-voce.

Further Suggestions:

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

Program/Class: B.Sc.	Year: Third	Semester: Fifth
Subject: STATISTICS		
Paper Code: 0520601	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 matrices in order to study multivariate distribution.

❖ Ability to understand bivariate normal distribution and its applications

❖ Knowledge of the applications of multivariate normal distribution and Maximum Likelihood estimates of mean vector and dispersion matrix.

❖ 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): 4-0-0.

Unit	Topics	No. of Lectures
I	Elementary operations on Matrices, Rank of Matrix, Row and Column Rank, Inverse of a matrix. Eigen values and Eigen vectors.	8
II	Introduction to multivariate analysis, Uses and Applications of multivariate analysis, Bivariate normal distribution: definition and Simple properties.	7
III	Multivariate Normal Distribution, Marginal and Conditional Distributions, Characteristics function	8
IV	Maximum Likelihood Estimation of Mean vector and Dispersion matrix and their Independence, sufficient statistics of these estimates.	7
V	Concepts and definitions of Multiple and Partial correlations and Multiple Regressions for Three variables only (with their practical applications)	8
VI	Non-parametric tests, Tests for location and symmetry, one sample tests: Sign test, Wilcoxon Signed rank test.	7
VII	Tests for randomness: Run test, Test for goodness of fit.	7
VIII	Two sample tests: Median Test, Kolmogorov-Smirnov's test and Mann-Whitney U test.	8

Suggested Readings:

• Anderson, T.W. (2003). An Introduction to Multivariate Statistical Analysis, 3rd Edn., John Wiley

• Gibbons, J.D. and Chakraborty, S. (2003). Non-parametric Statistical Inference, 4th Edition. Marcel
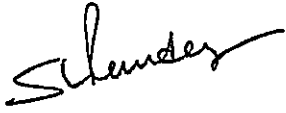
Dekker, CRC.

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

- Johnson, R.A. and Wichern, D.W. (2007). Applied Multivariate Analysis, 6th Edn., Pearson & Prentice Hall

- Kshirsagar, A.M. (1972). Multivariate Analysis, 1st Edn., Marcel Dekker.

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

- 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.aspxhttps://swayam.gov.in/explorer?searchText=statis ticshttps://nptel.ac.in/course.htmlhttps://www.edx.org/search?q=statisticshttps://www.coursera.org/s earch?query=statistics&

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on written Assignment, Presentation, Class test, Quiz, Essay, Exhibition etc. as per NEP revised guidelines.

Program/Class: B.Sc.	Year: Third	Semester: Fifth
Subject: STATISTICS		
Paper Code: 0520602	CourseTitle: 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): 4-0-0.

Unit	Topics	No. of Lectures
I	Definition of Analysis of Variance, Assumptions and Limitations of ANOVA, One way classification.	8
II	Two-way classification with one observation per cell. Multiple comparison tests using critical difference criteria.	8
III	Principles of Design of Experiment: Randomization, Replication and Local Control, Choice of size and type of a plot using uniformity trials.	7
IV	Completely Randomized Design (CRD), Concept and definition, Statistical analysis of CRD, Merits and demerits.	7
V	Randomized Block Design (RBD), Concept and definition of efficiency of design, Comparison of efficiency between CRD and RBD.	7
VI	Latin Square Design (LSD), Lay-out, ANOVA table, Comparison of efficiencies between LSD and RBD; LSD and CRD	8
VII	Missing plot technique: Estimation of missing plots by minimizing error sum of squares in RBD and LSD with one missing observation.	7
VIII	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,	8

Suggested Readings:

• Cochran, W.G. and Cox, G.M. (1957). Experimental Design. John Wiley & Sons, NewYork.
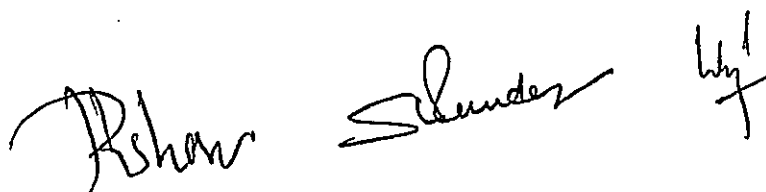
- Cochran, W.G. and Cox, G.M. (1959). Experimental Design. Asia Publishing House.
- Das, M.N. and Giri, N.S. (1986). Design and Analysis of Experiments, 2nd Edn., Wiley.
- Dean, A. and Voss, D. (1999). Design and Analysis of Experiments. Springer-Verlag, New York.
- Federer, W.T. (1955). Experimental 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. (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&

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on written Assignment, Presentation, Class test, Quiz, Essay, Exhibition etc. as per NEP revised guidelines.

Program/Class: **B.Sc.**	Year: **Third**	Semester: **Fifth**
Subject: **STATISTICS**		
Paper Code: **0520680**	Course Title: **Non-parametric Methods and DOE Lab**	

Course outcomes:

After completing this course, a student will have:

- ❖ Ability to conduct test of significance based on Non-parametric tests.
- ❖ Ability to deal with multivariate data.
- ❖ Ability to perform ANOVA for one way and two way classifications.
- ❖ Ability to perform post-hoc analysis.
- ❖ Ability to conduct analysis of CRD, RBD and LSD with and without missing observations.

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

Total No. of Lectures- Tutorials-Practical (in hours per week): 0-0-4.

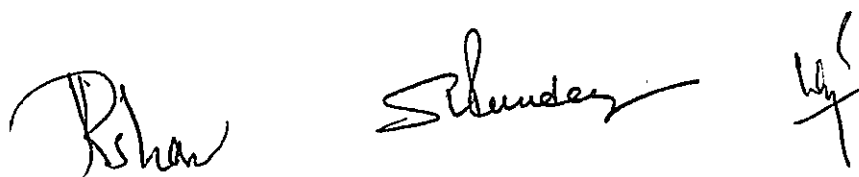| Topics	No. of Lectures
1. Problems based on Non-parametric tests for one sample.	
2. Problems based on Non-parametric tests for two samples.	
3. Problems based on Rank and Inverse of a matrix.	
4. Problems based on Mean vector and Dispersion matrix of a multivariate normal distribution.	
5. Problems based on Analysis of variance in one-way and two-way classification.	60
6. Problems based on Analysis of a Latin square design.	
7. Problems based on Analysis of variance in RBD and LSD with one missing observation.	

Suggested Readings:

As suggested for Paper Codes: 0520601 and 0520602.

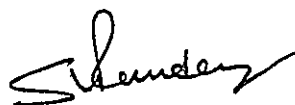**Practical Examination Evaluation Method (100 Marks):**

Practical Examination Evaluation shall be based on Practical record, Practical Exercises and Viva-voce.

Further Suggestions:

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

Program/Class: B.Sc.	Year: Third	Semester: Sixth
Subject: STATISTICS		
Paper Code: 0620601	Course Title: Statistical Computing and Introduction to Statistical Software	

Course outcomes:

After completing this course, a student will have:

❖ Basic Knowledge of Excel and R programming with some basic notions for developing their own simple programs and visualizing graphics in R and Excel.

❖ Ability to perform data analysis for both univariate and multivariate data sets using R as well as Excel.

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

Total No. of Lectures- Tutorials-Practical (in hours per week): 4-0-0.

Unit	Topics	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). Flowchart for simple statistical problems.	8
II	Solid Understanding of Basics Excel: Getting Started with Excel, Working with Cell and Ranges, Data Entry & Editing, Number formatting, delete, insert and adjust cells, columns and rows, Preview and print workbook.	6
III	Custom Fill, Autofill, Flash Fill, Date & Time, Data Formatting, Sort & Filter, Grouping Sheets, managing worksheets-Changing Name, Colour, Add, Delete, Hide/Unhide, Worksheet Views- Comparing Sheet Side by Side, Splitting Sheet into Panes, freezing Panes,	6
IV	Using Excel: Basic Mathematical functions, Graphs, Descriptive Statistics, Analysis of Variance (One-way & Two-way ANOVA), Karl Pearson correlation coefficient, Regression Analysis.	10
V	Introduction to R Programming and R Studio, Installing R, R as a calculator. Creating a dataset, Understanding a dataset, Data structure: Vectors, Matrices, Arrays, Data Frames, Factors and Lists	8
VI	Data inputs: Entering data from the keyboard, Importing Data, creating new variables, recoding variable, renaming variables,	7
VII	Graphs using R, Inferential Statistics- Parametric test: Test for Normality, t-test for single mean, t-test for difference between means, paired t-test.	8

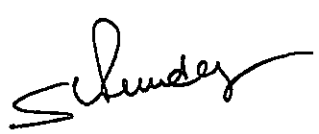| VIII	Using R: Wilcoxon signed rank sum test, Mann Whitney U test, Kolmogorov-Smirnov Test for normality, Analysis of Variance (One-way & Two-way ANOVA), Karl Pearson correlation coefficient, Regression Analysis.	7

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.
- Eckhouse, R.H. and Morris, L.R. (1975). Minicomputer Systems Organization, Programming and Applications, Prentice-Hall.
- Great Harvey (2019). Excel 2019 all in one, John Wiley & Sons.
- Matloff, N. (2011). The Art of R Programming, No Starch Press, Inc.

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&

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on written Assignment, Presentation, Class test, Quiz, Essay, Exhibition etc. as per NEP revised guidelines.

Program/Class: B.Sc.	Year: Third	Semester: Sixth
Subject: STATISTICS		
Paper Code: 0620602	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, 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): 4-0-0.

Unit	Topics	No. of Lectures
I	History & background of OR, Applications and uses of OR in different fields, General linear programming problems and their formulations.	6
II	Solving LPP by Graphical Method Solving LPP by Simplex method.	10
III	Method Solving LPP by Big–M method and Two-phase Method.	8
IV	Transportation problem: North-west corner rule, least cost method, Vogel's approximation method. Optimum solution: Modi method.	10
V	Assignment Problem: Hungarian Method, Travelling Salesman Problem,	6
VI	Job sequencing: n jobs–2 machines, n jobs–k machines, 2jobs –n machines.	6
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.	8
VIII	Dominance rule to reduce the game matrix and solution of Payoff matrix with mixed strategy.	6

Suggested Readings:

- Gupta, R.K. (2018). Operations Research. Krishna Publication.

- Hadley, G. (2002). Linear Programming. Narosa Publications

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

- Prabhakar, P. (2013). Operations Research: Principles and Practice, Oxford University Press.

- Swarup, K.,Gupta, P.K. and Manmohan (2007). Operations Research, 13th Edn., Sultan Chand & Sons.

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

Suggested Online Links/ Readings:

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

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on written Assignment, Presentation, Class test, Quiz, Essay, Exhibition etc. as per NEP revised guidelines.

Program/Class: B.Sc.	Year: Third	Semester: Sixth
Subject: STATISTICS		
Paper Code: 0620680	Course Title: Operations Research and Statistical Computing Lab	

Course outcomes:

After completing this course, a student will have:

❖ Knowledge of mathematical formulation of L.P.P.

❖ Ability of solving LPP using different methods.

❖ Ability to solve Allocation Problems based on Transportation and Assignment models.

❖ Ability to solve problems based on Game Theory.

❖ Ability to use programming language R as Calculator.

❖ Knowledge of using R in simple data analysis.

❖ Ability to perform statistical functions, creating graphs and statistical analysis by using Excel.

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

Total No. of Lectures- Tutorials-Practical (in hours per week): 0-0-4.

Topics	No. of Lectures
1. Problems based on Mathematical formulation of L.P.P. 2. Problems based on solving LPP using Graphical Method. 3. Problems based on solving LPP using Simplex Method. 4. Problems based on solving LPP using 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 pay off matrix. 8. Problems based on solving Graphical solution to mx2 /2xn rectangular game. 9. Problems based on solving Mixed strategy game. 10. Problems based on application of R as Calculator. 11. Problems based on application of R in simple data analysis 12. Problems based on application of Excel in data analysis	60

Suggested Readings:

As suggested for Paper codes: 0620601 and 0620602.

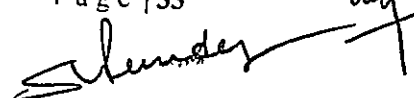**Practical Examination Evaluation Method (100 Marks):**

Practical Examination Evaluation shall be based on Practical record, Practical Exercises and Viva-voce.

Further Suggestions:

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

Programme/Class: B.Sc. (Honours)	Year: Fourth	Semester: Seventh
	Subject: STATISTICS	
Course Code: 0720601	Course Title: Population Studies	

Course Outcomes:

On successful completion of this course, the students will be able to:

❖ Understand how population trends influence various aspects of human life, such as social, cultural, political, and economic aspects.

❖ Understand the factors that influence the fertility, mortality and migration

❖ Understand the challenges and opportunities related to population growth, aging, and other demographic shifts.

Credits: 04	Core: Compulsory
Max. Marks:	Minimum Passing Marks: ....

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	Introduction to Demography, Sources of Demographic data, Limitations and uses of demographic data: Coverage and content errors in demographic data.	8
II	Use of balancing equations and Chandrasekharan-Deming formula to check the completeness of registration data, adjustment of age data- use of Whipple, Meyer and UN indices. Population composition, Age pyramid, Dependency ratio, Theory of demographic transition.	14
III	Measurement of Mortality: Crude death rate, Standardized death rates, Age-specific death rates, Infant Mortality rate, Definition, construction and uses of Life table, Complete and abridged life tables. Measurement of Fertility: Crude birth rate, General fertility rate, Age-specific birth rate, Total fertility rate, Gross reproduction rate, Net reproduction rate.	16
IV	Rate of Population Growth: Arithmetic, Geometric and Exponential growth rates, Decadal growth rate Doubling time, Models for population growth and their fitting to population data. Stochastic models for population growth. Internal migration and its measurement, Concept of international migration, Net migration, Factors affecting population migration. Stable and quasi-stable populations, Stationary population, Population projection, Methods for population projection, Component method of population projection.	22

Suggested Readings:

- Benjamin, B. (1969). Demographic Analysis. George, Allen and Unwin.

- Biswas, S. (1988). Stochastic Processes in Demography and Applications, Wiley Eastern Ltd.

- Cox, P.R (1970). Demography. Cambridge University Press.

- Keyfitz, N. (1971). Applied Mathematical Demography, Springer Verlag.

- Office of Registrar General and Census Commissioner India (Ministry of Home Affairs)

- Spiegelman, M. (1969). Introduction to Demographic Analysis, Harvard Universit
- Principles and accommodation of National Populations Census UNESCO.
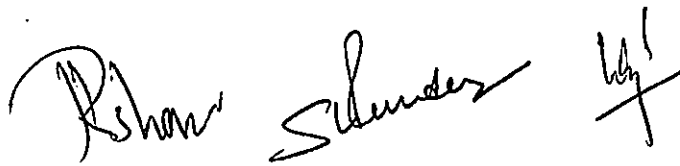
Principles and accommodation of National Populations Census UNESCO.

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on written Assignment, Presentation, Class test, Quiz, Essay, Exhibition etc. as per NEP revised guidelines.

Course Prerequisite:

To study this course, student must have passed U.G. Degree.

Programme/Class: **B.Sc. (Honours)**	Year: **Fourth**	Semester: **Seventh**
Subject: **STATISTICS**		
Course Code: **0720602**	Course Title: **Distribution Theory**	

Course Outcomes:

On successful completion of this course, students will be able to:

❖ Understand different types of distributions and their application in real-life problems.

❖ Describe the distinguishing features of various probability distributions.

❖ Work with sampling distributions (central and non-central Chi-square, t and F distributions).

Credits: 04	Core: Compulsory
Max. Marks:	
	Minimum Passing Marks: ....

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	Joint, marginal, and conditional distributions of two-dimensional and multi-dimensional random variables, Distributions of transformations of random variable.	8
II	Characterization and applications of discrete probability distributions: Binomial, Poisson, Multinomial, Hyper-geometric, Geometric, Negative binomial. Continuous probability distributions: Uniform, Normal (univariate and bivariate), Exponential (univariate and bivariate), Laplace, Cauchy, Beta, Gamma, Weibull and lognormal distributions.	20
III	Symmetric distributions, Truncated distributions, Compound distributions, Mixture distributions, Exponential family of distributions. Sampling distributions, elementary ideas of non-central distributions: non-central Chi-square, t and F distributions and their properties.	16
IV	Distributions of quadratic forms. Approximating distributions of sample moments, limiting moment generating function, Order statistics, their distribution and properties, Joint and marginal distributions of order statistics, Extreme values and their asymptotic distributions (statement only) with applications.	16

Suggested Readings:

- Edn., The World Press, Kolkata.

- Goon A.M., Gupta, M.K. and Gupta, B.D. (2002). Fundamentals of Statistics, Vol. I & II, 8th

- Goon, A.M., Gupta, M.K. and Gupta, B.D. (2011). Fundamentals of Statistics, Vol. I. The World Press, Kolkata.

- Hogg, R.V., Tanis, E.A. and Rao, J.M. (2009). Probability and Statistical Inference, 7th Edn., Pearson Education, New Delhi.

- Hogg, Robert V. and Craig, A.T. (1995). Introduction to Mathematical Statistics 5th Edn., Englewood Hills, New Jersey.

- Johnson, Norman L., K. Samuel and Balakrishnan, N. (1995). Continuous Univariate Distributions. John Wiley and Sons.

- Mood, A.M., Graybill, F.A. and Boes, D.C. (1963). Introduction to the Theory of Statistics. Mc-Graw Hill Book Company, Inc., New York.

- Rohatgi, V. K. (1976). An Introduction to Probability Theory and Mathematical Statistics. Wiley, New York.

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on written Assignment, Presentation, Class test, Quiz, Essay, Exhibition etc. as per NEP revised guidelines.

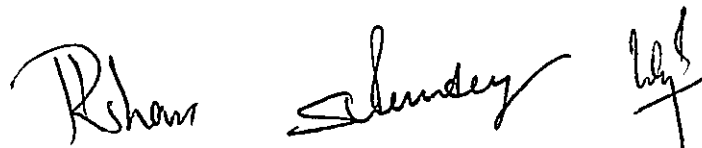| Programme/Class: B.Sc. (Honours)	Year: Fourth	Semester: Seventh
Subject: STATISTICS		

Course Code: 0720603	Course Title: Survey Sampling

Course Outcomes:

On successful completion of this course, students will be able to:

❖ Understand the distinctive features of different sampling schemes and related estimation problems.

❖ Learn about various approaches to estimate the parameters; with and without replacement sampling scheme, sampling with varying probability of selection.

❖ Learn the practical applications of the various sampling techniques in real-life situations.

Credits: 04	Core: Compulsory
Max. Marks:	Minimum Passing Marks: ....

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	Concept of population and sample, Need for sampling, Complete enumeration versus sampling, Basic concepts in sampling, Basic principles of sample surveys, Sampling and non-sampling errors, Types of sampling, Non-probability and probability samplings. Simple random sampling, Sampling from finite populations with and without replacement, Unbiased estimation and confidence intervals for population mean and total, Simple random sampling of attributes.	14
II	Stratified random sampling, Reasons for stratification, Estimation of population mean and its variance, Construction of strata, Proportional and optimum allocation, Variances of estimates under different allocations, Comparison with simple random sampling for fixed sample size, Systematic Sampling (when population size (N) is an integral multiple of sampling size (n), Estimation of population mean and variance of this estimate, Comparison with simple random sampling.	18
III	Ratio, product and regression methods of estimation, Estimation of population mean, Evaluation of bias and variance to the first order of approximation, and Comparison with simple random sampling.	10
IV	Cluster Sampling, Estimates of mean and its variance for equal and unequal clusters, Efficiency in terms of the intra-class correlation coefficient. Concept of multistage sampling and its application, Two-stage sampling with equal number of second stage units, Estimation of population mean and total, Double sampling for stratification, Sampling with probability proportional to size (with and without replacement method), Des Raj estimator, Horvitz-Thomson's estimator, Mid-ZunoSen sampling scheme.	18

Suggested Readings:

- Cochran, William G. (1977). Sampling Techniques, 3rd Edition. John Wiley and Sons.
- Des Raj and P. Chandhok (1998). Sample Survey Theory. Narosa Publishing House.
- Mukhopadhyay, Parimal (2008). Theory and Methods of Survey Sampling. PHI Learning Pvt. Ltd.
- Murthy, M.N. (1977). Sampling Theory and Methods. Statistical Publishing Society,Calcutta.
- Sampat, S. (2001). Sampling Theory and Methods. Narosa Publishing House.
- Singh, Daroga, and Chaudhary, F.S. (1986). Theory and Analysis of Sample Survey Designs. John Wiley and Sons.
- Sukhatma, P.V.and Sukhatme, B.V. (1970). Sampling Theory with Applications, 2nd Edition. Iowa State University Press.

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on written Assignment, Presentation, Class test, Quiz, Essay, Exhibition etc. as per NEP revised guidelines.

Programme/Class: B.Sc. (Honours)	Year: Fourth	Semester: Seventh
Subject: STATISTICS		
Course Code: 0720604	Course Title: Programming with R	

Course Outcomes:

On successful completion of this course, students will be able to:

❖ Effectively visualize and summarize the data using R-language.

❖ Carry out data analysis using R-language

❖ Interpret the results of statistical analysis.

Credits: 04	Core: Compulsory
Max. Marks:	
	Minimum Passing Marks: ....

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	Introduction to R, Advantages of R over other programming languages, R Studio: R Command prompt, R Script file, comments, handling packages in R, Installing an R package, R Data types: Vectors, Lists, Matrices, Arrays, Factors, Data frame, R variables, Variable assignment, Data types of variable, Finding variable ls(), Deleting variables, R Operators: Arithmetic operators, Relational operators, Logical operator, Assignment operators, Miscellaneous operators.	16
II	R Decision making: if statement, if – else statement, if – else if statement, switch statement, R loops: repeat loop, while loop, for loop, Loop control statement: break statement, next statement, Loading and handling Data in R: Getting and setting the working directory – getwd(), setwd(), dir(), R-CSV Files - Input as a CSV file, Reading a CSV File, Analyzing the CSV File: summary(), min(), max(), range(), mean(), median(), apply() - Writing into a CSV File, R -Excel file, Reading the excel file.	16
III	Data visualization using R (both two and three dimensions); Tables, charts and plots. Visualising Measures of Central Tendency, Variation, and Shape. Histogram, Boxplot, Scatter plot, Pareto diagrams, pie chart, stem and leaf display.	12
IV	Statistical computing with R: Univariate and Multivariate statistics; Mean, Median, Variance, Covariance, Correlation, Linear regression. One and two sample t-tests, Analysis of Variance (ANOVA), Chi-square tests: goodness of fit, Contingency tables, Non-parametric tests, Distribution functions in R.	16

Suggested Readings:

- Alain F. Zuur, Ieno, E.N. and Meesters, E. (2009). A Beginner's Guide to R. Springer.

- Braun W. J. and Murdoch, D.J (2007). A First Course in Statistical Programming with R. Cambridge University Press, New York.
- Chambers, John M. (2008). Software for Data Analysis: Programming with R, Vol. 2. New York: Springer.
- Dalgaard, Peter (2020). Introductory Statistics with R. Springer.
- Gardener, M. (2012). Beginning R: The Statistical Programming Language, Wiley Publications.
- Maria L. Rizzo (2008). Statistical Computing with R. Chapman and Hall/CRC, Boca Raton, FL.
- Michael J. Crawley (2005). Statistics: An Introduction using R. Wiley.
- Sandip Rakshit (2017). R Programming for Beginners. McGraw Hill Education India.
- Seema Acharya (2018). Data Analytics using R. McGraw Hill Education, India.

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on written Assignment, Presentation, Class test, Quiz, Essay, Exhibition etc. as per NEP revised guidelines.

Programme/Class: B.Sc. (Honours)	Year: Fourth	Semester: Seventh
Subject: STATISTICS		

Course Code: 0720680	Course Title: Practical Lab

Course Outcomes:

On successful completion of this course, students will be able to:

❖ Learn the practical knowledge of the model fitting approach.

❖ Solve real life problems with the knowledge of R-Software.

❖ Learn the practical knowledge of sampling through R-Software.

Credits: 04	Core: Compulsory
Max. Marks: …..	Minimum Passing Marks: ….

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-4

Topics	No. of Lectures
1. Problems based on fitting of Distributions e.g., Binomial, Poisson, Normal etc. 2. Problems based on Simple random sampling. 3. Problems based on Stratified random sampling. 4. Problems based on Ratio and regression methods of estimation. 5. Problems on data analysis with R.	60

Suggested Readings:

As suggested for Paper codes: 0720602, 0720603 and 0720604.

Practical Examination Evaluation Method (100 Marks):

Practical Examination Evaluation shall be based on Practical record, Practical Exercises and Viva-voce.

Further Suggestions:

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

Programme/Class: B.Sc. (Honours)	Year: Fourth	Semester: Eight
Subject: STATISTICS		
Course Code: 0820601	Course Title: Probability Theory	

Course Outcomes:

On successful completion of this course, students will be able to:

❖ To work with probability measures, random variables and their distributions in an abstract framework.

❖ Prove and apply the convergence of a sequence of random variables.

❖ Understand the concept of independence of random variables, weak and strong laws of large numbers and central limit theorem.

Credits: 04	Core: Compulsory
Max. Marks:	Minimum Passing Marks: ....

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	Classes of Sets, Fields, Sigma-Fields, Minimal Sigma Field, Borel Sigma Field, Sequence of Sets, LimsupandLiminf of Sequence of Sets, Measure, Properties of a measure, Probability Measure, Random experiment, Outcomes, Sample space, Events, Various definitions of probability, Laws of total and compound probability, Boole's inequality, Conditional probability, Independence of events, Bayes Theorem.	16
II	Random variable, Probability mass function (pmf), Probability density function (pdf), Cumulative distribution function (cdf), Expectation of a random variable, Properties of expectation, Moment generating function, Probability generating function, Characteristic function and its properties, Uniqueness theorem, Levy's continuity theorem.	15
III	Markov's, Chebychev's, Kolmogorov's, Minkowski's and Jenson's inequalities. Different modes of convergence (convergence in distribution, in probability, almost surely, and r^{th} mean) and their interrelations. Borel-Cantelli lemma and Borel 0-1 law.	10
IV	Weak law of large numbers (WLLN), Kolmogorov strong law of large numbers, Liapounoff's Central limit theorem for a sequence of independent random variables, Central limit theorem for independently and identically distributed random variables.	19

Suggested Readings:

- Ash, Robert B. (2000). Probability and Measure Theory. Academic Press.

- Bhat, B. R. (2014). Modern Probability Theory. Wiley Eastern Limited.

- Hogg, R.V., J. McKean, and A.T. Craig(2013). Introduction to Mathematical Statistics, 7th Edition. Pearson.

- Mood, A. M., F. A. Graybill, and D. C. Boes (1963). Introduction to the Theory of Statistics. McGraw Hill Book Company, Inc., New York.

- Mukhopadhyay, Parimal (2012). Theory of Probability. New Central Book Agency.

- Pittman, J. (1993). Probability. Narosa Publishing House.

- Rohatgi, V. K. (1976). An Introduction to Probability Theory and Mathematical Statistics. Wiley, New York.

- Ross, Sheldon M. (2014). Introduction to Probability Models. Academic Press.

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on written Assignment, Presentation, Class test, Quiz, Essay, Exhibition etc. as per NEP revised guidelines.

Programme/Class: B.Sc. (Honours)	Year: Fourth	Semester: Eight
Subject: STATISTICS		
Course Code: 0820602	Course Title: Statistical Inference-I	

Course Outcomes:

On successful completion of this course the students will be able to:

❖ Understand the various estimation and testing procedures to deal with real-life problems.

❖ Learn about the Fisher Information, lower bounds to variance of estimators, and MVUE.

❖ Understand the concept of the Neyman-Pearson fundamental lemma and UMP test.

Credits: 04	Core: Compulsory
Max. Marks:	Minimum Passing Marks: ....

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	Characteristics of a good estimator, Consistency, Unbiasedness, Efficiency, Sufficiency and Completeness, Sufficiency when the range of variate depends on the parameter, Characterization of distribution admitting sufficient statistics, Factorization theorem.	12
II	Minimum variance bound (MVB) estimator, Cramer-Rao Inequality, Extension of Cramer-Rao inequality for multi-parameter case, Bhattacharya bounds, Rao-Blackwell theorem, Lehman-Scheffe's theorem, Uniformly Minimum Variance Unbiased Estimator (UMVUE).	16
III	Estimation methods of Maximum likelihood, Minimum chi-square, Moment and Least squares. Optimal properties of maximum likelihood estimator, Existence of a Best Asymptotically Normal (BAN) estimate, Hazoor Bazar's theorem.	12
IV	Null, alternative, simple and composite hypotheses, Concept of Critical Region, Critical function, Two-type of Errors, Power of a Test, Level of Significance, p-value, Neyman-Pearson Lemma and its Generalization, Uniformly Most Powerful (UMP) Test, UMP tests for simple null hypothesis against one-sided alternatives and for one-sided null against one-sided alternatives in one parameter exponential family. Extension of these results to distributions with Monotone Likelihood Ratio (MLR) property, Randomized Tests, Uniformly Most Powerful unbiased (UMPU) test, Types A, A₁ Critical Regions, Likelihood Ratio Test.	20

Suggested Readings:

- Bartoszynski, R. and Bugaj, M.N. (2007). Probability and Statistical Inference. John Wiley and Sons.

- Dudewitz, E.J. and Mishra, S.N. (1988). Modern Mathematical Statistics. John Wiley.

- Ferguson, T.S. (1967). Mathematical Statistics. Academic Press.

- Gupta, S.C. and Kapoor, V.K. (2000). Fundamentals of Mathematical Statistics, 10th Edition. Sultan Chand and Sons.
- Kale, B.K. (1999). A First Course on Parametric Inference. Narosa Publishing House.
- Lehman, E.L (1988). Theory of point estimation. John Wiley.
- Lehmann, E.L. (1986). Testing Statistical Hypotheses. Student Editions.
- Rao, C.R. (1973). Linear Statistical Inference and its Applications. Wiley Eastern.
- Rohatgi, V.K. (1988). An Introduction to Probability and Mathematical Statistics. Wiley Eastern, New Delhi.
- Zacks, S. (1971). Theory of Statistical Inference. Wiley, New York.

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on written Assignment, Presentation, Class test, Quiz, Essay, Exhibition etc. as per NEP revised guidelines.

Programme/Class: B.Sc. (Honours)	Year: Fourth	Semester: Eight
Subject: STATISTICS		
Course Code: 0820603	Course Title: Linear Models and Experimental Designs	

Course Outcomes:

On successful completion of this course the students will be able to

❖ Understand the concepts of linear estimation.

❖ Know about the theory and applications of ANOVA, ANCOVA.

❖ Apply and analyse various forms of Designs i.e., CRD, RBD, LSD etc. to various fields of applications.

Credits: 04	Core: Compulsory
Max. Marks:	Minimum Passing Marks: ....

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	Gauss-Markov linear models, Estimable functions, Error and estimation space, Normal equations and least square estimators, Properties of least square estimators, Generalized inverse of a matrix and solution of normal equations, Variances and covariances of least square estimators, Best linear unbiased estimator (BLUE).	16
II	One-way and two-way classifications, fixed, random and mixed effects models. Analysis of variance for one-way and two-way classifications, Analysis of Covariance for a one-way layout with concomitant variable.	14
III	The basic principle of experimental design (Randomization, Replication and Local control), Complete analysis and layout of completely randomized design (CRD), Randomized block design (RBD) and Latin square design (LSD), and Missing plot technique.	14
IV	Factorial experiments (2^n, 3^2, 3^3), Complete and Partial, and balanced confounding, Incomplete block designs, Balanced Incomplete Block Designs (BIBD) with parametric relations and analysis under a fixed effect model, Split Plot Design and Strip Plot Design.	16

Suggested Readings:

- Bapot, R.B. Linear Algebra and Linear Model. Cambridge University Press.

- Cochran W.G. and Cox, G.M. (1959). Experimental Design. Asia Publishing House.

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

- Federer, W.T. (1955). Experimental Design: Theory and Applications. Oxford and IBH (P) Ltd., New Delhi.

- John, P.W.M. (1971). Statistical Design and Analysis of Experiments. Macmillan Co., New York.

- Joshi, D.D. (1987). Linear Estimation and Design of Experiments. John Wiley.

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

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

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on written Assignment, Presentation, Class test, Quiz, Essay, Exhibition etc. as per NEP revised guidelines.

Programme/Class: B.Sc. (Honours)	Year: Fourth	Semester: Eight
Subject: STATISTICS		
Course Code: 0820604	Course Title: Statistical Quality Control and Reliability Theory	

Course Outcomes:

On successful completion of this course the students will be able to:

❖ Understand the techniques of Statistical Quality control and application of these techniques to improve the quality of production.

❖ Apply reliability tools to improve the system's reliability.

Credits: 04	Core: Compulsory
Max. Marks:	Minimum Passing Marks: ....

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	Statistical process and product control, Quality of a product, Need for quality control, Basic concept of process control, Process capability and Product control, General theory of control charts, Causes of variation in quality, Control limits, Charts for variables: R, $(\bar{X}, R)$, $(\bar{X}, \sigma)$charts., Charts for attributes: p-chart, np-chart, C-chart.	12
II	Sampling inspection v/s 100% inspection. Introduction to acceptance sampling, Rejection and Rectification types, Consumer's risk, Producer's risk, Acceptance sampling plans for attributes: Single, Double, Multiple and Sequential sampling plans and their properties, OC, AOQL, ASN and ATI curves.	12
III	Reliability, its concept and measures, Components and systems, Reliability function, Failure rate, Hazard rate, Hazard models, Bath-tub failure rate curve, Reliability estimation with complete and censored sample, Lifetime distributions: Exponential, Weibull, Gamma, Normal, Bivariate exponential distributions. Estimation of parameters and tests in these models.	18
IV	System configurations: Series, Parallel, Parallel-series, Series-parallel, Mixed, K-out of- n and related configurations. Mean time to system failure (MTSF) and mean time between failures, Concept of redundancy, different types of redundancy and its use in reliability improvement. Analysis of reliability and MTSF of n-unit standby redundancy, Analysis of non-identical unit series system with constant failure and repair rates, two identical unit active and passive redundant systems with constant failure and repair rates.	18

Suggested Readings:

• Balagurusamy, E. (1984). Reliability Engineering. Tata McGraw Hill Publishing Company Ltd, New Delhi.

• Barlow R.F. and F. Proschan (1965). Mathematical Theory of Reliability. John Wiley, New York.

- Goon, A.M., M.K. Gupta and B. Das Gupta (2002). Fundamentals of Statistics, Vol. 1 and 2. The World Press, Kolkata.
- Lawless, J.F. (2003). Statistical Models and Methods for Life Data. Wiley.
- Marshall, A.W. and Olkin, I. (2007). Life Distributions. Springer.
- Montgomery, D.C. (2009). Introduction to Statistical Quality Control. Wiley India Pvt. Ltd.
- Sinha, S.K. (1986). Reliability and Life Testing. Wiley Eastern.

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on written Assignment, Presentation, Class test, Quiz, Essay, Exhibition etc. as per NEP revised guidelines.

Programme/Class: B.Sc. (Honours)	Year: Fourth	Semester: Eight
Subject: STATISTICS		
Course Code: 0820680	Course Title: Practical Lab	

Course Outcomes:

On successful completion of this course, students will be able to:

❖ Solve day to day problems with knowledge of Statistical Inference.

❖ Learn the application of Design of experiments in real life scenario.

❖ Learn the application of Control charts.

Credits: 04	Core: Compulsory	
Max. Marks:		
	Minimum Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-4		

	Topics	No. of Lectures
	1. Problems on Estimation of Parameters.	
	2. Problems based on Testing of Hypothesis.	
	3. Problems based on One-way and Two-way ANOVA.	
	4. Problems based on CRD, RBD and LSD.	60
	5. Problems based on Factorial Experiments.	
	6. Problems based on Control charts.	

Suggested Readings:

As suggested for Paper codes: 0820602, 0820603 and 0820604.

Practical Examination Evaluation Method (100 Marks):

Practical Examination Evaluation shall be based on Practical record, Practical Exercises and Viva-voce.

Further Suggestions:

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

Programme/Class: B.Sc. (Honours with Research)	Year: Fourth	Semester: Seventh
Subject: STATISTICS		
Course Code: 0720601	Course Title: Population Studies	

Course Outcomes:

On successful completion of this course, the students will be able to:

❖ Understand how population trends influence various aspects of human life, such as social, cultural, political, and economic aspects.

❖ Understand the factors that influence the fertility, mortality and migration

❖ Understand the challenges and opportunities related to population growth, aging, and other demographic shifts.

Credits: 04	Core: Compulsory
Max. Marks:	Minimum Passing Marks: ....

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	Introduction to Demography, Sources of Demographic data, Limitations and uses of demographic data: Coverage and content errors in demographic data.	8
II	Use of balancing equations and Chandrasekharan-Deming formula to check the completeness of registration data, adjustment of age data- use of Whipple, Meyer and UN indices. Population composition, Age pyramid, Dependency ratio, Theory of demographic transition.	14
III	Measurement of Mortality: Crude death rate, Standardized death rates, Age-specific death rates, Infant Mortality rate, Definition, construction and uses of Life table, Complete and abridged life tables. Measurement of Fertility: Crude birth rate, General fertility rate, Age-specific birth rate, Total fertility rate, Gross reproduction rate, Net reproduction rate.	16
IV	Rate of Population Growth: Arithmetic, Geometric and Exponential growth rates, Decadal growth rate Doubling time, Models for population growth and their fitting to population data. Stochastic models for population growth. Internal migration and its measurement, Concept of international migration, Net migration, Factors affecting population migration. Stable and quasi-stable populations, Stationary population, Population projection, Methods for population projection, Component method of population projection.	22

Suggested Readings:

- Benjamin, B. (1969). Demographic Analysis. George, Allen and Unwin.

- Biswas, S. (1988). Stochastic Processes in Demography and Applications, Wiley Eastern Ltd.

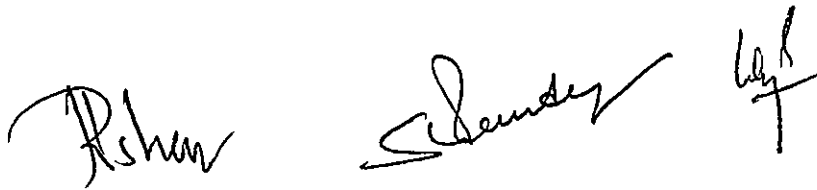- Cox, P.R (1970). Demography. Cambridge University Press.

- Keyfitz, N. (1971). Applied Mathematical Demography, Springer Verlag.
- Office of Registrar General and Census Commissioner India (Ministry of Home Affairs)
- Principles and accommodation of National Populations Census UNESCO.
- Spiegelman, M. (1969). Introduction to Demographic Analysis, Harvard University

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on written Assignment, Presentation, Class test, Quiz, Essay, Exhibition etc. as per NEP revised guidelines.

Course Prerequisite:

To study this course, student must have passed U.G. Degree with 75% marks.

Programme/Class: B.Sc. (Honours with Research)	Year: Fourth	Semester: Seventh
Subject: STATISTICS		

Course Code: 0720602	Course Title: Distribution Theory

Course Outcomes:

On successful completion of this course, students will be able to:

❖ Understand different types of distributions and their application in real-life problems.

❖ Describe the distinguishing features of various probability distributions.

❖ Work with sampling distributions (central and non-central Chi-square, t and F distributions).

Credits: 04	Core: Compulsory
Max. Marks:	Minimum Passing Marks: ....

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	Joint, marginal, and conditional distributions of two-dimensional and multi-dimensional random variables, Distributions of transformations of random variable.	8
II	Characterization and applications of discrete probability distributions: Binomial, Poisson, Multinomial, Hyper-geometric, Geometric, Negative binomial. Continuous probability distributions: Uniform, Normal (univariate and bivariate), Exponential (univariate and bivariate), Laplace, Cauchy, Beta, Gamma, Weibull and lognormal distributions.	20
III	Symmetric distributions, Truncated distributions, Compound distributions, Mixture distributions, Exponential family of distributions. Sampling distributions, elementary ideas of non-central distributions: non-central Chi-square, t and F distributions and their properties.	16
IV	Distributions of quadratic forms. Approximating distributions of sample moments, limiting moment generating function, Order statistics, their distribution and properties, Joint and marginal distributions of order statistics, Extreme values and their asymptotic distributions (statement only) with applications.	16

Suggested Readings:

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

- Goon, A.M., Gupta, M.K. and Gupta, B.D. (2011). Fundamentals of Statistics, Vol. I. The World Press, Kolkata.

- Hogg, R.V., Tanis, E.A. and Rao, J.M. (2009). Probability and Statistical Inference, 7th Edn., Pearson Education, New Delhi.

- Hogg, Robert V. and Craig, A.T. (1995). Introduction to Mathematical Statistics 5th Edn., Englewood Hills, New Jersey.

- Johnson, Norman L., K. Samuel and Balakrishnan, N. (1995). Continuous Univariate Distributions. John Wiley and Sons.

- Mood, A.M., Graybill, F.A. and Boes, D.C. (1963). Introduction to the Theory of Statistics. Mc-Graw Hill Book Company, Inc., New York.

- Rohatgi, V. K. (1976). An Introduction to Probability Theory and Mathematical Statistics. Wiley, New York.

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on written Assignment, Presentation, Class test, Quiz, Essay, Exhibition etc. as per NEP revised guidelines.

Programme/Class: **B.Sc. (Honours with Research)**	Year: **Fourth**	Semester: **Seventh**
Subject: **STATISTICS**		
Course Code: **0720603**	Course Title: **Survey Sampling**	

Course Outcomes:

On successful completion of this course, students will be able to:

❖ Understand the distinctive features of different sampling schemes and related estimation problems.

❖ Learn about various approaches to estimate the parameters; with and without replacement sampling scheme, sampling with varying probability of selection.

❖ Learn the practical applications of the various sampling techniques in real-life situations.

Credits: 04	Core: Compulsory
Max. Marks:	Minimum Passing Marks: ....

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

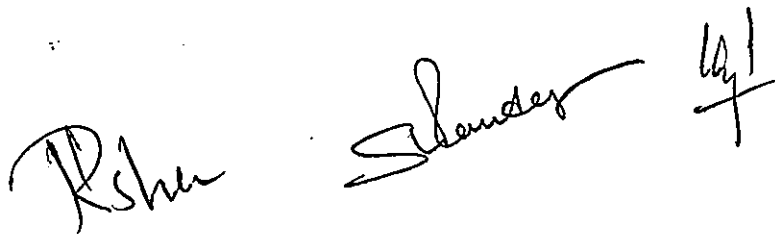| Unit	Topics	No. of Lectures
I	Concept of population and sample, Need for sampling, Complete enumeration versus sampling, Basic concepts in sampling, Basic principles of sample surveys, Sampling and non-sampling errors, Types of sampling, Non-probability and probability samplings. Simple random sampling, Sampling from finite populations with and without replacement, Unbiased estimation and confidence intervals for population mean and total, Simple random sampling of attributes.	14
II	Stratified random sampling, Reasons for stratification, Estimation of population mean and its variance, Construction of strata, Proportional and optimum allocation, Variances of estimates under different allocations, Comparison with simple random sampling for fixed sample size, Systematic Sampling (when population size (N) is an integral multiple of sampling size (n), Estimation of population mean and variance of this estimate, Comparison with simple random sampling.	18
III	Ratio, product and regression methods of estimation, Estimation of population mean, Evaluation of bias and variance to the first order of approximation, and Comparison with simple random sampling.	10
IV	Cluster Sampling, Estimates of mean and its variance for equal and unequal clusters, Efficiency in terms of the intra-class correlation coefficient. Concept of multistage sampling and its application, Two-stage sampling with equal number of second stage units, Estimation of population mean and total, Double sampling for stratification, Sampling with probability proportional to size (with and without replacement method), Des Raj estimator, Horvitz-Thomson's estimator, Mid-ZunoSen sampling scheme.	18

Suggested Readings:

- Cochran, William G. (1977). Sampling Techniques, 3rd Edition. John Wiley and Sons.
- Des Raj and P. Chandhok (1998). Sample Survey Theory. Narosa Publishing House.
- Mukhopadhyay, Parimal (2008). Theory and Methods of Survey Sampling. PHI Learning Pvt. Ltd.
- Murthy, M.N. (1977). Sampling Theory and Methods. Statistical Publishing Society, Calcutta.
- Sampat, S. (2001). Sampling Theory and Methods. Narosa Publishing House.
- Singh, Daroga, and Chaudhary, F.S. (1986). Theory and Analysis of Sample Survey Designs. John Wiley and Sons.
- Sukhatma, P.V.and Sukhatme, B.V. (1970). Sampling Theory with Applications, 2nd Edition. Iowa State University Press.

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on written Assignment, Presentation, Class test, Quiz, Essay, Exhibition etc. as per NEP revised guidelines.

Programme/Class: B.Sc. (Honours with Research)	Year: Fourth	Semester: Seventh
Subject: **STATISTICS**		

Course Code: 0720680	Course Title: Practical Lab

Course Outcomes:

On successful completion of this course, students will be able to:

- ❖ Learn the practical knowledge of the model fitting approach.
- ❖ Solve real life problems with the knowledge of R-Software.
- ❖ Learn the practical knowledge of sampling through R-Software.

Credits: 04	Core: Compulsory
Max. Marks:	
	Minimum Passing Marks: ....

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-4

Topics	No. of Lectures
1. Problems based on fitting of Distributions e.g., Binomial, Poisson, Normal etc. 2. Problems based on Simple random sampling. 3. Problems based on Stratified random sampling. 4. Problems based on Ratio method of estimation. 5. Problems based on Regression method of estimation.	60

Suggested Readings:

As suggested for Paper codes: 0720602 and 0720603.

Practical Examination Evaluation Method (100 Marks):

Practical Examination Evaluation shall be based on Practical record, Practical Exercises and Viva-voce.

Further Suggestions:

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

Programme/Class: B.Sc. (Honours with Research)	Year: Fourth	Semester: Eight
Subject: STATISTICS		
Course Code: 0820601	Course Title: Probability Theory	

Course Outcomes:

On successful completion of this course, students will be able to:

❖ To work with probability measures, random variables and their distributions in an abstract framework.

❖ Prove and apply the convergence of a sequence of random variables.

❖ Understand the concept of independence of random variables, weak and strong laws of large numbers and central limit theorem.

Credits: 04	Core: Compulsory
Max. Marks:	Minimum Passing Marks: ....

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	Classes of Sets, Fields, Sigma-Fields, Minimal Sigma Field, Borel Sigma Field, Sequence of Sets, LimsupandLiminf of Sequence of Sets, Measure, Properties of a measure, Probability Measure, Random experiment, Outcomes, Sample space, Events, Various definitions of probability, Laws of total and compound probability, Boole's inequality, Conditional probability, Independence of events, Bayes Theorem.	16
II	Random variable, Probability mass function (pmf), Probability density function (pdf), Cumulative distribution function (cdf), Expectation of a random variable, Properties of expectation, Moment generating function, Probability generating function, Characteristic function and its properties, Uniqueness theorem, Levy's continuity theorem.	15
III	Markov's, Chebychev's, Kolmogorov's, Minkowski's and Jenson's inequalities. Different modes of convergence (convergence in distribution, in probability, almost surely, and r^{th} mean) and their interrelations. Borel-Cantelli lemma and Borel 0-1 law.	10
IV	Weak law of large numbers (WLLN), Kolmogorov strong law of large numbers, Liapounoff's Central limit theorem for a sequence of independent random variables, Central limit theorem for independently and identically distributed random variables.	19

Suggested Readings:

- Ash, Robert B. (2000). Probability and Measure Theory. Academic Press.
- Bhat, B. R. (2014). Modern Probability Theory. Wiley Eastern Limited.
- Hogg, R.V., J. McKean, and A.T. Craig(2013). Introduction to Mathematical Statistics, 7th Edition. Pearson.

- Mood, A. M., F. A. Graybill, and D. C. Boes (1963). Introduction to the Theory of Statistics. McGraw Hill Book Company, Inc., New York.
- Mukhopadhyay, Parimal (2012). Theory of Probability. New Central Book Agency.
- Pittman, J. (1993). Probability. Narosa Publishing House.
- Rohatgi, V. K. (1976). An Introduction to Probability Theory and Mathematical Statistics. Wiley, New York.
- Ross, Sheldon M. (2014). Introduction to Probability Models. Academic Press.

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on written Assignment, Presentation, Class test, Quiz, Essay, Exhibition etc. as per NEP revised guidelines.

Maa Shakumbhari University

Programme/Class: B.Sc. (Honours with Research)	Year: Fourth	Semester: Eight
Subject: STATISTICS		
Course Code: 0820602	Course Title: Statistical Inference-I	

Course Outcomes:

On successful completion of this course the students will be able to:

❖ Understand the various estimation and testing procedures to deal with real-life problems.

❖ Learn about the Fisher Information, lower bounds to variance of estimators, and MVUE.

❖ Understand the concept of the Neyman-Pearson fundamental lemma and UMP test.

Credits: 04		
Max. Marks:	Core: Compulsory	
	Minimum Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0		

Unit	Topics	No. of Lectures
I	Characteristics of a good estimator, Consistency, Unbiasedness, Efficiency, Sufficiency and Completeness, Sufficiency when the range of variate depends on the parameter, Characterization of distribution admitting sufficient statistics, Factorization theorem.	12
II	Minimum variance bound (MVB) estimator, Cramer-Rao Inequality, Extension of Cramer-Rao inequality for multi-parameter case, Bhattacharya bounds, Rao-Blackwell theorem, Lehman-Scheffe's theorem, Uniformly Minimum Variance Unbiased Estimator (UMVUE).	16
III	Estimation methods of Maximum likelihood, Minimum chi-square, Moment and Least squares. Optimal properties of maximum likelihood estimator, Existence of a Best Asymptotically Normal (BAN) estimate, Hazoor Bazar's theorem.	12
IV	Null, alternative, simple and composite hypotheses, Concept of Critical Region, Critical function, Two-type of Errors, Power of a Test, Level of Significance, p-value, Neyman-Pearson Lemma and its Generalization, Uniformly Most Powerful (UMP) Test, UMP tests for simple null hypothesis against one-sided alternatives and for one-sided null against one-sided alternatives in one parameter exponential family. Extension of these results to distributions with Monotone Likelihood Ratio (MLR) property, Randomized Tests, Uniformly Most Powerful unbiased (UMPU) test, Types A, A₁ Critical Regions, Likelihood Ratio Test.	20

Suggested Readings:

- Bartoszynski, R. and Bugaj, M.N. (2007). Probability and Statistical Inference. John Wiley and Sons.

- Dudewitz, E.J. and Mishra, S.N. (1988). Modern Mathematical Statistics. John Wiley.

- Ferguson, T.S. (1967). Mathematical Statistics. Academic Press.

- Gupta, S.C. and Kapoor, V.K. (2000). Fundamentals of Mathematical Statistics, 10th Edition. Sultan Chand and Sons.
- Kale, B.K. (1999). A First Course on Parametric Inference. Narosa Publishing House.
- Lehman, E.L (1988). Theory of point estimation. John Wiley.
- Lehmann, E.L. (1986). Testing Statistical Hypotheses. Student Editions.
- Rao, C.R. (1973). Linear Statistical Inference and its Applications. Wiley Eastern.
- Rohatgi, V.K. (1988). An Introduction to Probability and Mathematical Statistics. Wiley Eastern, New Delhi.
- Zacks, S. (1971). Theory of Statistical Inference. Wiley, New York.

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on written Assignment, Presentation, Class test, Quiz, Essay, Exhibition etc. as per NEP revised guidelines.

Programme/Class: B.Sc. (Honours with Research)		Year: Fourth	Semester: Eight
Subject: STATISTICS			
Course Code: 0820603	Course Title: Linear Models and Experimental Designs		

Course Outcomes:

On successful completion of this course the students will be able to

❖ Understand the concepts of linear estimation.

❖ Know about the theory and applications of ANOVA, ANCOVA.

❖ Apply and analyse various forms of Designs i.e., CRD, RBD, LSD etc. to various fields of applications.

Credits: 04	Core: Compulsory
Max. Marks:	Minimum Passing Marks: ....

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	Gauss-Markov linear models, Estimable functions, Error and estimation space, Normal equations and least square estimators, Properties of least square estimators, Generalized inverse of a matrix and solution of normal equations, Variances and covariances of least square estimators, Best linear unbiased estimator (BLUE).	16
II	One-way and two-way classifications, fixed, random and mixed effects models. Analysis of variance for one-way and two-way classifications, Analysis of Covariance for a one-way layout with concomitant variable.	14
III	The basic principle of experimental design (Randomization, Replication and Local control), Complete analysis and layout of completely randomized design (CRD), Randomized block design (RBD) and Latin square design (LSD), and Missing plot technique.	14
IV	Factorial experiments (2^n, 3^2, 3^3), Complete and Partial, and balanced confounding, Incomplete block designs, Balanced Incomplete Block Designs (BIBD) with parametric relations and analysis under a fixed effect model, Split Plot Design and Strip Plot Design.	16

Suggested Readings:

- Bapot, R.B. Linear Algebra and Linear Model. Cambridge University Press.
- Cochran W.G. and Cox, G.M. (1959). Experimental Design. Asia Publishing House.
- Das, M.N. and Giri, N.C. (1986). Design and Analysis of Experiments, 2nd Edition. Wiley.
- Federer, W.T. (1955). Experimental Design: Theory and Applications. Oxford and IBH (P) Ltd., New Delhi.
- John, P.W.M. (1971). Statistical Design and Analysis of Experiments. Macmillan Co., New York.
- Joshi, D.D. (1987). Linear Estimation and Design of Experiments. John Wiley.
- Kempthorne, O. (1965). The Design and Analysis of Experiments. John Wiley.
- Montgomery, D.C. (2008). Design and Analysis of Experiments. John Wiley.

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on written Assignment, Presentation, Class test, Quiz, Essay, Exhibition etc. as per NEP revised guidelines.

Programme/Class: B.Sc. (Honours with Research)	Year: Fourth	Semester: Eight
Subject: STATISTICS		
Course Code: 0820680	Course Title: Practical Lab	

Course Outcomes:

On successful completion of this course, students will be able to:

❖ Solve day to day problems with knowledge of Statistical Inference.

❖ Learn the application of Design of experiments in real life scenario.

Credits: 04	
Max. Marks:	Core: Compulsory
	Minimum Passing Marks: ....
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-4	

Topics	No. of Lectures
1. Problems based on fitting of Distributions. 2. Problems based on Simple random sampling. Problems based on Stratified random sampling. 3. Problems based on Ratio and regression methods of estimation. 4. Problems based on regression method of estimation. 5. Problems based on Experimental Designs e.g., CRD, RBD, LSD etc.	60

Suggested Readings:

As suggested for Paper codes: 0820602 and 0820603.

Practical Examination Evaluation Method (100 Marks):

Practical Examination Evaluation shall be based on Practical record, Practical Exercises and Viva-voce.

Further Suggestions:

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

Minor Multidisciplinary Course open to all other faculty
To be opted in First/Second Semester

Course prerequisites: To study this course, a student must have the subject Mathematics/ Elementary Mathematics in class 10th.

This course can be opted as a Minor Multidisciplinary Course open to all other faculty.

Syllabus of the Course

Program/Class: Certificate	Year: First	Semester: First
Subject: STATISTICS		
Course Code: B060103T	Course Title: Basic Statistics	

Course outcomes:

After completing this course, a student will have:

- ❖ Ability to understand concepts of collecting Primary and Secondary data.
- ❖ Knowledge of methods for summarizing data sets, including common graphical tools (such as Boxplot, Histogram etc.). Interpret histograms and boxplots.
- ❖ Ability to describe data with measures of central tendency and measures of dispersion.
- ❖ Ability to understand the concept of probability along with basic laws and axioms of probability.
- ❖ Ability to understand the terms: mutually exclusive and equally likely 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.
- ❖ Knowledge of the concepts of correlation and simple linear regression and Perform correlation and regression analysis.
- ❖ Ability to interpret results from correlation and regression

Credits: 06	Core: Minor Elective
Max. Marks: 25+75	Min. Passing Marks: ....

Part-A: Basic Statistics

Unit	Topics	No. of Lectures
I	Primary and Secondary data and their collection, Types of classification: Chronological, Geographic, Qualitative and Quantitative, Construction of frequency distributions, Cumulative frequency distribution.	18

II	Tabulation of data, preparing a table, Types of tables, Diagrammatic representation of data using various Bar diagrams, Area diagrams, Pie chart, Graphs: Histogram, Frequency Polygon, Frequency curve, Ogive.		18
III	Meaning of Measures of Central Tendency, Characteristics of a good average, Arithmetic mean, Geometric mean, Harmonic mean, Median, Mode, Partition values: Quartiles and Percentiles their properties, merits, demerits and applications of the above measures.		18
IV	Meaning of variability or dispersion, Measures of Dispersion: Range, Quartile Deviation, Variance, Mean Deviation, and Standard Deviation, coefficient of variation with their merits, demerits and applications.Concepts of Skewness and Kurtosis.		18
V	Meaning of correlation, Types of correlation, Scatter diagram, Karl-Pearson correlation coefficient with its properties, Spearman's Rank Correlation. Concept of Regression analysis, Properties of Regression lines.		18

Suggested Readings:

- Gupta, S.C. (2015). Business Statistics. Sultan Chand & Sons, New Delhi.

- Gupta, S.C. and Kapoor, V.K. (2016). Fundamentals of Mathematical Statistics. Sultan Chand & Sons, New Delhi.

- Sharma, K.K., Arun Kumar and Chaudhary, A. (2006). Statistics in Management Studies. Krishna Publication Media Pvt. Ltd., Meerut.

- Snedecor, G.W. and Cochran, W.G. (1989). Statistical Methods, Iowa State University Press, Ames, Iowa.

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation (CIE) of 25 marks shall be based on written Assignment, Presentation, Class test, Quiz, Essay, Exhibition etc. as per NEP revised guidelines.